



Features

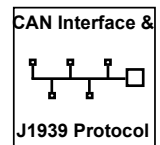
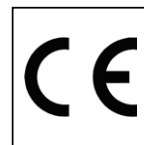
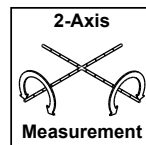
- Dual axis measurement range from ± 15 to $\pm 60^\circ$
- Multi-drop CAN interface with J1939 protocol
- Dual redundant, solid state MEMS sensing elements with high performance relative to cost
- User-configurable CAN Source Address and damping filter (with options from 0.1 to 40Hz)
- Optional temperature compensation
- Anodised Aluminium housing, IP67 / IP69K rated
- 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 bussed 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 and low cost sensor. It features a user-programmable damping filter which can be used to reduce the effects of vibration on the output, this

makes it suitable for use in a wide variety of applications. The MAS-2 series also incorporates dual redundant sensing elements for advanced fault detection in safety critical applications such as aerial work platforms, and they can optionally be produced with bus termination (e.g. 120 Ω). These devices are manufactured and calibrated in our UK factory to guarantee performance to the stated specification.



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	°C	Maximum operating temperature range.
CAN Data Rate	50 / 250 / 500	Kbps	Bit rate is adjustable (50, 250 or 500Kbit/s) via the CAN interface
Default Address	129		The default J1939 Source Address is 129. This is user-adjustable using the Commanded Address (CA) function. See the communication specification for details
Damping Filter (default)	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 vibration.
Mechanical shock	3000 (0.5ms) 10000 (0.1ms)	g	Shock survival limit for MEMS sensor.
Cable Length	0.45	m	Other lengths available on request
Connector	DT04-4P		Deutsch DT04-4P male connector
Sealing	IP67 / IP69K		
Weight	60	g	Including cable and connector



Performance Specifications

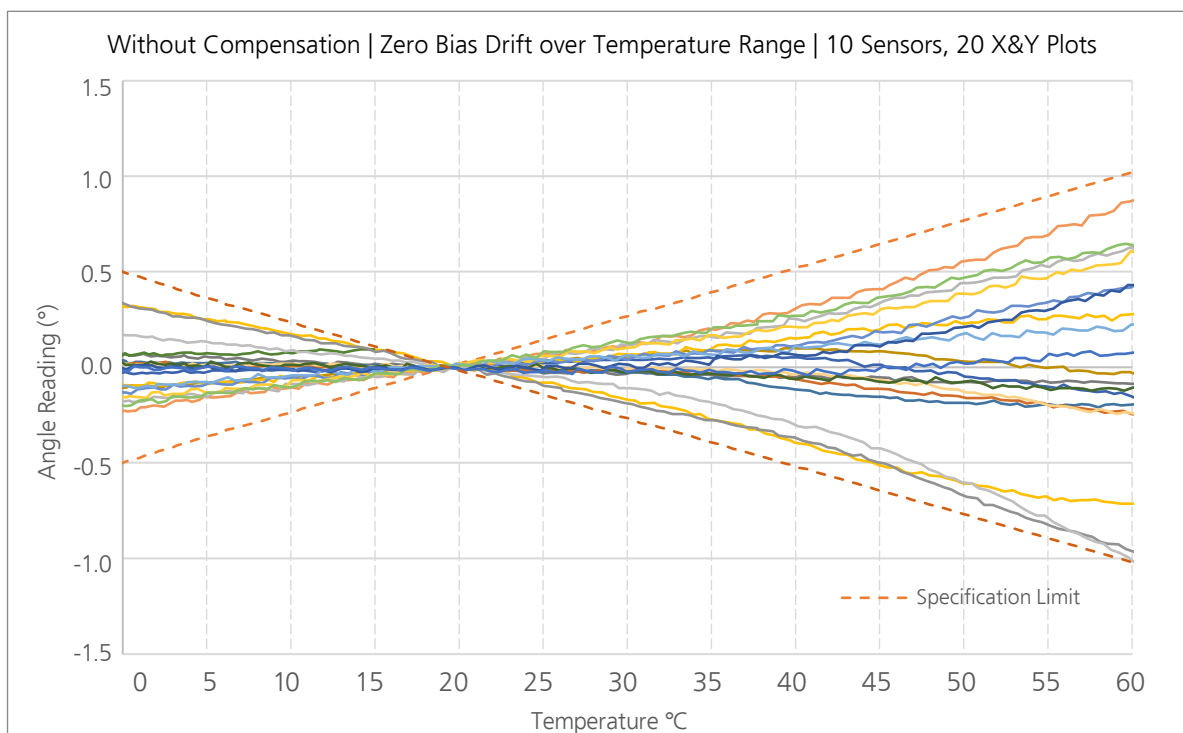
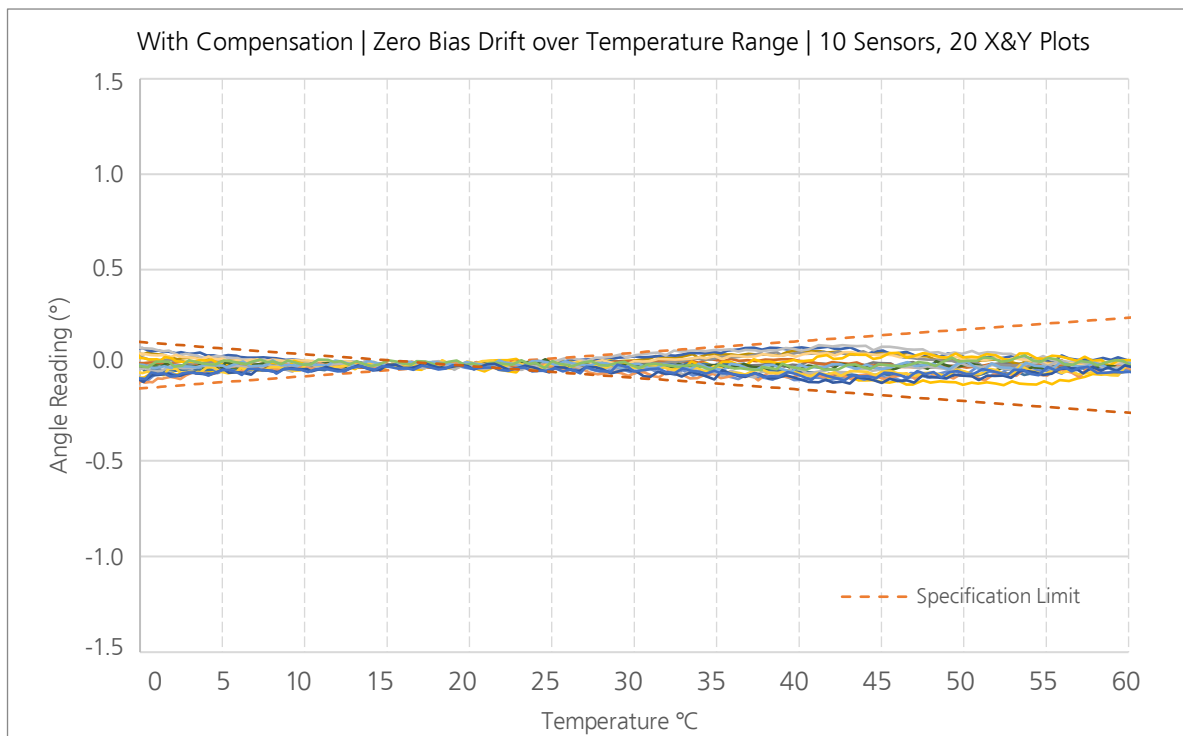
Parameter	MAS-2-15	MAS-2-30	MAS-2-45	MAS-2-60	Unit
Measuring range	±15	±30	±45	±60	°
Zero Bias Error	±0.05	±0.05	±0.05	±0.05	°
Accuracy (@20°C)	±0.1	±0.125	±0.15	±0.175	°
Temperature Errors (without compensation)					
Zero Drift (Typical)	0.015	0.015	0.015	0.015	°/°C
Zero Drift (Maximum)	0.025	0.025	0.025	0.025	°/°C
Sensitivity Drift (Maximum)	0.020	0.020	0.020	0.020	%/°C
Temperature Errors (with compensation)					
Zero Drift (Typical)	0.003	0.003	0.003	0.003	°/°C
Zero Drift (Maximum)	0.006	0.006	0.006	0.006	°/°C
Sensitivity Drift (Maximum)	0.003	0.003	0.003	0.003	%/°C
Accuracy -10 to 60°C (Typical, without compensation)	0.85	1	1.15	1.3	°
Accuracy -10 to 60°C (Typical, with compensation)	0.3	0.35	0.4	0.45	°
Resolution (with 1Hz Damping Filter)	0.01	0.01	0.01	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.
Zero Bias Error	This is the maximum 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 maximum 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 typical/maximum drift (as specified) 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%) ΔT is the change in temperature in °C θ is the current angle of the inclinometer axis in question in degrees.
Accuracy -10 to 60°C (without compensation)	This is the maximum 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 maximum 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 Filter)	Resolution is the smallest measurable change in output. Resolution is inversely proportional to the square root of the damping filter's response, and as such the resolution will be lower for faster response settings.



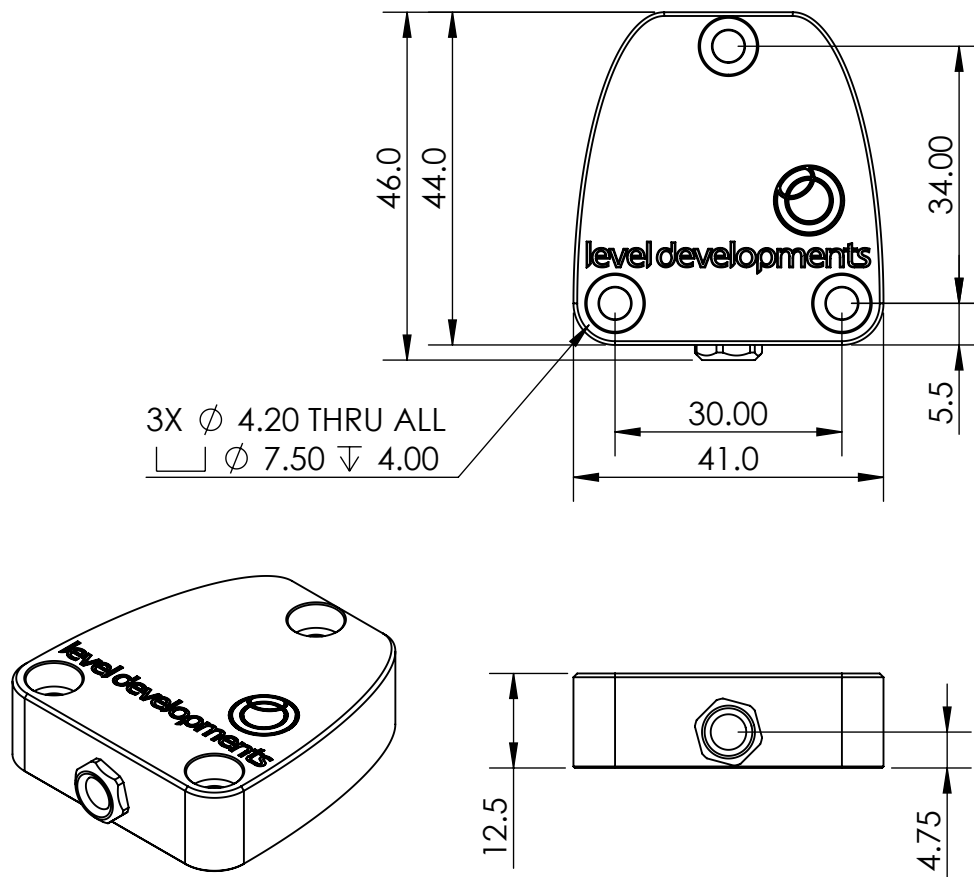
Temperature Performance and Optional Temperature Compensation

All inclinometer sensors can be influenced by temperature-induced zero-bias drift. The MAS-2 uses high-quality sensing components which have low drift compared with competitive devices. However, a version is available with Level Developments' unique and highly effective temperature compensation which maintains stability over a wider temperature range. The graphs below show the performance of the same 10 devices, (both) with & without this temperature compensation.



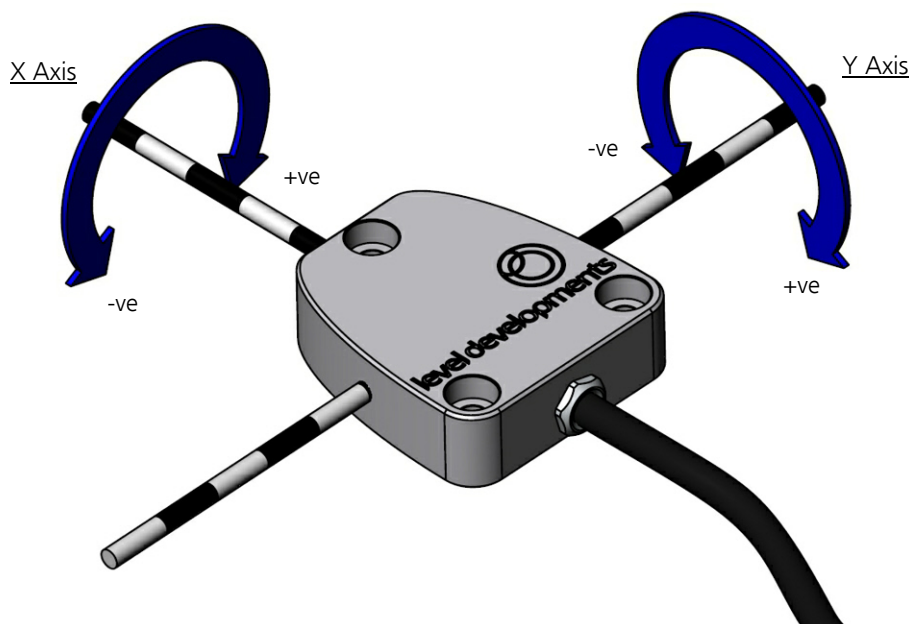


Dimension Drawing



Axis Direction and Mounting Orientation

Mounted on Horizontal Surface

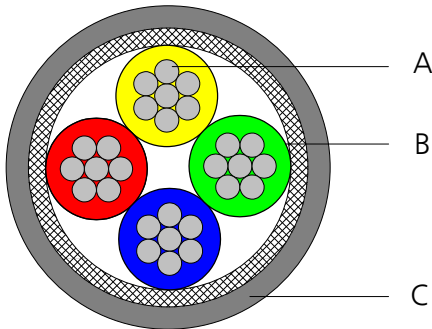




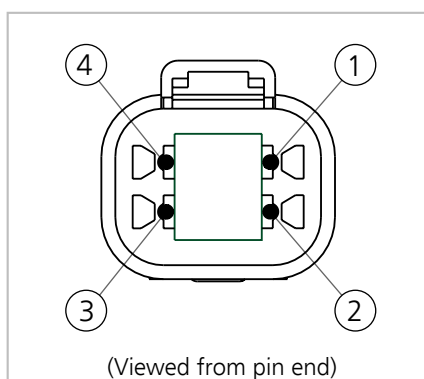
Cable and Connector Details

Standard cable is 0.45m long. In volume they can be supplied any length.

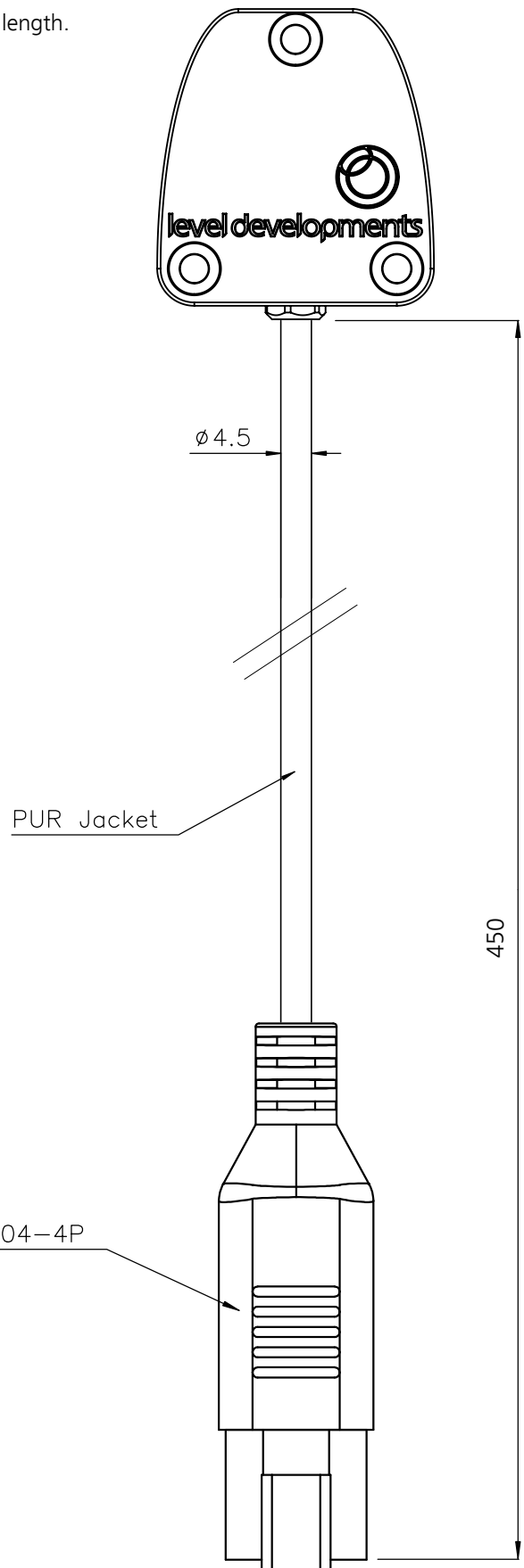
- A. Core wires, tin plated copper, 41x0.08mm strands per conductor (24 AWG).
- B. 4 conductors, colours red, blue, yellow and green. PVC core insulation.
- C. Black PUR Solar jacket. Flame retardant, reduced smoke generation, zero halogen, excellent for use in water and oil, good for use in acids and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

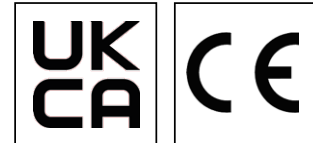




UKCA & CE Certification

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

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

15 - $\pm 15^\circ$ Full Scale Measurement Range
30 - $\pm 30^\circ$ Full Scale Measurement Range
45 - $\pm 45^\circ$ Full Scale Measurement Range
60 - $\pm 60^\circ$ 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)