



## Features

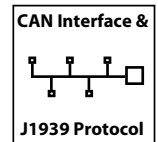
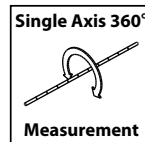
- Single axis measurement range  $\pm 180^\circ$
- Dual redundant, solid state MEMS sensing elements with high performance relative to cost
- Optional temperature compensation to further improve performance over a wide operating range
- Multi-drop CAN Bus interface, with SAE J1939 protocol
- User-configurable CAN Source Address and damping filter (with options from 0.1 to 40Hz)
- Accuracy to  $\pm 0.15^\circ$  over full range
- Anodised Aluminium housing, IP67 / IP69K rated
- Optional termination resistor



## Description

The MAS-360 series are a range of high-accuracy, low-cost tilt sensors that are configured for single-axis measurement over a  $360^\circ$  range. They feature two solid state MEMS sensing elements, which exhibit high-performance relative to cost. Each sensor has a CAN communications interface, and is designed for use with industrial, agricultural and construction machinery using the SAE J1939 protocol. They are bus/network compatible, user-addressable, and are supplied in a machined anodised Aluminium housing. The devices are individually calibrated to minimise non-linearity, zero bias, and temperature errors. User-adjustable

damping makes this suitable for a variety of applications, and the dual redundant sensing elements provide fault detection in safety-critical applications e.g. aerial work platforms. It can optionally be produced with bus termination (enquire for details). These devices are manufactured & calibrated in our UK factory to guarantee performance to the stated specification.



## Specifications

Parameter	Value	Unit	Notes
<b>Supply Voltage</b>	6.5 to 36	V dc	Supply voltage is protected internally against reverse polarity, and supply transients.
<b>Operating Current</b>	20	mA	When operated from 12V supply. Power consumption increases when transmitting into a terminated bus
<b>Operating Temperature</b>	-40 to 85	°C	Maximum operating temperature range.
<b>CAN Data Rate</b>	50 / 250 / 500	Kbps	Bit rate is adjustable (50, 250 or 500Kbit/s) via the CAN interface
<b>Default Address</b>	129		The default J1939 Source Address is 129. This can be user-adjusted using the Commanded Address (CA) function. See <a href="#">communication specification</a> for details
<b>Damping Filter (default)</b>	1	Hz	A user-selectable low-pass filter which is adjustable between 0.1-40Hz via the CAN interface. It can be useful (for example) to reduce the effects of Vibrations.
<b>Mechanical shock</b>	3000 (0.5ms) 10000 (0.1ms)	g	Shock survival limit for MEMS sensor.
<b>Cable Length</b>	0.45	m	Other lengths available on request
<b>Connector</b>	DT04-4P		Deutsch DTM04-4P male connector
<b>Sealing</b>	IP67 / IP69K		
<b>Weight</b>	60	g	Including cable and connector



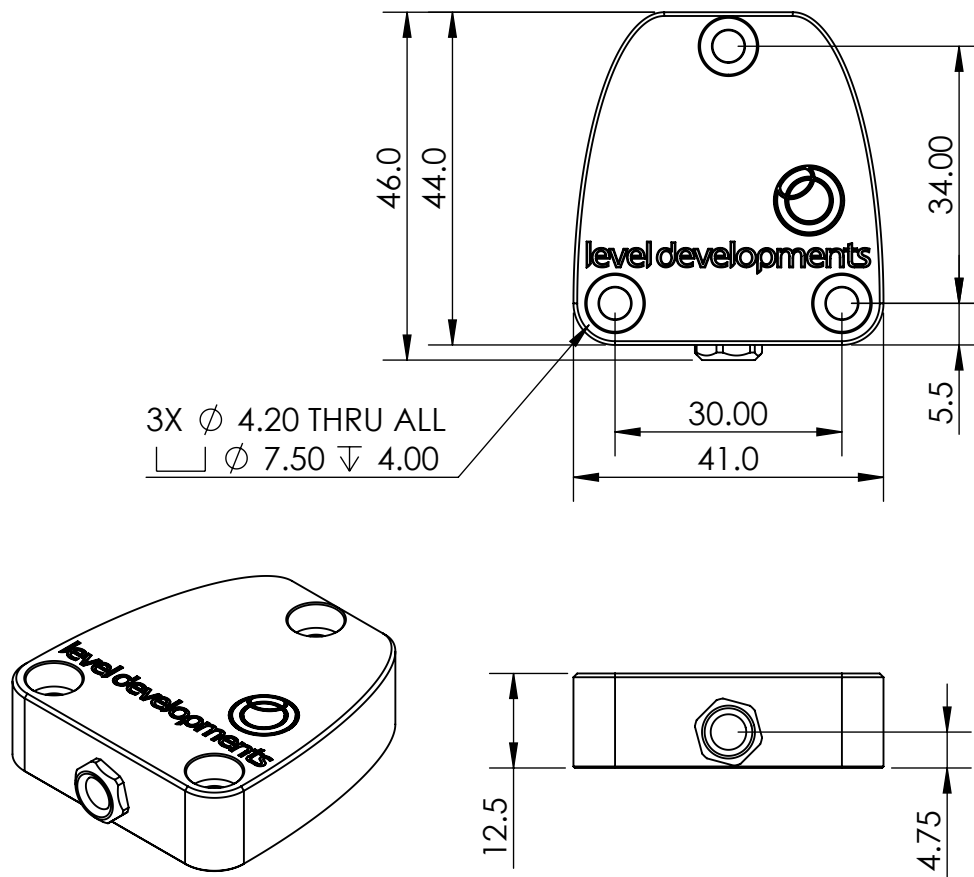
## Performance Specifications

Parameter	Specification	Unit
Measuring range	±180	°
Accuracy (@20°C)	±0.15	°
<b>Temperature Errors (without compensation)</b>		
Zero Drift	±0.02	°/°C
Sensitivity Drift	±0.02	%/°C
<b>Temperature Errors (with compensation)</b>		
Zero Drift	±0.002	°/°C
Sensitivity Drift	±0.003	%/°C
Accuracy -10 to 50°C (without compensation)	±0.85	°
Accuracy -10 to 50°C (with compensation)	±0.25	°
Resolution (with 1Hz damping)	0.01	°

Parameter	Notes
Measuring range	Defines the calibrated measurement range. Zero position can be reset anywhere in range. Settings are stored in non volatile memory so are remembered after power down. Device may continue to measure outside this range, but performance specification cannot be guaranteed outside the specified range.
Accuracy (@20°C)	This is the <b>maximum</b> error between the measured and displayed value at any point in the measurement range when the device is at room temperature (20°C). This value includes non-linearity and cross axis errors.
<b>Temperature Errors</b>	Temperature changes cause drift in the zero position output as well as changes to the sensitivity of the sensor. These specifications are defined below:
Zero Drift	If the device is mounted to a level surface in the zero position, this value is the <b>maximum</b> drift of the output angle per °C change in temperature.
Sensitivity Drift	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: $E_{sd} = SD \times \Delta T \times \theta$ Where: $E_{sd}$ is the change in output (in degrees) due to sensitivity temperature change $SD$ is the sensitivity drift specification from the above table (0.02% or 0.002%) $\Delta T$ is the change in temperature in °C $\theta$ is the current angle of the inclinometer axis in question in degrees.
Accuracy -10 to 50°C (without compensation)	This is the <b>maximum</b> error between the measured and displayed value at any point in the measurement range at any temperature over the specified temperature range without individual temperature compensation.
Accuracy -10 to 50°C (with compensation)	This is the <b>maximum</b> error between the measured and displayed value at any point in the measurement range at any temperature over the calibrated temperature range with individual temperature compensation.
Resolution (with 1Hz damping)	Resolution is the smallest measurable change in output. Resolution is inversely proportional to the square root of the frequency response, and as such the resolution will be lower for faster frequency response settings.

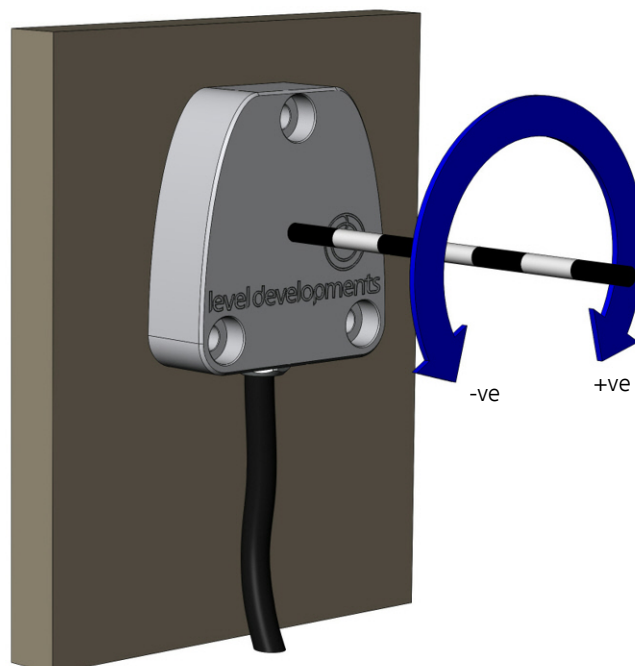


## Dimension Drawing



## Axis Direction and Mounting Orientation

### Mounted on Vertical Surface

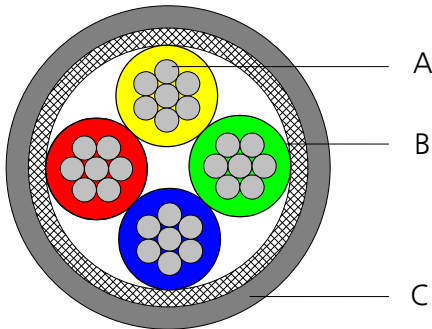




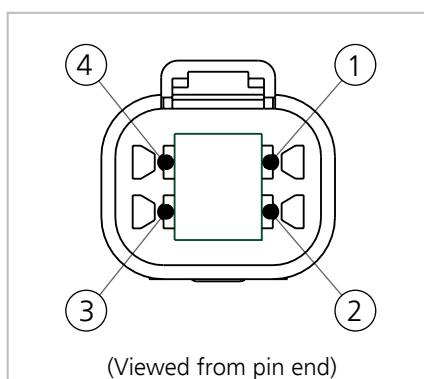
## Cable and Connector Details

Standard cable is 0.45m long. Cables can be supplied in any length.

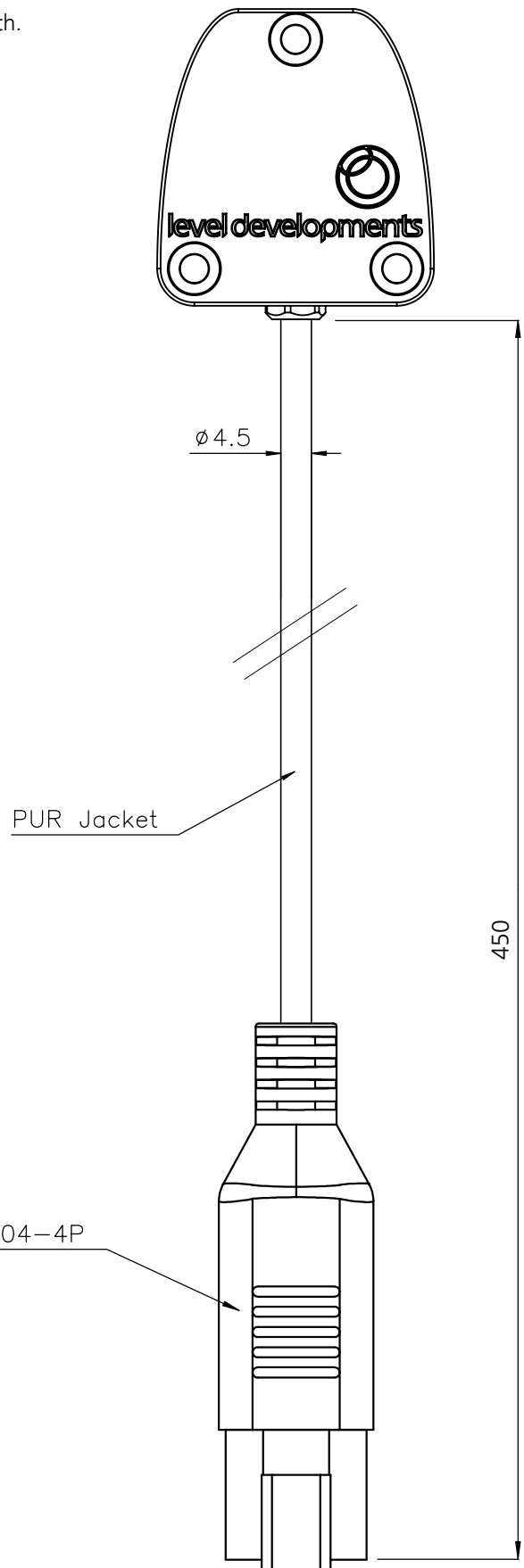
- A. Core wires, tin plated copper, 41x0.08mm strands per conductor (24 AWG).
- B. 4 conductors, colours red, blue, yellow and green. PVC core insulation.
- C. Black PUR Solar jacket. Flame retardant, reduced smoke generation, zero halogen, excellent for use in water and oil, good for use in acids and fuels, radiation tolerance: 10E6 Gy, UV stable, suitable for continuous outdoor use.



Parameter	Value	Unit	Notes
Approximate Weight	50	g/m	
Operating Temperature	-20 to 70	°C	Dynamic
Operating Temperature	-40 to 85	°C	Fixed
Conductor Resistance	80	Ω/Km	Maximum
Insulation Resistance	1500	MΩ/Km	Minimum
Test Voltage	1	KV DC	
Voltage Rating	250	V	
Core Current Rating	1	A	At 40°C
Individual Core Diameter	1.3	mm	
Overall Diameter	4.5	mm	



Pin No.	Internal Wire Colour	Function
1	Red	+ve Supply
2	Blue	Ground
3	Green	CAN-L
4	Yellow	CAN-H

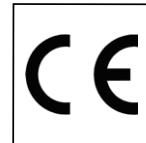




### UKCA & CE Certification

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

- EMC Directive 2004/108/EC



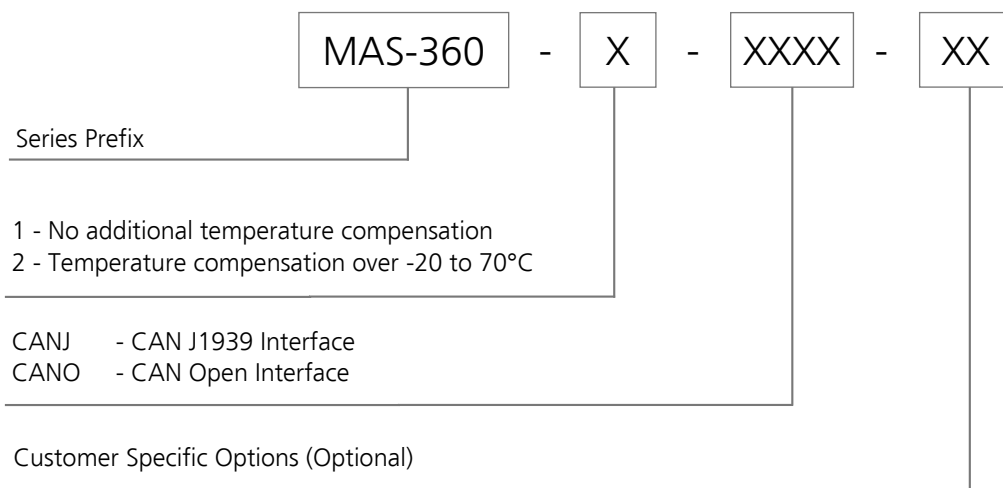
And it has been designed, manufactured and tested to the following specifications:

- BS EN61326-1:2006
- BS EN55011:2007, Group 1, Class B

Electrical equipment for measurement, control and laboratory use - EMC Requirements

Certification is available on request.

### Part Numbering



Example:

#### **MAS-360-2-CANJ**

MAS-360 Series single axis inclinometer ( $\pm 180^\circ$  Full Scale Measurement Range)

Temperature compensated over the range -10 to 60°C

CAN interface with J1939 protocol