



## Features

- Dual axis measurement range from  $\pm 15$  to  $\pm 60^\circ$
- Solid state MEMS sensor
- CAN Bus interface with SAE J1939 protocol
- Accuracy down to  $\pm 0.1^\circ$
- Optional dual redundant sensing elements
- Temperature compensated
- Anodised Aluminium housing, IP67 / IP69K rated
- Programmable frequency response (0.1 to 40Hz)
- Onboard temperature sensor
- Small size, 44 x 41 x 12.5mm
- Optional bus termination resistor



## Description

The MAS-2 is a low cost dual axis inclinometer sensor supplied in a sealed machined anodised Aluminium housing. It has a CAN J1939 digital interface and is designed for use with industrial, agricultural and construction machinery with a CAN bus system using the SAE J1939 protocol. The devices are individually calibrated to minimise non-linearity errors, cross axis, zero bias and temperature related errors. Our automated calibration system combined with our powerful compensation algorithms make for a high performance low cost sensor. It has a programmable filter so that it can be used in a wide variety of applications. Filtering can be used to reduce the effects of machine vibration

on the output. The device also incorporates options for a  $120\Omega$  bus terminator and a redundant sensing element for advanced fault detection in safety critical applications. These devices are manufactured and calibrated in our UK factory to guarantee performance to the stated specification.

Applications include:

- Excavator position measurement and levelling
- Agricultural and industrial vehicle tilt monitoring
- Mobile crane position monitoring and levelling
- Telescopic and scissor lift platform monitoring
- Auger and pile driving machinery

## Specifications

Parameter	Value	Unit	Notes
Supply Voltage	6.5 to 36	V dc	Supply voltage is protected internally against reverse polarity, and supply transients.
Operating Current	20	mA	When operated from 12V supply. Power consumption increases when transmitting into a terminated bus
Operating Temperature	-40 to 85	$^\circ\text{C}$	Maximum operating temperature range.
CAN Data Rate	250 / 500	Kbps	Bit rate is adjustable (250 or 500Kbit/s) via the CAN interface
Default Address	129		Default device address is 129 (with arbitrary address capability).
Frequency Response	1	Hz	2nd order Bessel low pass filter response. This is adjustable between 0.1Hz and 40Hz via the CAN interface
Mechanical shock	3000 (0.5ms) 10000 (0.1ms)	g	Shock survival limit for MEMS sensor.
Cable Length	0.3	m	Other lengths available on request
Connector	DTM04-4P		Deutsch DTM04-4P male connector
Sealing	IP67 / IP69K		
Weight	60	g	Including cable and connector



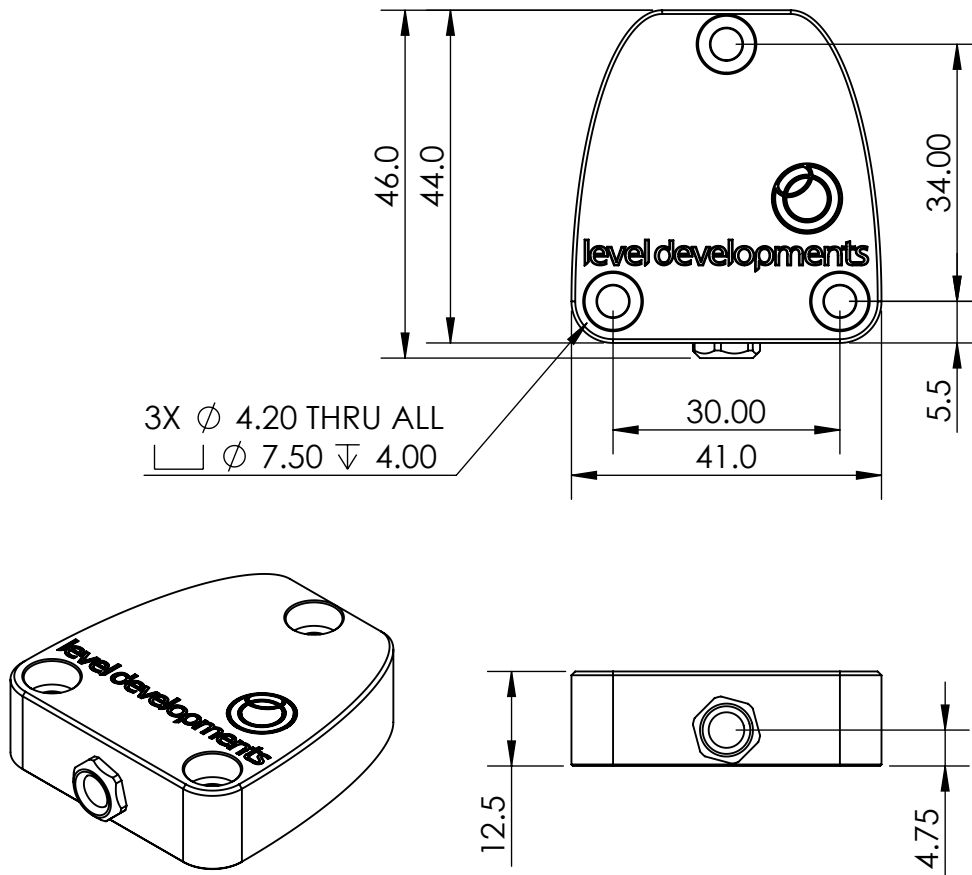
Performance Specifications

Parameter	MAS-2-15	MAS-2-30	MAS-2-45	MAS-2-60	Unit
Measuring range	±15	±30	±45	±60	°
Zero Bias Error	±0.1	±0.1	±0.1	±0.1	°
Accuracy (@20°C)	±0.1	±0.2	±0.3	±0.4	°
<b>Temperature Errors (without compensation)</b>					
Zero Drift	±0.02	±0.02	±0.02	±0.02	°/°C
Sensitivity Drift	±0.02	±0.02	±0.02	±0.02	%/°C
<b>Temperature Errors (with compensation)</b>					
Zero Drift	±0.002	±0.002	±0.002	±0.002	°/°C
Sensitivity Drift	±0.003	±0.003	±0.003	±0.003	%/°C
Accuracy -10 to 60°C (without compensation)	±1	±1.2	±1.5	±1.7	°
Accuracy -10 to 60°C (with compensation)	±0.17	±0.29	±0.40	±0.52	°
Resolution (@1Hz bandwidth)	0.02	0.02	0.02	0.02	°

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.
Zero Bias Error	This is the <b>maximum</b> angle from the device when it is placed on a perfectly level surface. The zero bias error can be removed from measurement errors either by mechanical adjustment, or as a fixed offset value after installation, or by using the relevant CAN message command to zero the device
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.
Temperature Errors	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: <b>E<sub>sd</sub></b> is the change in output (in degrees) due to sensitivity temperature change <b>SD</b> is the sensitivity drift specification from the above table (0.02% or 0.002%) <b>ΔT</b> is the change in temperature in °C <b>θ</b> is the current angle of the inclinometer axis in question in degrees.
Accuracy -10 to 60°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 60°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 (@1Hz bandwidth)	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.

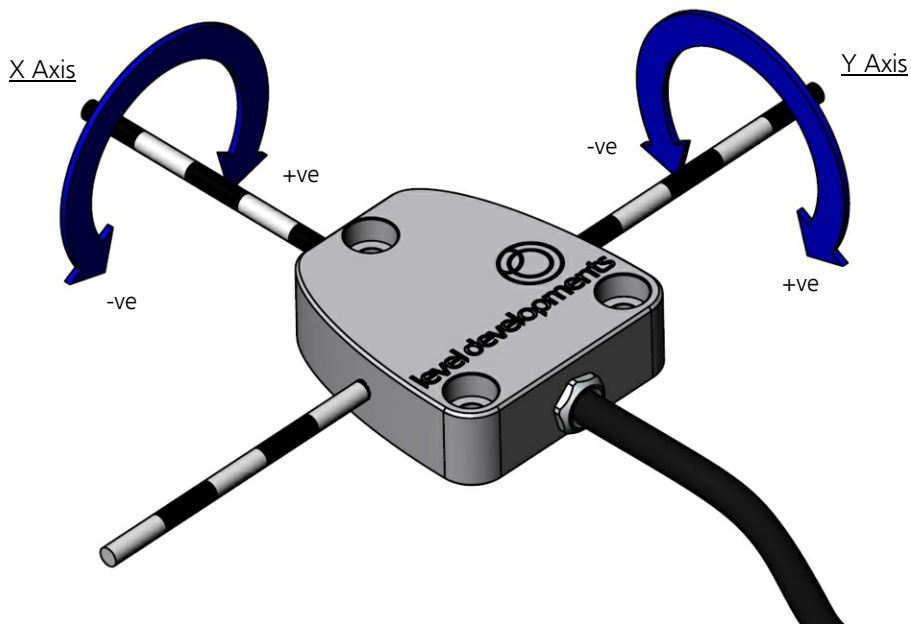


Dimension Drawing



Axis Direction and Mounting Orientation

Mounted on Horizontal Surface

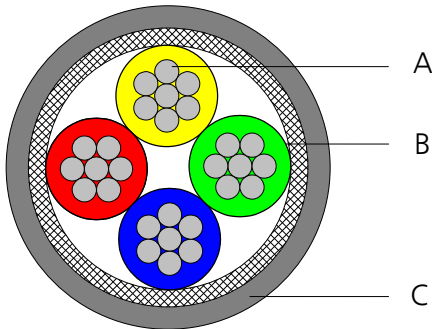




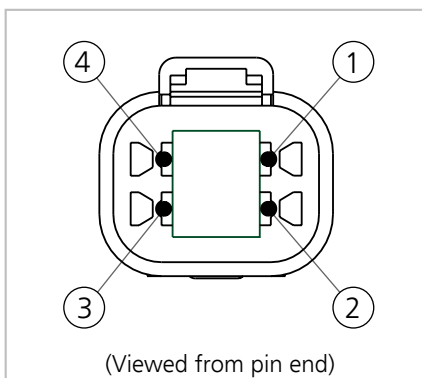
**Cable and Connector Details**

Standard cable is 0.3m long. Cables can be supplied in any length.

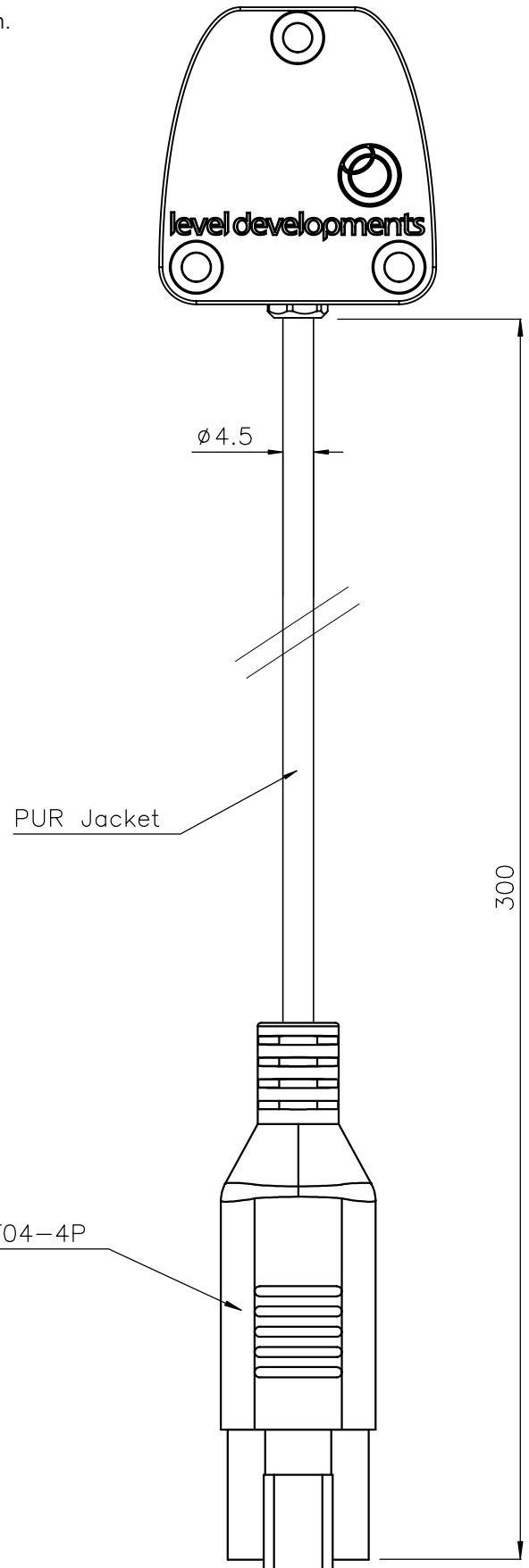
- A. Core wires, tin plated copper, 41x0.08mm strands per conductor (24 AWG).
- B. 4 conductors, colours red, blue, yellow and green. PVC core insulation.
- C. Black PUR Solar jacket. Flame retardant, reduced smoke generation, zero halogen, excellent for use in water and oil, good for use in acids and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





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

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

BS EN55011:2007, Group 1  
Class B

Certification is available on request.

Part Numbering



Series Prefix

- MA - Medium accuracy (utilises lower cost sensor)
- HA - Higher accuracy (utilises precision sensor)
- DR - Dual redundant (utilises both sensors)

- 15 - ±15° Full Scale Measurement Range
- 30 - ±30° Full Scale Measurement Range
- 45 - ±45° Full Scale Measurement Range
- 60 - ±60° Full Scale Measurement Range

- 1 - No additional temperature compensation
- 2 - Temperature compensation over -20 to 70°C

- CANJ - CAN J1939 Interface
- CANO - CAN Open Interface

Customer Specific Options (Optional)