level developments

DAS : High Resolution Inclinometer, ±10, ±30 or ±90°, 0.5-4.5V Out

Description

The DAS inclinometers are range of high performance low-cost dual-axis tilt sensors for measurement of angle in both pitch and roll axes. They utilise a very high performance MEMS sensor which exhibits low long term & temperature drift compared with competitive devices. Optional temperature compensation is also available to further enhance performance. Each sensor is packaged in a small, robust, sealed Aluminium housing and supplied with a 2m screened PUR cable terminated with a 4 pin M12 connector. The input supply range is from 7 to 32VDC, and the the high resolution output voltage varies from 0.5-4.5V over the range of the sensor. Three measurement range options are available: ±10°, ±30° & ±90°. These sensors are CE certified, and are made and individually calibrated in our UK factory to guarantee performance to the specifications.

Features

- Dual axis, measuring ranges : ±10°, ±30° or ±90°
- High performance ceramic packaged MEMS sensor with optional temperature compensation
- Input supply voltage 7-32V DC
- High resolution (16 bit) 0.5-4.5V voltage output
- Sealed to IP67
- Low cost relative to performance
- Small size, 46 x 43.5 x 13.5mm

Typical Applications

- Position feedback for solar tracking systems
- Platform levelling and monitoring
- GPS compensation
- Agricultural and industrial vehicle tilt monitoring
- Telescopic and scissor lift platform monitoring
- Platform scales and weigh bridge levelling
- Robotics position sensing
- Can be readily customised to suit most applications

Specifications

Parameter	Value	Unit	Notes
Supply Voltage	7-32	V dc	Supply is filtered, suppressed and regulated internally, however we recommend the use of a low noise supply to prevent noise coupling to the sensor.
Operating Current	20 15 10	mA	The supply current will vary depending on the Voltage supplied to the sensor. at 7V at 12V at 24V
Operating Temperature	-40 to 85	°C	This is the maximum operating temperature range.
Low Pass Filter Frequency Response	3	Hz	Includes a 2nd order low pass filter on the output with a 3Hz -3dB cut-off. This is factory configurable for OEM applications
Mechanical shock	5000	G	Shock survival limit for internal sensor 5000G for 0.5ms.
0° Output Level	2.5	V	For optimum zero point accuracy, mounting of the part can be adjusted.
Output Impendence	100	Ω	
Output Range	0.5 - 4.5	V	See page 4 for more details.
Cable	2	m	4 core braided screen cable with black PUR jacket (see page 7 for details).
Connector	M12	-	4 pole M12 male connector (see page 7 for details).
Sealing	IP67	-	Applies to housing, cable gland & connector (while attached to female M12). Gland is not designed for flexible cable installation which may compromise the seal.
Weight	90	g	Including cable.
Size Width Length Height	 46.0 43.5 13.5	 mm mm mm	

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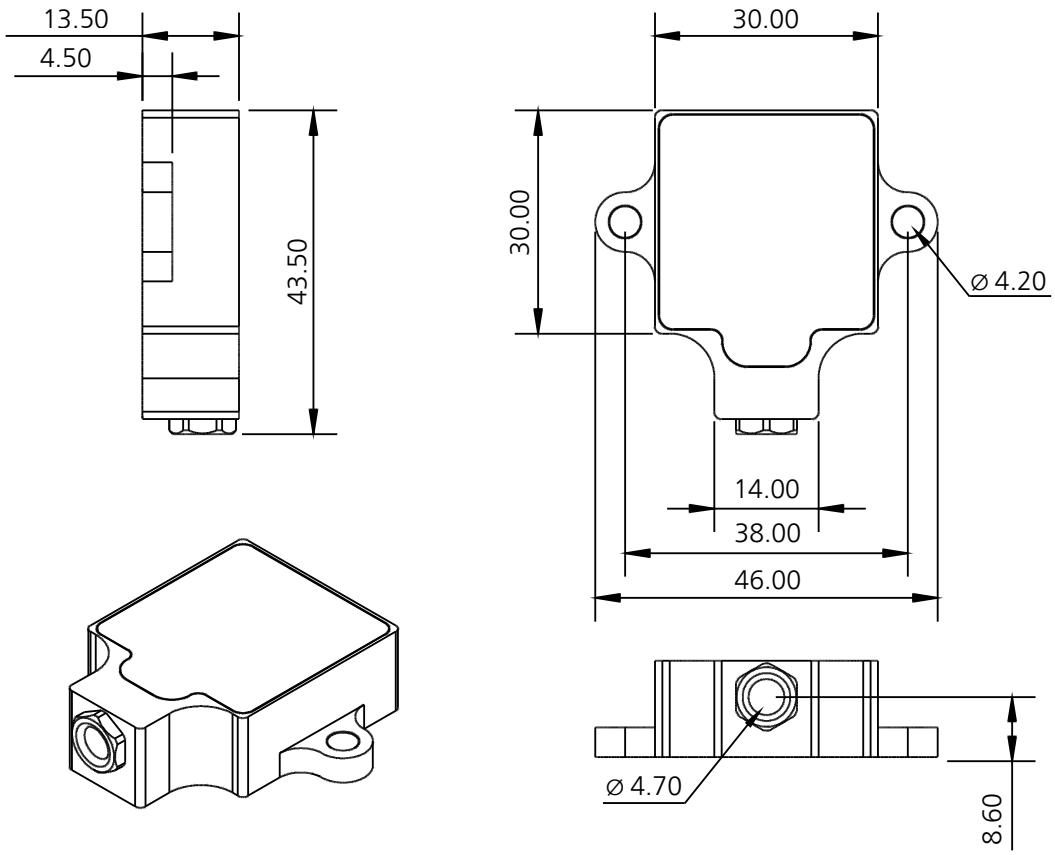
Performance & Output Specifications

Parameter	DAS-10-A	DAS-10-B	DAS-30-A	DAS-30-B	DAS-90-A	DAS-90-B	Unit
Measuring range	±10		±30		±90		°
Zero Bias Error	±0.01		±0.02		±0.04		°
Accuracy (20°C)	±0.02		±0.05		±0.1		°
Scale Factors For first 1° For 1g range	201 11.518	200	70 4	66.667	35 2	22.222	mV / ° V / g
Temperature Errors Without Compensation Zero Drift Sensitivity Drift	±0.001 ±0.001						° / °C % / °C
Temperature Errors With Compensation Zero Drift Sensitivity Drift	±0.0002 ±0.0006						° / °C % / °C
Accuracy (-10 to 60°C) Without Temperature Compensation With Temperature Compensation	±0.06 ±0.03		±0.10 ±0.07		±0.16 ±0.13		°
Long Term Stability	±0.01		±0.01		±0.01		°
Resolution (using standard @3Hz filter)	0.001		0.002		0.003		°

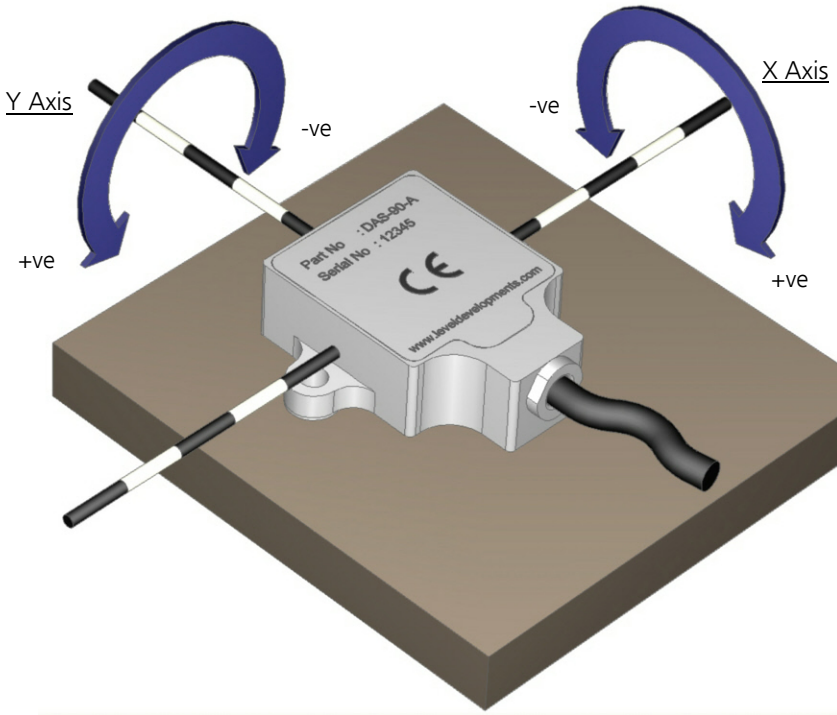
Parameter	Notes
Zero Bias Error	This is the maximum angle from the device when it is placed on a perfectly level surface. For optimum accuracy, the mounting angle of the part can be adjusted.
Accuracy (20°C)	This is the maximum error between the measured and displayed value at any point in the measurement range, up to ±45°, when the device is at room temperature (20°C). Most manufacturer's datasheets quote 'typical' values. Typical values are usually less than half of the maximum values. Note: Inclinometers with a ±90° measurement range are likely to experience reduced accuracy as they approach ±90° due to decreasing sensitivity to tilt.
Sensitivity	This is the nominal amount that the voltage will change with when tilted throughout the range specified. For the DAS-A the output is proportional to the sine of the input angle, for the DAS-B the output is linear to the input angle. See page 4 for more details.
Temperature Errors Zero Drift Sensitivity Drift	Temperature variation can affect the output of the sensor as described below: If the device is mounted to a level surface in the zero position, this value is the RMS drift of the output angle per °C change in temperature. When the temperature changes there is a change in sensitivity of the sensor's output. The error this causes in the measurement is calculated from the formula: $\mathbf{E_{sd} = SD \times \Delta T \times \theta}$ Where: $\mathbf{E_{sd}}$ is the change in output (in degrees) due to sensitivity temperature change **SD** is the sensitivity drift specification from the above table **ΔT** is the change is temperature in °C **θ** is the current angle of the inclinometer axis in question in degrees. All specified Temperature Error values are derived from the RMS drift data of 20 sensors sampled at random (see page 5 & 6 for more details).
Accuracy (-10 to 60°C)	This is the error between the measured and displayed value at any point in the measurement range, at any temperature over the specified temperature range. It is derived from the maximum accuracy error (20°C), plus the RMS of all temperature errors tested between -10 and 60°C. Based on 20 sensors sampled at random.
Long Term Stability	Stability depends on environment (temperature, vibration & power supply). This figure is based on being powered continuously in an ideal environment, and is independent from accuracy specifications.
Resolution (using standard @3Hz filter)	Resolution is the smallest measurable change with the default 3Hz low pass filter.

Housing Drawing



Axis Direction and Mounting Orientation and Wiring Details

Horizontal surface is the zero plane



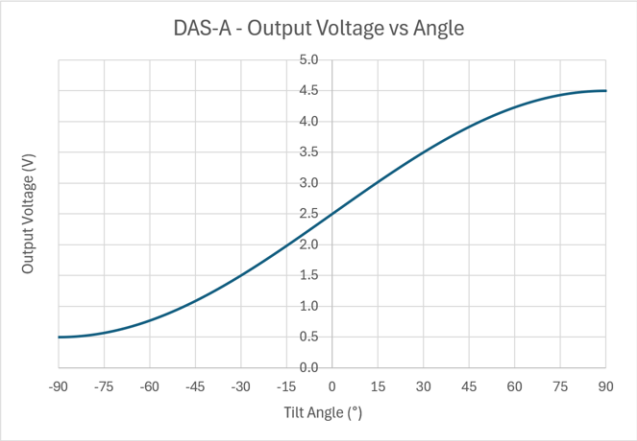
M12 Pin #	Internal Wire Colour	Function
1	Brown	+ve Supply
2	White	Y Axis Output
3	Blue	Gnd (0V)
4	Black	X Axis Output

Voltage Output Change With Angle

All inclinometers measure a change in gravitational field on a mass to derive angle. As the inclinometer sensor is rotated, the sensing element is subject to gravitational forces which move the proof mass, and this movement is measured, compensated and converted to an output voltage. In this sensor there are two output options:

- The -A type sensor has a voltage output that is linear to the change in acceleration (which means that the output is a sine function of the change in angle).
- The -B type sensor has a voltage output that is linear with the change in angle.

DAS-90-A - Voltage Proportional to the Sine of the Angle

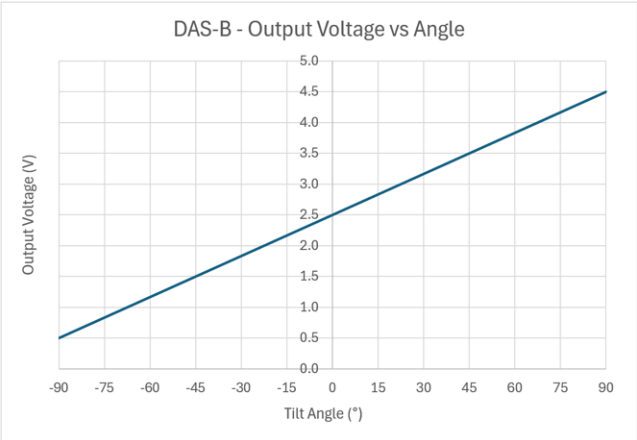


The formula to calculate the angle from the voltage is given by :

$$angle = \sin^{-1}\left(\frac{(Vout - Voffset)}{SF}\right)$$

Where :
Vout = Measured voltage from the sensor
Voffset = Measured voltage from the sensor when the sensor is at 0° (usually 2.5V)
SF = Scale Factor of the device in V/g (see specification table on page 2)

DAS-90-B - Voltage Linear to Angle



The formula to calculate the angle from the voltage is given by :

$$angle = \left(\frac{(Vout - Voffset) \times 1000}{SF}\right)$$

Where :
Vout = Measured voltage from the sensor
Voffset = Measured voltage from the sensor when the sensor is at 0° (usually 2.5V)
SF = Scaling of the device in mV / ° (see specification table on page 2)

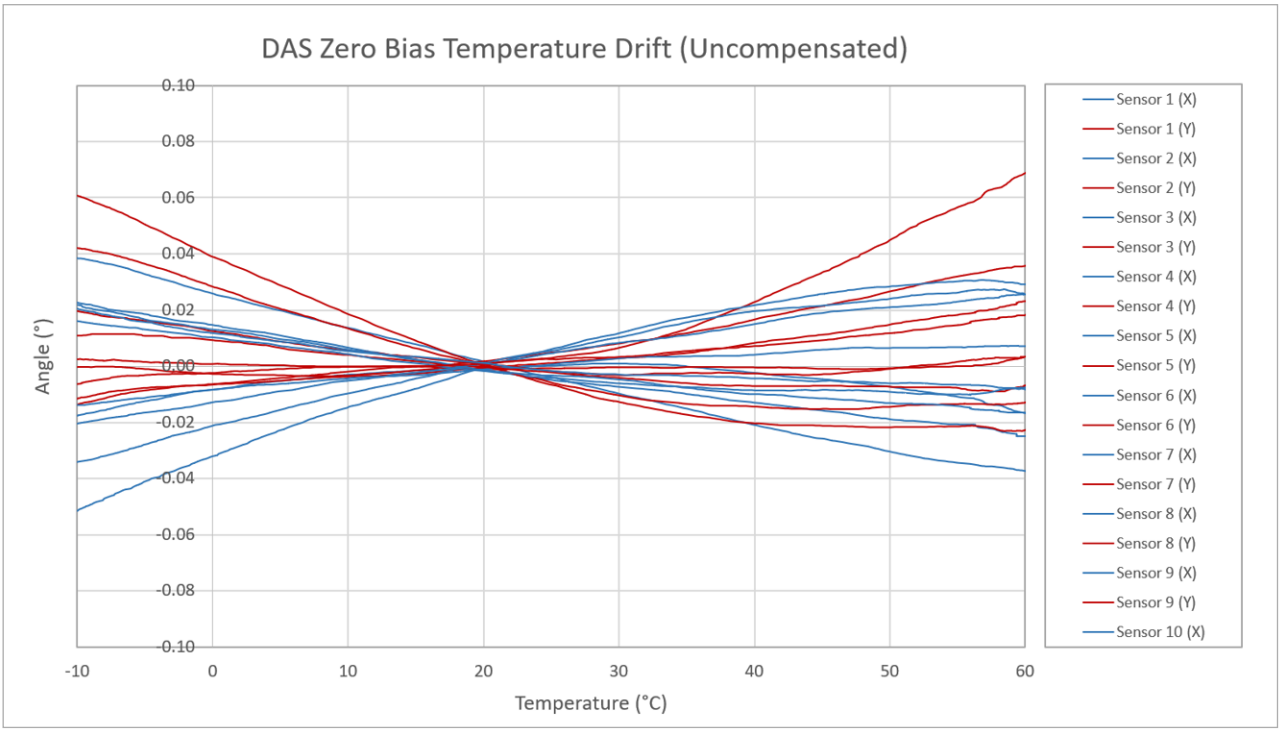
Product Options

1. Output voltage level and range can be factory modified to suit most requirements
2. Temperature compensation over custom range (a standard option for -10°C to 60°C is available, see page 6)
3. Standard cable length is 2m, others are available on request.
4. The low pass output filter frequency response can be factory adjusted between 0.125 and 32Hz
5. Axis Orientation and directions can be factory modified.
6. Various connector options, including moulded Deutsch DT04, Amp Superseal and M8.

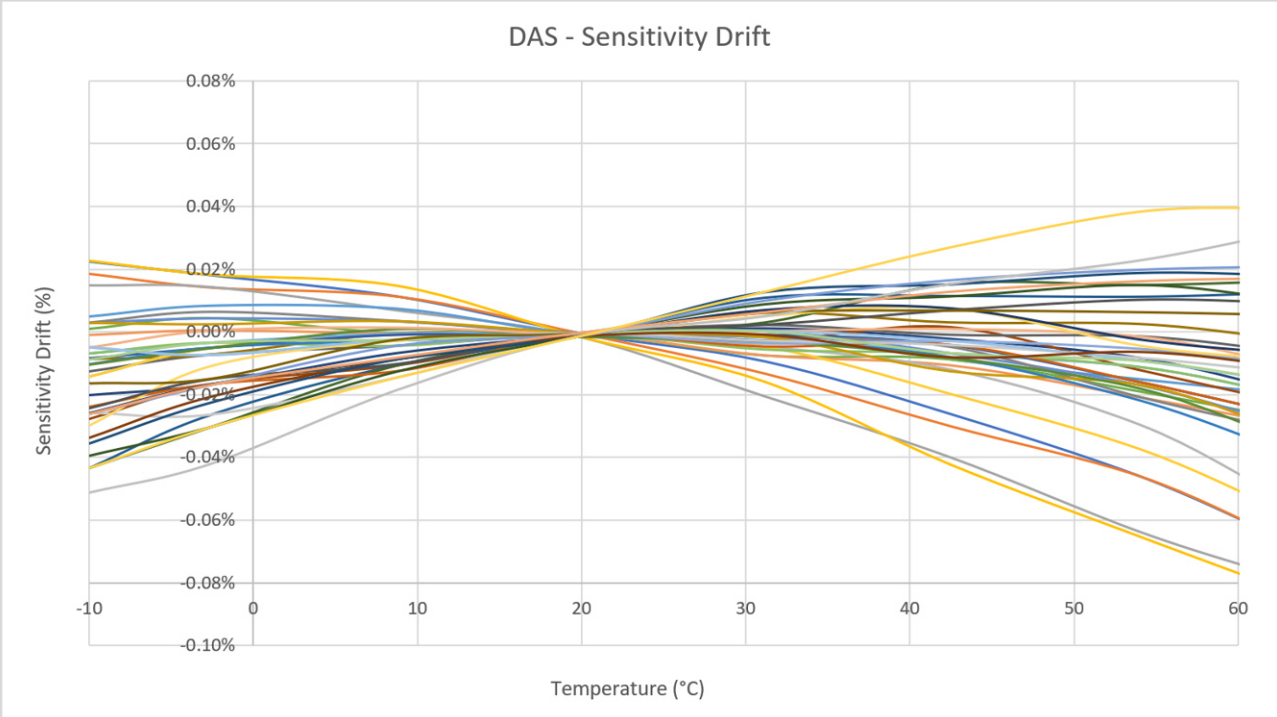
Special order versions are generally only available for OEM customers with ongoing requirements.

Temperature Performance - Without Temperature Compensation

The DAS sensor uses a ceramic packaged MEMS sensor which is very stable over temperature. The exact error introduced by temperature variation depends from device to device. Below shows a random sample of temperature drift from 20 sensors. These values are uncompensated. The drift can be reduced by a factor of 5 with additional temperature compensation.

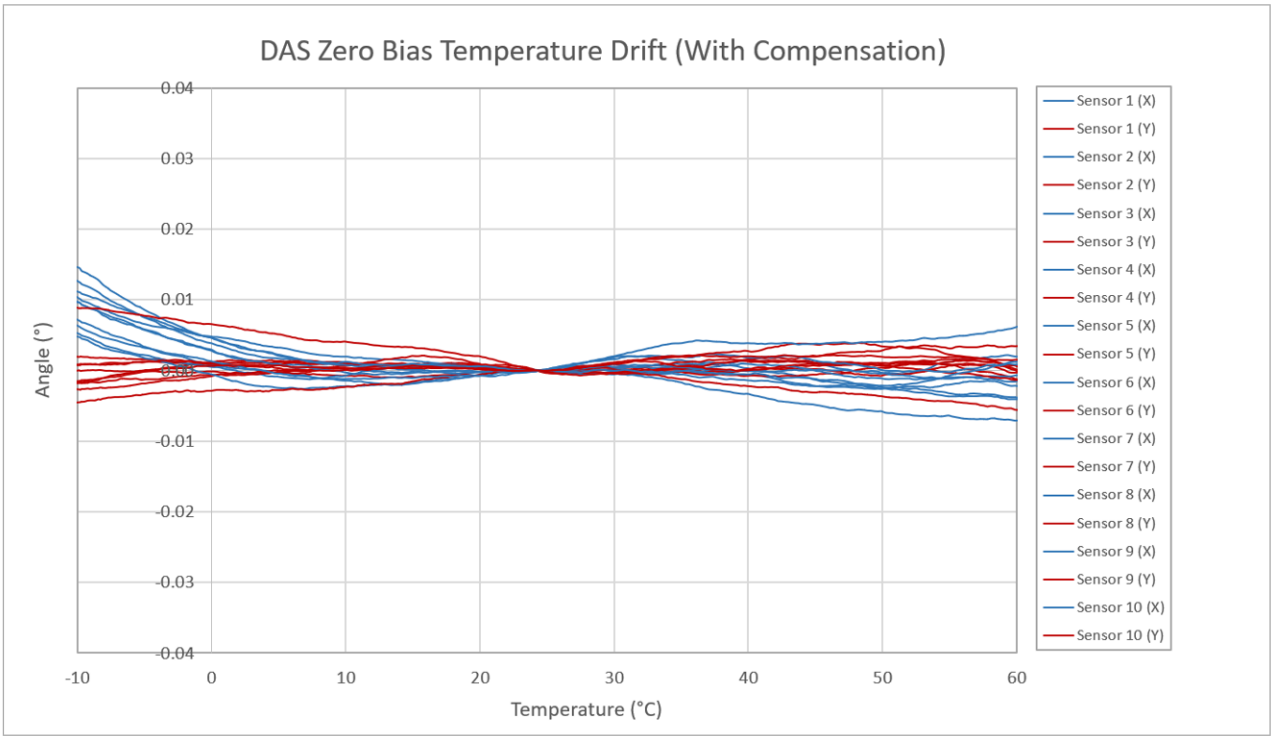


The sensor exhibits zero position drift (shown above) as well as a change in sensitivity (shown below). The change in sensitivity is shown as a percentage, and is applied to the measured value. As such, small angles are relatively unaffected by changes in sensitivity over temperature.



Temperature Performance - With Temperature Compensation

Although the ceramic-packaged MEMS sensor is inherently very stable throughout temperature changes, optional temperature compensation is available to achieve the best possible performance over a wide temperature range. Each device is physically tested and monitored through varying temperatures to calculate the optimal compensation coefficients. These coefficients are then programmed into the sensor to minimise the impact of temperature on the device. The graph below shows a random sample of temperature drift from 20 sensors after compensation. Please note the reduced Y-axis graph scale compared to the previous page.



Part Numbering

DAS - XX - X - XX - XX

Series Prefix

10 - ±10° Full Scale Measurement Range
30 - ±30° Full Scale Measurement Range
90 - ±90° Full Scale Measurement Range

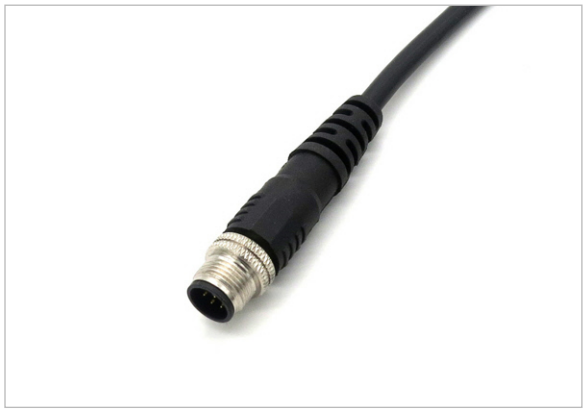
A - Output voltage proportional to the sine of the input angle
B - Output voltage proportional linearly to the input angle

[ ] - Without additional temperature compensation (leave blank for this option)
TC - With additional temperature compensation

Customer Specific Options

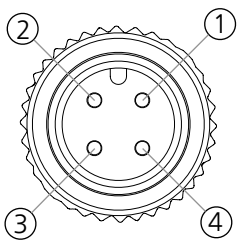
Cable and Connector Details

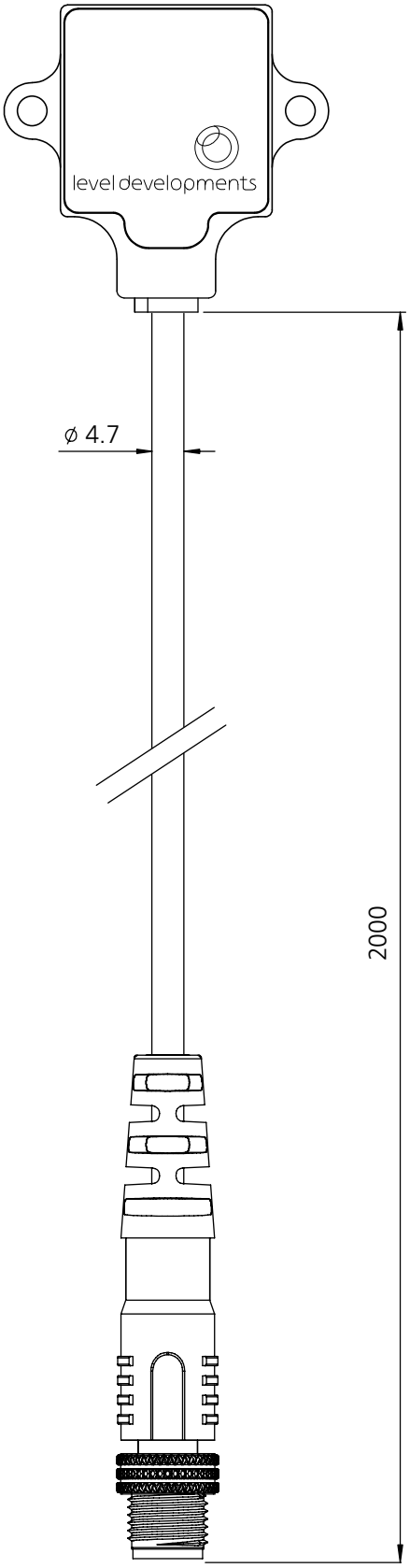
Parameter	Value
Connector description	M12 4-pin male
Connector make-up	Over-moulded
Coding	A-coded
Overall length	2 meters
Connector seal rating	IP67
Braided	Yes
Braid type	Tin plated Copper
Jacket material	PUR
Jacket diameter	4.7mm (max)
Wire Gauge	24 AWG
Conductor strands	41x0.08mm



Pin Number	Internal Wire Colour	Function
1	Brown	+ve Supply
2	White	Y Axis Output
3	Blue	Gnd (0V)
4	Black	X Axis Output

M12 male connector
View from front:





Certification

The products are type approved to in accordance with the following directive(s):

EMC Directive 2004/108/EC

And it has been designed, manufactured and tested to the following specifications:

BS EN61326-1:2021 - Electrical equipment for measurement, control and laboratory use

Standard	Description
EN 55011: 2016 + A2: 2021 Class A Table 2 Rated Input power ≤ 20 kVA	Conducted RF Emissions
EN 55011: 2016 A2: 2021 Class A Table 4 Rated Input power ≤ 20 kVA	Radiated Emissions
EN 61326-1: 2021 Table 2 Performance criteria B	Electrostatic Discharge
EN 61326-1: 2021 Table 2 Performance criteria A 10 V/m, 80 % AM 1 kHz, 80 MHz to 1 GHz 3 V/m, 80 % AM 1 kHz, 1.4 GHz to 6 GHz	Radiated RF Immunity 80 MHz to 2.7 GHz
EN 61326-1: 2021 Table 2 Performance criteria B	Fast Transient and Burst Immunity
EN 61326-1: 2021 Table 2 Performance criteria B	Surge Immunity
EN 61326-1: 2021 Table 2 Performance criteria A 3 V, 80 % AM 1 kHz	Conducted RF Immunity
EN 61326-1: 2021 Table 2 Performance Criteria A	Power Frequency Magnetic Field Immunity

Certification is available on request.