ALTHEN SENSORS & CONTROLS

α X520

APPLICATION

- Intrinsically safe for Gas: Ex II 1G
- Non-contacting inductive technology to eliminate wear
- Angle set to customer's requirement
- Durable and reliable
- High accuracy and stability
- Pressure balanced for use to 350 Bar in under water applications

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 X520 incorporates electronics system EX07 which is ATEX / IECEx / UKEX approved for use in potentially explosive gas/vapour atmospheres. The X520 is designed to provide feedback for arduous underwater applications, such as ROVs, where hazardous surface conditions may exist. The X520, like all Althen sensors, is supplied with the output calibrated to the angle required by the customer, between 15 and 160 degrees and with full EMC protection built in. The sensor provides a linear output proportional with input shaft rotation, which has full 360 degree rotational freedom. There is a machined registration mark to identify the calibrated mid point.

Overall performance, repeatability and stability are outstanding over a wide temperature range. The X520 has long service life and environmental resistance with a rugged 316 stainless steel body and shaft, The flange mounting makes the sensor easy to install. There are a range of electrical options. Environmental sealing is to IP68 350Bar.

SPECIFICATIONS

Dimensions[1]	
Body diameter	60 mm
Flange Diameter	92 mm
Body Length (to mounting face)	70 mm
Shaft	15 mm Ø 6 mm
Independent Linearity	≤ ± 0.25% FSO @ 20°C - up to 100° travel
Pressure Effects	Output changes with pressure < 1°
Temperature Coefficients	< ± 0.01%/°C Gain & < ± 0.01%FS/°C Offset
Frequency Response	> 10 kHz (-3dB)
Resolution	Infinite
Noise	< 0.02% FSO
Torque	< 20 mNm Static
Intrinsic Safety[2]	Ex II 1G Ex ia IIC T4 Ga (Ta= -40°C to 80°C)
Sensor Input Parameters **(without cable)** **(with cable)**	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 (Non Icing)	
Operating	-4°C to +50°C
Storage	-4°C to +50°C
Sealing	Sealed to 350 Bar
EMC Performance	EN 61000-6-2, EN 61000-6-3

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SPECIFICATIONS (CONTINUED)

Vibration	IEC 68-2-6: 10 g
Shock	IEC 68-2-29: 40 g
MTBF	350,000 hrs 40°C Gf
Drawing List[3]	
X520-11	Sensor Outline

[1] *For full mechanical details see drawings X520-11*
[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 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 / vapour (Zones 2 to 0).

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.

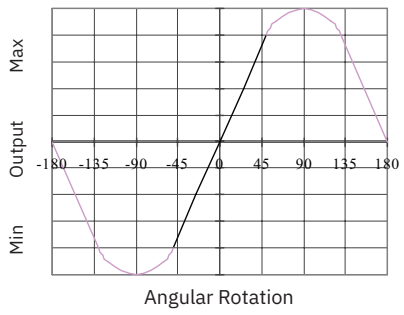
Ambient temperature range extended to -40°C to +80°C.

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 dust (E series) and mining (M series) applications, are also available from Althen.

Standard Output Characteristic



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	a	b	c	d
X520 .	Displacement	A	K50	Z000

a Displacement		**Value**
Factory set to any angle from 0-16° (±8°) to 0-160° (±80°) (e.g. 0-54°)		**54**
b Output		
Supply V_{dc} (tolerance)	**Output**	**Code**
+5V (4.5 - 5.5V)	0.5 - 4.5V (ratiometric with supply)	**A**
Supply Current 10mA typical, 12mA max.		
c Connections		**Code**
Connector radial IP68 350 Bar Wet mate 4 pin MC BH-4-M		**K50**
Supplied with an over-moulded MC IL-4-F connector with 0.5 m, 4-core 20 AWG (0.5mm²) EPDM cable assembly, and locking collar as standard.		
d Z-code (optional)		**Code**
Calibration to suit X005 required		**Z000**
≤± 0.1% FSO @20°C Independent Linearity 0 - 16° min. to 0 - 100° max.		**Z650**

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.

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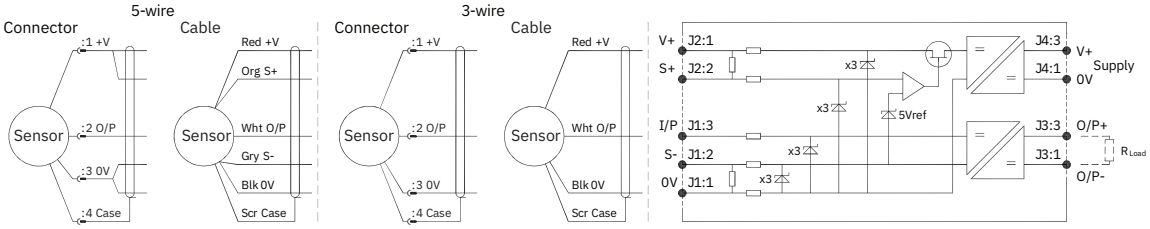


Cable Length (metres)	Up to 150	150 - 300	300 - 450	450 - 600	600 - 900	900 - 1000
Cross Section (mm²)	0.25	0.5	0.75	1.0	1.5	2.0

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

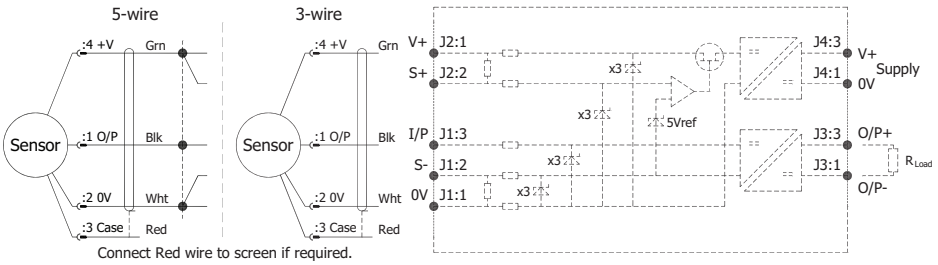
† R = ρL/A ρ is the resistivity of the conductor (Ωm) L is the length of conductor (m) A is the conductor cross-sectional area (m²).

‡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

ATEX / IECEx / UKEX Qualified to Intrinsic Safety Standard Certificate numbers SIRA 13ATEX2371X IECEx SIR 13.0154X CSAE 21UKEX2537X			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:
MC BH 4 M (face view)



Connect Red wire to screen if required.

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.

N.b. Cable free end must be appropriately terminated, including preventing water ingress into the cable. See page 2 for connector handling instructions.

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.

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 rotary 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.

MECHANICAL MOUNTING

Flange mounted - see drawing X520-11. The sensor should be mounted with minimal axial and radial loading on the shaft for optimum life. It is recommended that the shaft is coupled to the drive using a flexible coupling, recommended maximum axial load 1kg. Tests indicate that life in excess of 16 million cycles can be achieved with 1kg side and end load.

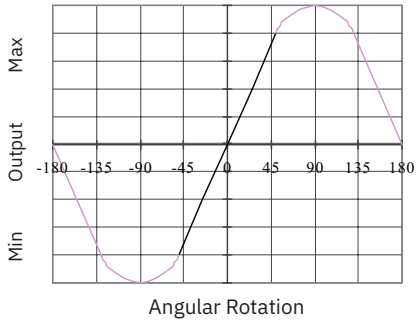
INCORRECT CONNECTION PROTECTION LEVELS

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.

OUTPUT CHARACTERISTIC

The sensor has full rotational freedom and two sectors, 180° apart, over which linear response can be achieved. At the mid point of the calibrated range the output signal will be half full scale deflection, and the flat on the shaft is aligned with the registration mark in the base of the sensor. In the calibrated range the output increases as the shaft is rotated in an anti-clockwise direction viewed from the shaft. The calibrated output is factory set to be between 15° and 160°.

Standard Output Characteristic



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CONNECTOR MATING INSTRUCTIONS

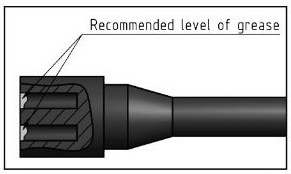
Handling

- Always apply grease mating
- Disconnect by pulling straight, not at an angle
- Do not pull on the cable and avoid sharp bends at cable entry
- When using bulkhead connector, ensure that there are no angular load
- Do not over-tighten the bulkhead nuts
- Connectors should not be exposed to extended periods of heat or direct sunlight. If a connector becomes very dry, it should be soaked in fresh water before use

Cleaning

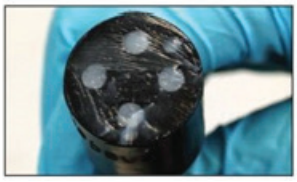
- General cleaning to remove any accumulated sand or mud on a connector should be performed using spray based contact cleaner (isopropyl alcohol)
- New grease must be applied again prior to mating

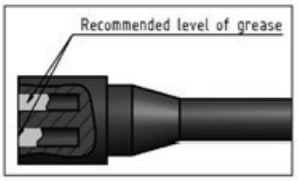
GREASING AND MATING ABOVE WATER (DRY MATE)



- Connectors must be greased with Molykote 44 Medium before every mating
- A layer of grease corresponding to approximately 1/10 of the socket depth should be applied to the female connector
- The inner edge of all the sockets should be completely covered, and a transparent layer of grease left visible on the face of the connector
- After greasing, fully mate the male and female connector in order to secure optimal distribution of grease on pins and in sockets
- To confirm that the grease has been sufficiently applied, de- mate and check for grease on every male min. Then re-mate the connector

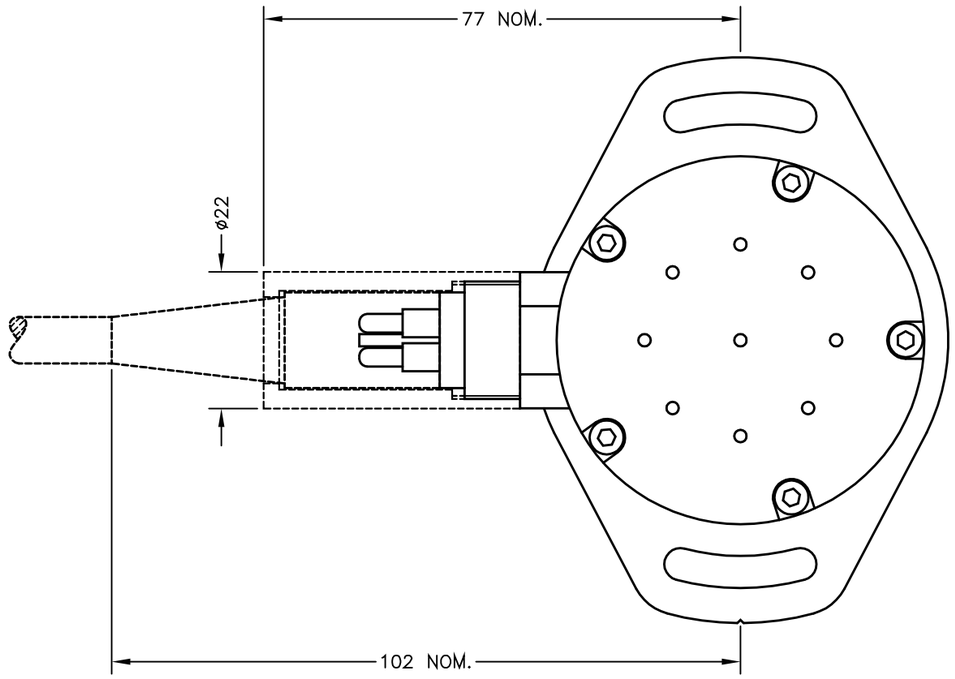
GREASING AND MATING ABOVE WATER (WET MATE)

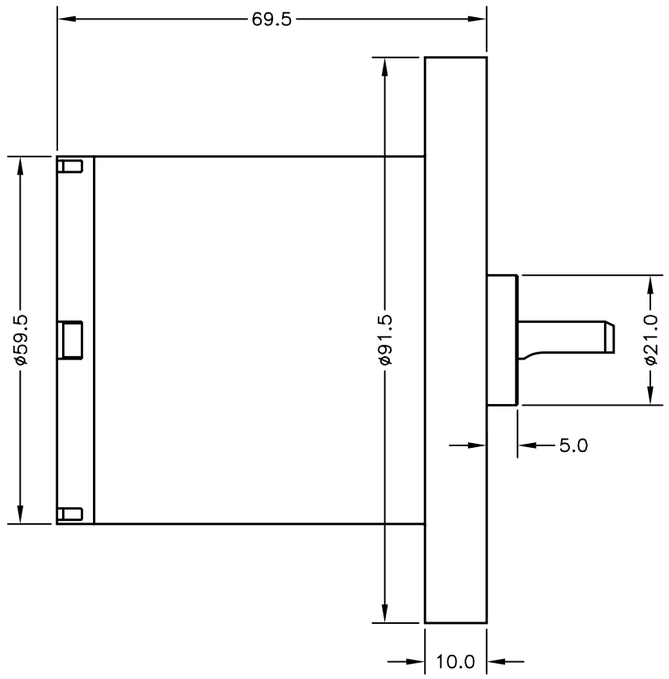


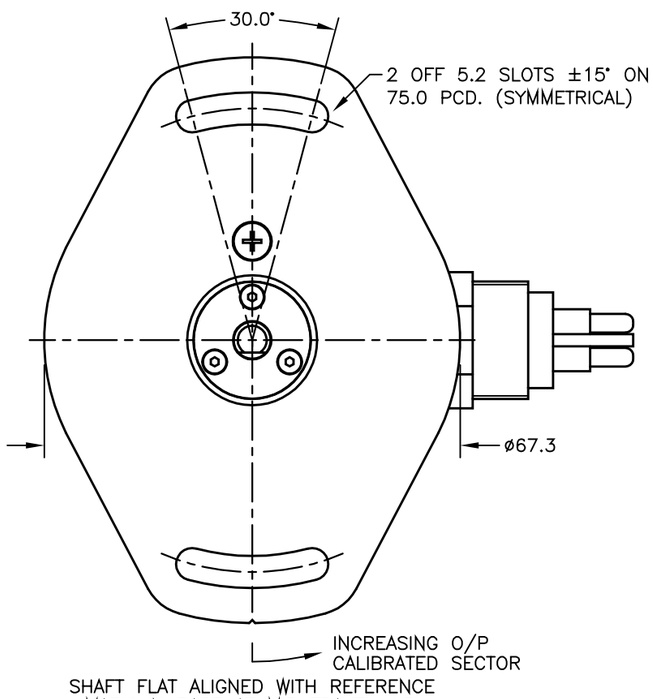


- Connectors must be greased with Molykote 44 Medium before every mating
- A layer of grease corresponding to approximately 1/3 of the socket depth should be applied to the female connector
- All sockets should be completely sealed, and a transparent layer of grease left visible on the face of the connector
- After greasing, fully mate the male and female connector and remove any excess grease from the connector joint

CONNECTORS; WETMATE, 4–POLE.
BULKHEAD: MC–BH–4–M–SS, STAINLESS STEEL/MOLDED NEOPRENE, SEALING; 340 BAR OPEN FACE, 600 BAR MATED.
IN–LINE: MC–IL–4–F, MOLDED NEOPRENE WITH CABLE. LOCKING SLEEVE; MCDLS–F, DELRIN.

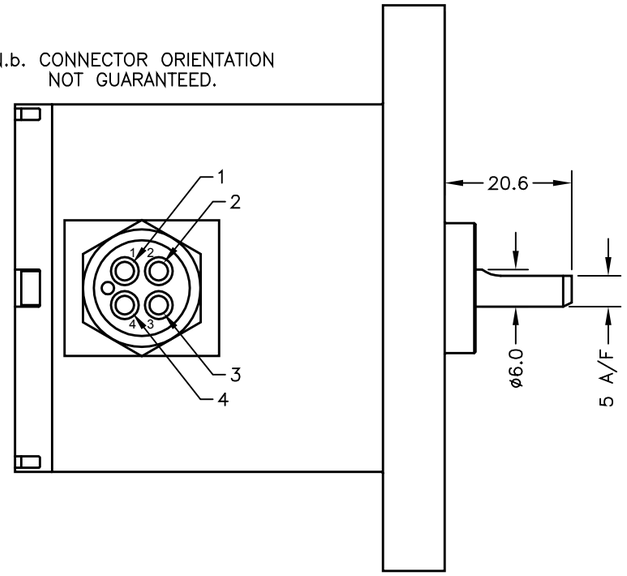






SHAFT FLAT ALIGNED WITH REFERENCE MARK IN BASE AT MID TRAVEL ±5°

N.b. CONNECTOR ORIENTATION NOT GUARANTEED.



ELECTRICAL OPTIONS/ SPECIFICATIONS

OUTPUT	SUPPLY
0.5 TO 4.5V RATIOMETRIC	5V

SUPPLY CURRENT 12mA TYP. 20mA MAX.

MATING CONNECTOR SUPPLIED WITH 50cm MOULDED CABLE AS STANDARD.
4–CORE SCREENED: 0.5mm², ø7.5mm MAX. JACKET / CORE INSULATION: EPDM.
CONNECTIONS:–

1	BLACK	OUTPUT
2	WHITE	0V
3	RED	BODY
4	GREEN	+Ve
	SCREEN	NOT CONNECTED TO SENSOR

RANGE OF DISPLACEMENT FROM 0–15° TO 0–160° e.g. 76°, IN INCREMENTS OF 1°.
BODY MATERIAL:– STAINLESS STEEL 316.

NOTE:– READ INSTALLATION SHEET X520–19 FOR FULL INSTRUCTIONS FOR USE.

ATEX / IECEx APPROVED TO
Ex 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!

A	FIRST ISSUE.	PDM
B	DISP. FROM 15° WAS 16° - RAN1146	PDM
C	CABLE COLOURS CORECTED - RAN1190	PDM
D	RANGE NOTE AMENDED ~ RAN1200	PDM

CE

MAXIMUM WORKING DEPTH: 3500 METRES 350 BAR. WHERE THE FREE END OF THE CABLE IS TO BE TERMINATED IN A SUBMERGED POSITION, ADEQUATE SEALING MUST BE PROVIDED TO PROTECT CONNECTIONS.

SENSOR IS OIL FILLED AND PRESSURE BALANCED. PRESSURE SENSITIVITY <1%FS TO 350 BAR

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

A	27/10/16	CHECKED BY	X ±0.4
B	12/12/16	RDS	X.X ±0.2
C	14/06/17		X.XX ±0.1
D	12/09/17		DIMS mm

DESCRIPTION
INTRINSICALLY SAFE 350 BAR SUBMERSIBLE ROTARY SENSOR

SCALE 10mm

DRAWING NUMBER X520-11 REV D

SHEET 1 OF 1