



mm **M111**

APPLICATION

- 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



As a leading designer and manufacturer of linear, rotary, tilt and intrinsically safe position sensors, Althen has the expertise to supply a sensor to suit a wide variety of applications. Our M111 incorporates electronics system EX07 which is ATEX / IECEx / UKEX approved for use in potentially explosive **gas/vapour, dust** atmospheres and **mining** environments. This heavy-duty version of the M101 sensor with a stronger 12.6mm push rod, recommended for applications where vibration is an issue or there is a need for longer travel sensors, mounted horizontally, and supported between rod eyes. It remains 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. Like all Althen sensors, the M111 provides a linear output proportional to travel. Each sensor 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 M8 rod eye bearings and body clamps. The push rod can be supplied free or captive with female M8 thread, an M8 rod eye, dome end or magnetic tip. M12 and 1/2" rod eye options available. Captive push rods can be sprung loaded, in either direction, on sensors up to 300mm of travel. The M111 also offers a range of mechanical options, environmental sealing is to IP67.

SPECIFICATIONS

Dimensions¹ Body diameter Body length (Axial version) Body length (Radial version) Push rod extension	35 mm calibrated travel + 163 mm calibrated travel + 186 mm calibrated travel + 7 mm, OD 12.6 mm
Independent Linearity	$\leq \pm 0.25\%$ FSO @ 20°C - up to 450 mm $\leq \pm 0.5\%$ FSO @ 20°C - over 450 mm
Temperature Coefficients	$< \pm 0.01\%/^{\circ}\text{C}$ Gain & $< \pm 0.01\%$ FS/ $^{\circ}\text{C}$ Offset
Frequency Response	> 10 kHz (-3dB)
Resolution	Infinite
Noise	$< 0.02\%$ FSO
Intrinsic Safety²	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)
Sensor Input Parameters (connector option/s) (cable option/s)	Ui: 11.4V, Ii: 0.20A, Pi: 0.51W. Ci: 1.16μF, Li: 50μH Ci: 1.36μF, Li: 860μH with 1km max. cable
Environmental Temperature Limits Operating Storage	-40°C to +80°C -40°C to +125°C
Sealing	IP67

SPECIFICATIONS (CONTINUED)

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 ³ M111-11	Sensor Outline
¹ For full mechanical details see drawings M111-11 ² Approval only applies to the specified ambient temperature range and atmospheric conditions in the range 0.80 to 1.10 Bar, oxygen ≤ 21% ³ 3D models, step or .igs format, available on request	

INTRINSICALLY SAFE EQUIPMENT

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 / UKEX 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 / Vapour:

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

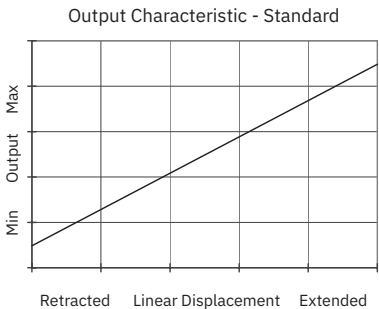
Dust:

T135°C: maximum surface temperature under fault conditions.
Ambient temperature range extended to -40°C to +80°C.

It is imperative Althen intrinsically safe sensors be used in conjunction with a galvanic barrier to meet the requirements of the product certification. The Althen X005 Galvanic Isolation Amplifier is purpose made for Althen IS sensors making it the perfect choice. Refer to the X005 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.

ATEX / IECEx / UKEX approved sensors suitable for gas (X series) and dust (E series) applications, are also available from Althen.



M111	a	b	c	d	e	f	g	h	j	k
	Displacement	A	Y	Connections	Option	Option	Option	Option	Option	Z000

a Displacement		Value
Factory set to any length from 0-5 mm to 0-800 mm (e.g. 0- 254 mm)		254
b Output		
Supply V _{dc} (tolerance)	Output	Code
+5V (4.5 - 5.5V)	0.5 - 4.5V (ratiometric with supply)	A
Supply Current: 10mA nominal, 12mA max.		
c Calibration Adjustments		Code
Sealed		Y
d Connections		Code
Cable gland radial IP67 Pg9, metal, 3-core cable		Ixx
Cable gland radial IP67 Pg9, metal, 5-core cable		IQxx
Connector axial IP67 4 pin M12 IEC 61076-2-101, metal		J
Connector axial IP67 4 pin M12 IEC 61076-2-101, metal, pre-wired 3-core cable		Jxx
Connector axial IP67 4 pin M12 IEC 61076-2-101, metal, pre-wired 5-core cable		JQxx
Connector radial IP67 4 pin M12 IEC 61076-2-101, metal		K
Connector radial IP67 4 pin M12 IEC 61076-2-101, metal, pre-wired 3-core cable		Kxx
Connector radial IP67 4 pin M12 IEC 61076-2-101, metal, pre-wired 5-core cable		KQxx
Cable gland axial IP67 Pg9, metal, 3-core cable		Lxx
Cable gland axial IP67 Pg9, metal, 5-core cable		LQxx
Cable gland, short† axial IP67, metal, 3-core cable		Mxx
Cable gland, short† axial IP67, metal, 5-core cable		MQxx
Specify required cable length 'xx' in cm. e.g. L2000 specifies axial cable gland with 20 m of cable, 50 cm supplied as standard. Note! maximum length supplied 15000cm. †Nb: restricted cable pull strength.		

e Body Fittings	Code
None default	blank
M8 Rod-eye bearing radial version only	N
f Body Clamps	Code
Body Clamps 1 pair	P
Body Clamps 2 pairs	P2
g Sprung Push Rod	Code
Not sprung default	blank
Spring extend	300 mm maximum displacement and captive push rod only. R
Spring retract	S
h Push Rod Fittings	Code
Female thread M8x1.25x12 deep default	blank
Dome end with spring extend option 'R'	T
M8 Rod-eye Bearing	U
Magnetic Tip	WA
j Push Rod	Code
Captive push rod retained default	blank
Non-captive push rod can depart body	V
k Z-code	Code
Calibration to suit X005 required	Z000
Tighter Independent Linearity; $\leq \pm xx\%$ FSO @20°C $\leq \pm 0.1\%$ 0 - 10 mm min. to 0 - 450 mm $\leq \pm 0.25\%$ 0 - 451 mm to 0 - 600 mm $\leq \pm 0.5\%$ 0 - 601 mm to 0- 800 mm max.	Z650
½" Rod eyes with options 'N' and/or 'U'	Z825
M12Rod eyes with options 'N' and/or 'U'	Z826

THREE OR FIVE-WIRE MODE CONNECTION

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 Althen Intrinsically Safe sensor or one with a connector, choosing the right mode of connection and cable to suit the application requires careful consideration.

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

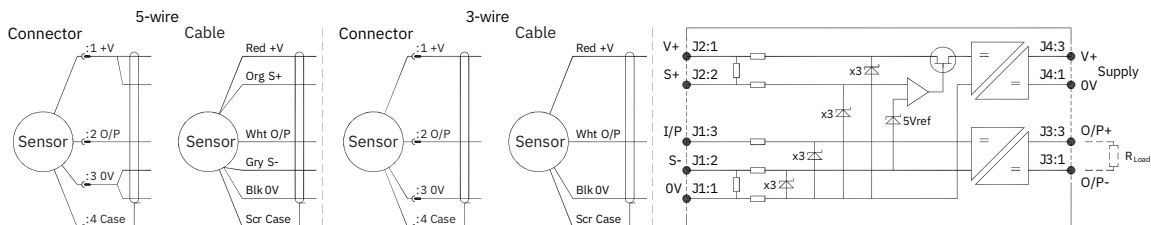
This is important because the effects of volts drop can significantly alter the perceived accuracy of the sensor which is ratiometric i.e. the output signal is directly affected by the voltage across the sensor. Changes in temperature will also be seen as gain variation in the sensor output.

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

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

For this reason Althen 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 (mm ²)	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.

Althen 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;

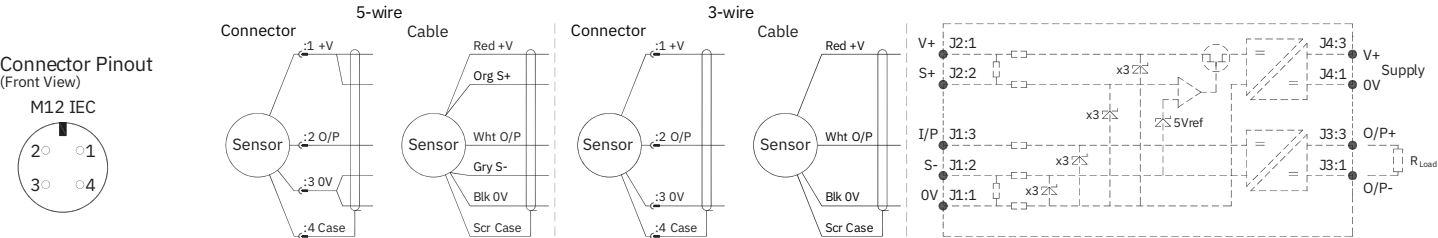
- G005-*** for ‘G’ and ‘H’ prefix sensors
- X005-*** for ‘E’, ‘M’ and ‘X’ prefix sensors

† $R = \rho L / A$ ρ is the resistivity of the conductor (Ωm) L is the length of conductor (m) A is the conductor cross-sectional area (m^2).
‡ It is presumed that 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 / UKEX Qualified to Intrinsic Safety Standard Certificate numbers SIRA 13ATEX2371X IECEX SIR 13.0154X CSAE 21UKEX2537X		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*	(with maximum cable length)
Ci = 1.16μF	Li = 50μH	(without cable)

*Figures for 1km cable where: Ci = 200pF/m & Li = 810nH/m
The sensor is certified to be used with up to **1000m** of cable, cable characteristics must not exceed:-
Capacitance: ≤ 200 pF/m or max. total of: 200 nF
Inductance: ≤ 810 nH/m or 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.

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!**

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.

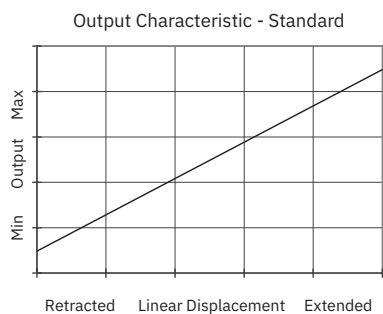
When using a Sensor that has an integral cable in a dust application, the free end of the cable shall be appropriately terminated for the zone of use. Under certain extreme circumstances, the non-metallic and isolated metal parts incorporated in the enclosure of this equipment may generate an ignition-capable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

OUTPUT CHARACTERISTIC

Target is extended 7 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.



MECHANICAL MOUNTING

Depending on options; Body can be mounted by rod eye bearing or by clamping the sensor body - body clamps are available, if not already ordered. Target by M8x1.25 female thread, rod eye bearing or magnetic tip. It is assumed that the sensor and target mounting points share a common earth.

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.
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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:-

U_i = 11.4V	I_i = 0.20A	P_i = 0.51W
C_i = 1.36μF*	L_i = 710μH* ('Ixx' or 'Lxx' options)	*Figures for 1km cable where: C _i = 200pF/m & L _i = 660nH/m
C_i = 1.16μF	L_i = 50μH ('J' or 'K' options)	

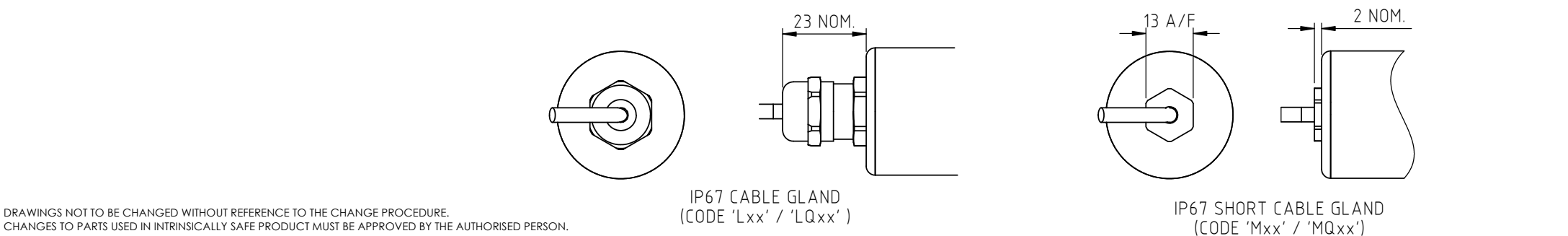
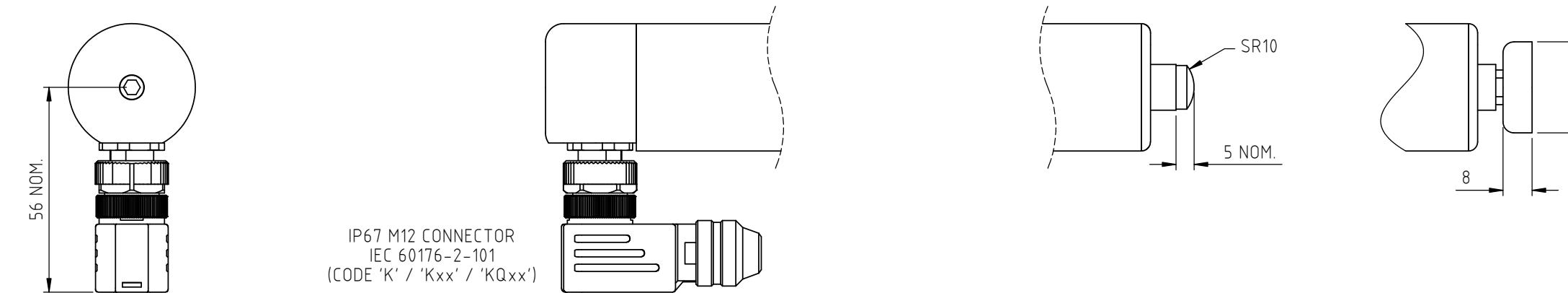
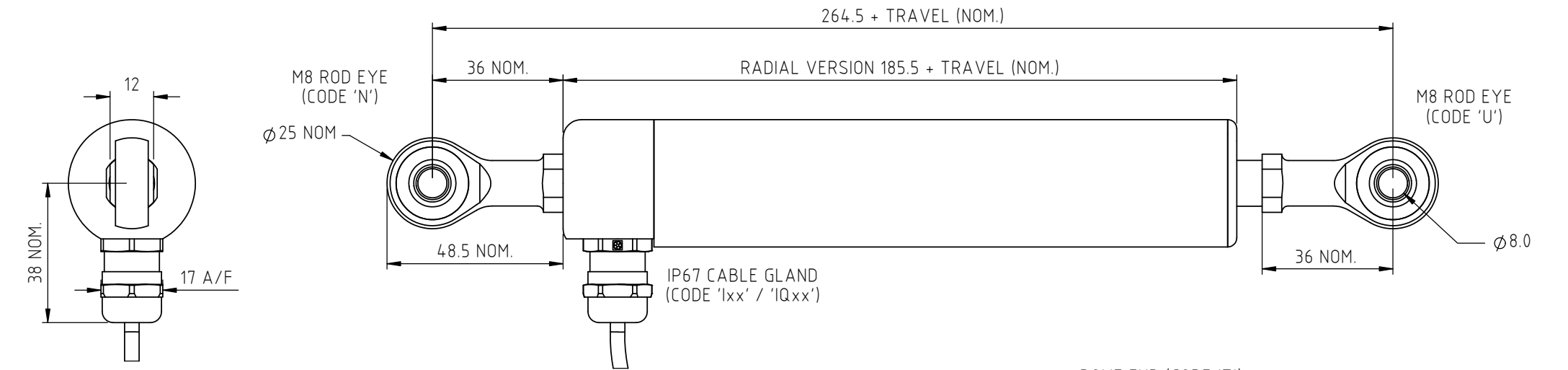
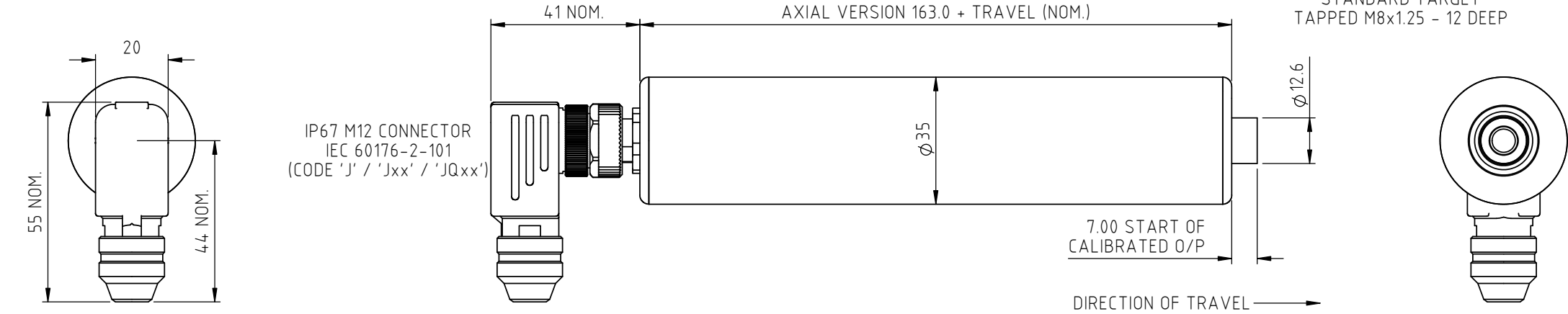
The sensor is certified to be used with up to **1000m** of cable, cable characteristics must not exceed:-

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

Inductance: ≤ 660 nH/m or 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.

NOTE. ROD-EYE ORIENTATION NOT GUARANTEED



REV	CHANGE HISTORY	DR'WN	DATE	CHK'D
N	RAN1311 - MAGNETIC TIP OPTION 'WA' ADDED	ASC	05/06/2023	ASC

THE PUSH-ROD RETRACTS 4mm NOM. BACK FROM THE START OF CALIBRATED TRAVEL.
THE PUSH-ROD EXTENDS 8mm NOM. BEYOND THE END OF CALIBRATED TRAVEL.
SPRUNG OPTIONS:- CODE 'R': 1mm, CODE 'S': 2mm.
CODE 'V': PUSH-ROD NOT RETAINED.

ELECTRICAL OPTIONS/ SPECIFICATIONS

OUTPUT
'A' 0.5 - 4.5V RATIOMETRIC
SUPPLY CURRENT 12mA TYP. 20mA MAX.

SUPPLY (NOM)
5V

CONNECTIONS:

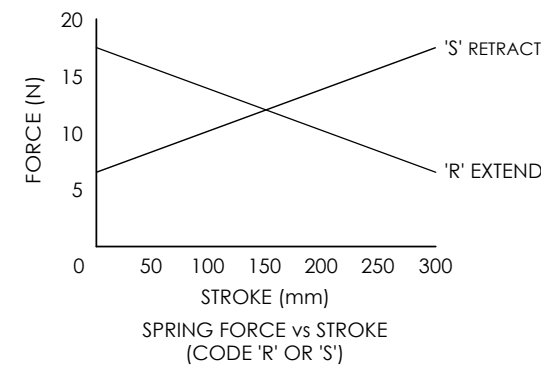
	3-CORE	5-CORE	CONNECTOR
+Ve	RED	RED	:1
+SENSE (5-WIRE ONLY)	-	ORANGE	:1
0V	BLACK	BLACK	:3
-SENSE (5-WIRE ONLY)	-	GRAY	:3
OUTPUT	WHITE	BLUE	:2
BODY	SCREEN	SCREEN	:4

CABLE: 0.2mm², O/A SCREEN, PUR JACKET, SUPPLIED WITH 50cm OR REQUIRED LENGTH IN cm (15000cm MAX).
STANDARD 3-CORE: BLACK Ø4mm JACKET e.g. L50
OPTIONAL 5-CORE: BLUE Ø4.6mm JACKET e.g. LQ50
CONNECTORS; MAXIMUM CONDUCTOR CROSS SECTION 0.75mm²

RANGE OF DISPLACEMENT FROM 0-5mm TO 0-800mm e.g. 76.
BODY MATERIAL:- STAINLESS STEEL.

FURTHER OPTIONS:
BODY CLAMP CODE 'P'
TWO BODY CLAMPS CODE 'P2'
CLAMP CONSISTS OF 2 PARTS AND
REQUIRES 2 OFF M6x55 (MIN.) CAPHEAD SCREWS.

SPRUNG PUSH-ROD, ≤300mm:
EXTENDED POSITION CODE 'R'. RETRACTED CODE 'S'
PUSH-ROD FREE CODE 'V' - NOT AVAILABLE WITH CODES 'R' OR 'S'



NOTE:- READ INSTALLATION SHEET M111-19
FOR FULL INSTRUCTIONS FOR USE.

ATEX / IECEx / UKEX APPROVED TO
Ex ia IIC T4 Ga (Ta= -40° to +80°C)
Ex ia IIC T135°C Da (Ta= -40° to +80°C)
Ex ia I Ma (Ta= -40° to +80°C)
Ui 11.4V, li 0.2A, Pi 0.51W

APPROVED FOR USE IN CONJUNCTION
WITH A GALVANICALLY ISOLATED BARRIER.

NOTE: APPROVAL ONLY APPLIES AT NORMAL
ATMOSPHERIC PRESSURE!

APPROVED BY RDM	REV N		X X.X X.XX DIM'S mm	±0.4 ±0.2 ±0.1
DESCRIPTION M111 INTRINSICALLY SAFE STAND ALONE LINEAR POSITION SENSOR				
SCALE A3	DRAWING NUMBER M111-11			
SHEET 1 OF 1				