ALTHEN SENSORS & CONTROLS

M101
Stand-Alone Linear Position Sensor

FEATURES

- Intrinsically safe for Mining to: Ex I/II M1/GD
- Non-contacting inductive technology to eliminate wear
- Travel set to customer's requirement
- High durability and reliability
- High accuracy and stability
- Sealing to IP67

M101-17n

Intrinsically safe for hazardous mining environments

Our intrinsically safe M101 LIPS® (LinearInductive Position Sensor) incorporates electronicssystem EX07 which is ATEX/IECEx approved foruse in potentially explosive gas/vapour, dustatmospheres and mining environments.

The M101 is designed for industrial andscientific feedback applications and is ideal for OEMs seeking good sensor performance forarduous applications in hazardous areas. Theunit is highly compact and space-efficient, beingresponsive along almost its entire length.

The M101, provides alinear output proportional to travel. Each unit issupplied with the output calibrated to the travelrequired by the customer, any stroke from 0-5mmto 0-800mm and with full EMC protection built in. The sensor is very robust, the body and push rodbeing made of stainless steel for long service lifeand environmental resistance.

Overall performance, repeatability and stabilityare outstanding over a wide temperature range. The sensor is easy to install with mountingoptions including M5 rod eye bearings and body-clamps. The push rod can be supplied free orcaptive, with female M5 thread, an M5 rod eye, ordome end, Captive push rods can be sprungloaded, in either direction, on sensors up to 300mm of travel. The M101 also offers a range of mechanical options, environmental sealing is toIP65 or IP67, depending on selected cable orconnector 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 M101-11

Power Supply	+5V dc nom. ± 0.5V, 10mA typ 20mA max
Output Signal	0.5-4.5 V dc ratiometric, Load: 5kΩ min.
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)
Resolution	Infinite
Noise	< 0.02% FSO
Intrinsic Safety	Ex I/II M1/GD Ex ia II C T4 Ga (Ta= -40°C to 80°C) Ex ia IIIC T135°C Da (Ta= -40°C to 80°C) Ex ia I Ma (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 (connector option/s)	Ui: 11.4 V, Ii: 0.20A, Pi: 0.51W. Ci: 1.16 µF, 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	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

M101-11	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.

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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 I/II M1/GD
Ex ia IIC T4 Ga (Ta= -40°C to 80°C)
Ex ia IIIC T135°C Da (Ta= -40°C to 80°C)
Ex ia I Ma (Ta=-40°C to 80°C)

Designates the sensor as belonging to; Groups I and II: suitable for all areas (including mining), Category M1/1 GD: can be used in areas with continuous, long or frequent periods of exposure to hazardous gas (Zones 2 to 0) and dust (Zone 20), equipment remains energised.

Gas:
Protection class ia, denotes intrinsically safe for all zones Apparatus group IIC: suitable for IIA, IIB and IIC explosive gases. Temperature class T4: maximum surface temperature under fault conditions 135°C.

Dust:
T135°C: 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 gas (X series) and dust (E series) applications, are also available.

TABLE OF OPTIONS

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

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.

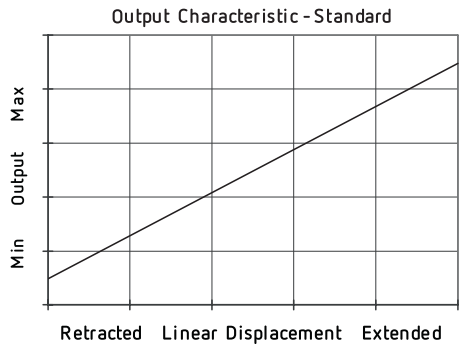
CONNECTOR/CABLE OPTIONS

Connector - Binder 713 series	Axial or Radial, IP67
Cable† with Pg 9 gland or short gland	Axial, IP67
Cable† with Pg 9 gland	Radial, IP67

†Three core (black jacket) or five core (blue jacket) cable options available. Cable length >5 0 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.



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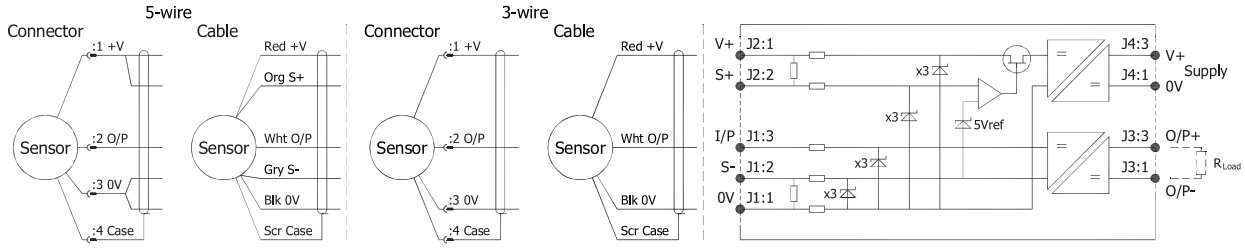
THREE OR FIVE-WIRE MODE CONNECTION FOR INTRINSICALLY SAFE SENSORS IN HAZARDOUS ATMOSPHERES

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 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 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.

We 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

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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.

The sensors are supplied with three core 0.25 mm² cable as standard, however five core 0.25 mm² cable can be supplied on request. **The galvanic isolation amplifier is available as;**

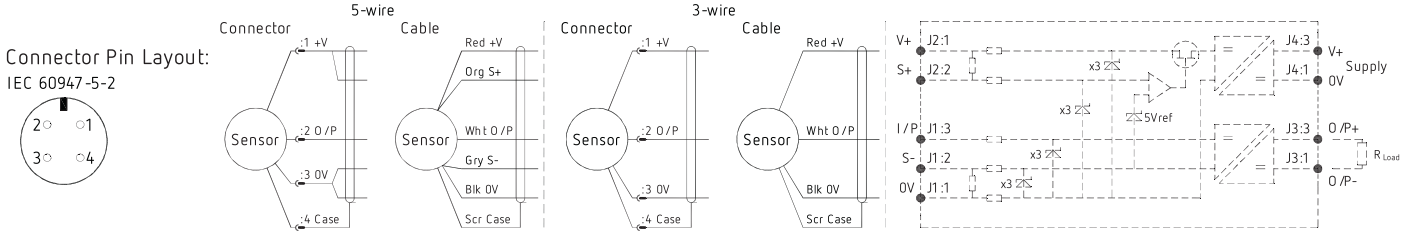
G005-* for 'G' and 'H' prefix sensors**
X005-* for 'E', 'M' and 'X' prefix sensors**

† 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.

INSTALLATION INFORMATION

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

ATEX /IECEx Qualified to Intrinsic Safety Standard Certificate numbers SIRA 13 ATEX2371X IECEx SIR 13.0154X			Ex I/II M1/1GD Ex ia IIC T4 Ga (Ta = -40°C to +80°C) Ex ia IIIC T135 °C Da (Ta = -40°C to +80°C) Ex ia I Ma (Ta = -40 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:-

Ui = 11.4V	**Ii = 0.20A**	**Pi = 0.51W**	
Ci = 1.36µF*	**Li = 860µH***	('1xx', '1Qxx', 'Lxx', 'LQxx', 'Mxx' or 'MQxx' options)	*Figures for 1km cable
Ci = 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: ≤ 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.

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!

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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.

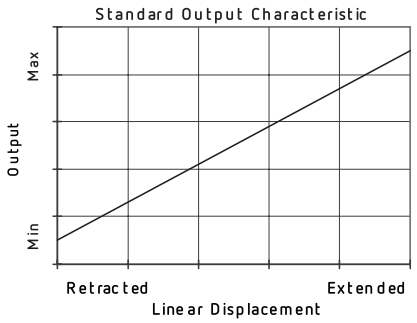
When using a Sensor that has an integral cable in a dust application, the free end of the cable shall be appropriately terminated for the zone of use. Under certain extreme circumstances, the non-metallic and isolated metal parts incorporated in the enclosure of this equipment may generate an ignition-capable 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: 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.

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 I /II M1/1GD EEx ia I /IIC T4 (Ta = -40°C to + 80°C) Ex ia D 20 T135 °C (Ta = -40°C to + 80°C)
Electronics Version	**Output Description:**	**Supply Voltage:** V_s (tolerance)	**Load resistance:**
EX04	0.5 - 4.5V (ratiometric with supply) [Output code 'A']	+ 5V (4.5 - 5.5V)	5kΩ min

The barrier parameters must not exceed:-

Ui = 11.4V **Ii = 0.20A** **Pi = 0.51W**
Ci = 1. 36µ F* **Li = 710µ H*** ('Ixx' or 'Lxx' options) *Figures for 1km cable
Ci = 1. 16 µF **Li = 50 µH** ('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.

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HOW TO ORDER

	a	b	c	d	e	f	g	h	j
M101 .	Displacement	A	Y	Connections	Option	Option	Option	Option	Z-code

a **Displacement** (mm)		Value
Displacement in mm	e.g. 0 - 254 mm	254

b **Output**		
Supply V dc V_s (tolerance)	**Output**	**Code**
+5V (4.5 - 5.5V)	0.5 - 4.5V (ratiometric with supply)	A

c **Calibration Adjustments**		Code
Sealed		Y

d **Connections** Cable* or Connector		Code
Cable Gland - Radial	IP67 Pg9 - 3-core cable	Ixx
Cable Gland - Radial	IP67 Pg9 - 5-core cable	IQxx
Connector - Axial	IP67 M12 IEC 60947-5-2	J
Connector - Radial	IP67 M12 IEC 60947-5-2	K
Cable Gland - Axial	IP67 Pg9 - 3-core cable	Lxx
Cable Gland - Axial	IP67 Pg - 5-core cable	LQxx
Cable Gland - Axial	IP67 Short - 3-core cable	Mxx
Cable Gland - Axial	IP67 Short - 5-core cable	MQxx

*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.

e **Body Fittings**		Code
None - default		blank
M5 Rod-eye Bearing	Radial body style only	N
Body Clamps - 1 pair		P
Body Clamps - 2 pairs		P2

f **Sprung Push Rod**		Code
None - default		blank
Spring Extend	Up to 300mm displacement. Captive push rod only.	R
Spring Retract		S

g **Push Rod Fittings**		Code
None - default	Female Thread M5x0.8x9 deep	blank
Dome end	Required for option 'R'	T
M5 Rod-eye Bearing		U

h Push Rod Options		Code
Captive - default	Push rod is retained	blank
Non-captive	Push rod can depart body	V

j **Z-code**	Code
Calibration to suit X005 - Default	Z000
≤± 0.1 % @20°C Independent Linearity displacement between 10mm & 400mm only!	Z650
Connector with cable option 'J', 'JQ', 'K' or 'KQ' with length required in cm i.e. J100 specifies connector with 100cm of cable.	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.

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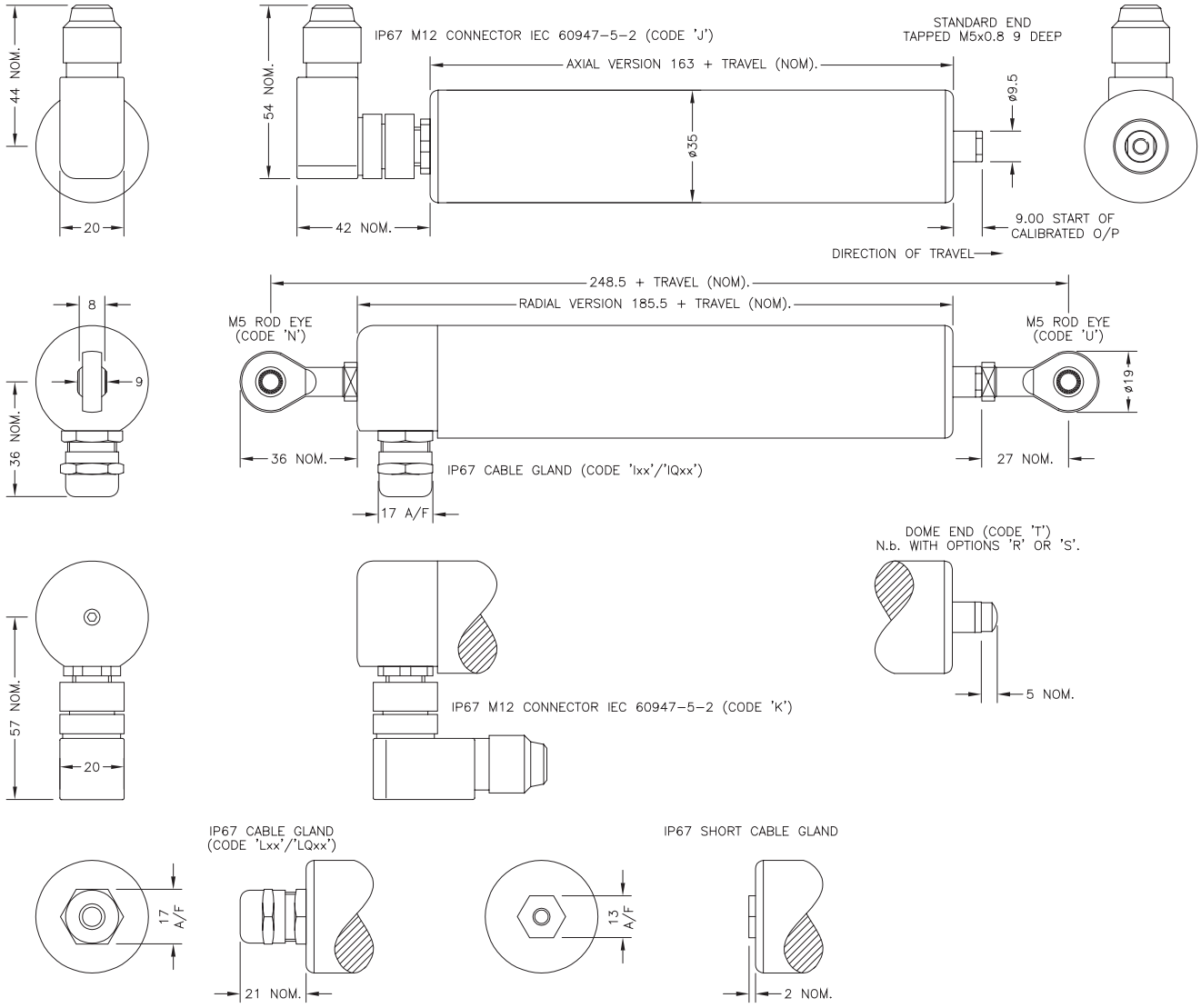
ALTHEN SENSORS & CONTROLS

M101
Stand-Alone Linear Position Sensor

N.b. ROD–EYE ORIENTATION NOT GUARANTEED.



ELECTRICAL OPTIONS/ SPECIFICATIONS

OUTPUT	SUPPLY
0.5 TO 4.5V RATIOMETRIC	5V

SUPPLY CURRENT 12mA TYP. 20mA MAX.

CABLE: 0.2mm², 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

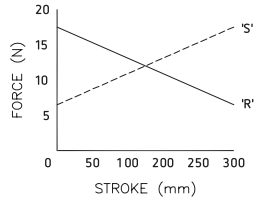
*CONNECTORS; MAXIMUM CONDUCTOR CROSS SECTION 0.75mm²

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.



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

NOTE:– READ INSTALLATION SHEET M101–19 FOR FULL INSTRUCTIONS FOR USE.

ATEX /IECEx APPROVED TO
Ex I/IIM1/1 GD
Ex ia IIC T 4 Ga (Ta= -40 to +80 C)
Ex ia IIIC T135 C Da (Ta= -40 to +80 C)
Ex ia I Ma (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!

J	OPTIONS 'R' & 'S' OVER TRAVEL DIMS MODIFIED - RAN1030.	PDM
K	RANGE WAS 50-600mm RAN1056	RDS
L	5-CORE OPTION ADDED ~ RAN1102	PDM
M	OPTION 'M' ADDED ~ RAN1166, RANGE NOTE AMENDED ~ RAN1200	PDM

CE

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.

J	28.07.15		CHECKED BY	X ±0.4
K	9.11.15		RDS	X.X ±0.2
L	07.04.17			X.XX ±0.1
M	29.08.17			DIMS mm
		DESCRIPTION	M101 INTRINSICALLY SAFE STAND ALONE LINEAR POSITION SENSOR	
SCALE 12.5mm		DRAWING NUMBER	M101-11	REV M
				SHEET 1 OF 1