



Features

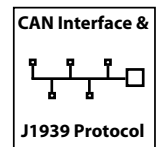
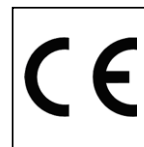
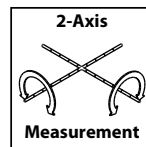
- Dual axis inclinometer, measurement range $\pm 90^\circ$
- DOG2 compatible J1939 protocol over multi-drop CAN interface, optional bus termination resistor.
- Dual redundant, solid state MEMS sensing elements with high performance relative to cost
- Option for user-configurable CAN Source Address and damping filter (with settings from 0.4 to 20Hz)
- Optional temperature compensation
- Anodised Aluminium housing, IP67 / IP69K rated
- Onboard temperature sensor
- Small size, 45 x 70.5 x 14.5mm



Description

The TDR-2-CANJ series of inclinometer sensors is built using the technology from our MAS-2 series sensors, but packaged and cabled for compatibility with DOG2 sensors. These low-cost, dual-axis sensors are packaged in sealed, machined anodised Aluminium housings. They utilise a CAN J1939 digital interface, and are ideal for industrial, agricultural, and construction machinery using the SAE J1939 protocol. Each sensor is individually calibrated to minimize non-linearity, cross-axis, zero bias, and temperature errors. Our automated calibration system and powerful compensation algorithms ensure high performance and low cost. A user-programmable damping filter can be used to reduce the

effects of vibration, making them suitable for a wide range of applications. The TDR-2-CANJ series also includes 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	250	Kbps	50 & 500Kbit/s options available for volume orders
Default Address	0xC2/ 0xC0		The default J1939 Source Address is 0xC2 or 0xC0 depending on model. This is user-adjustable for the TDR-...-2 model over CAN bus. See page 6.
Damping Filter (default)	5	Hz	A user-selectable low-pass filter which is adjustable between 0.4-20Hz 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	0.5	m	
Connector	Superseal		AMP Superseal 1.5 Series 4 Pole PN: 282106-1 see page 5
Sealing	IP67 / IP69K		
Weight	120	g	Including cable and connector



Performance Specifications

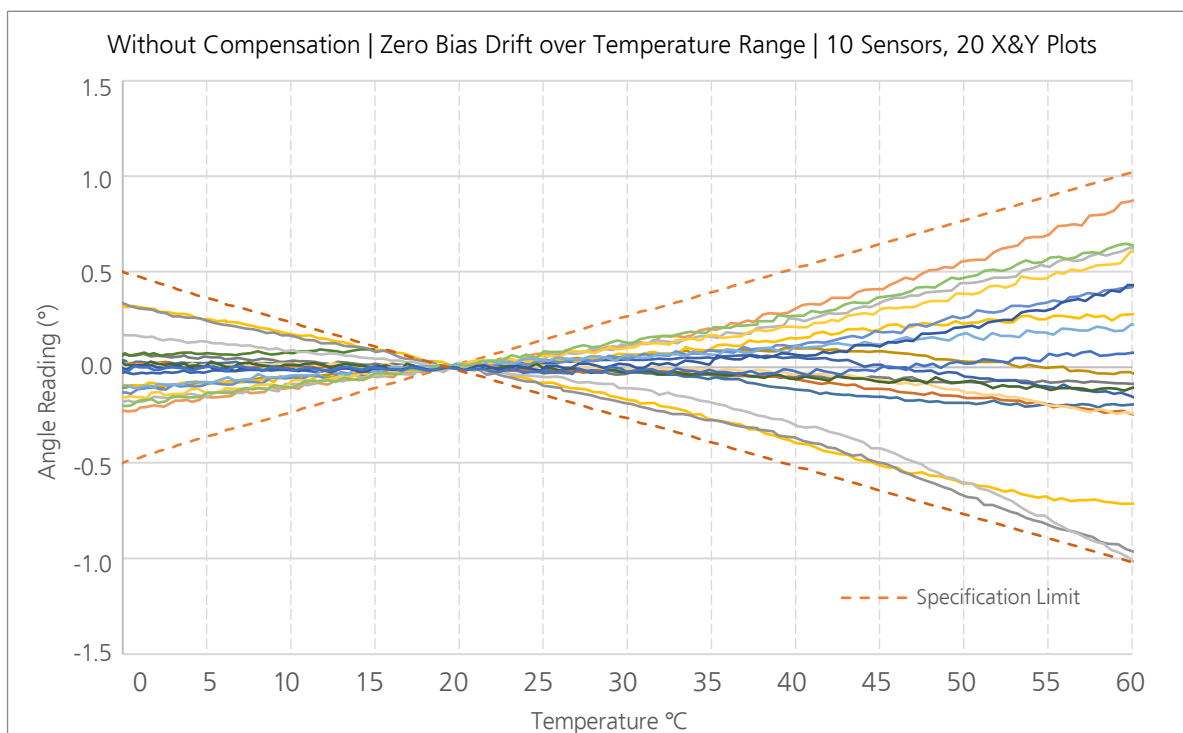
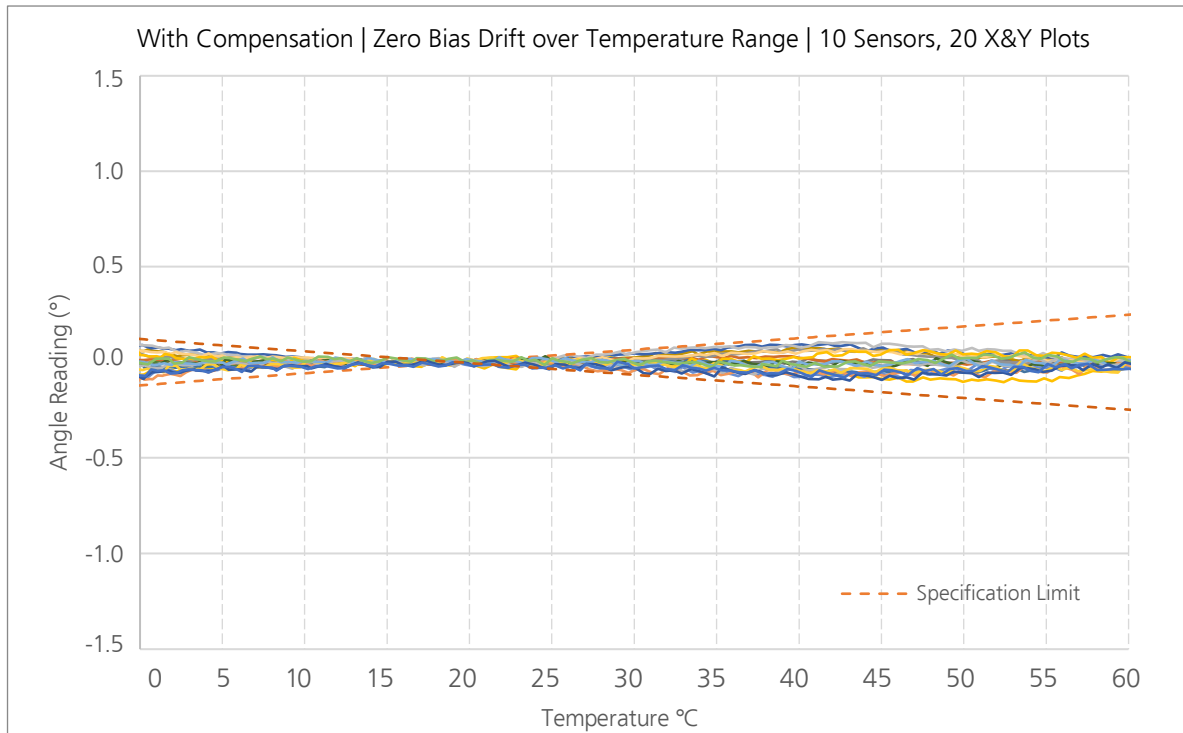
Parameter	Value	Unit
Measuring range	±90	°
Zero Bias Error	±0.05	°
Accuracy (@20°C)	±0.15	°
Temperature Errors (without compensation)		
Zero Drift (Typical)	0.015	°/°C
Zero Drift (Maximum)	0.025	°/°C
Sensitivity Drift (Maximum)	0.020	%/°C
Temperature Errors (with compensation)		
Zero Drift (Typical)	0.003	°/°C
Zero Drift (Maximum)	0.006	°/°C
Sensitivity Drift (Maximum)	0.003	%/°C
Accuracy -10 to 60°C (Typical, without compensation)	1.15	°
Accuracy -10 to 60°C (Typical, with compensation)	0.4	°
Resolution (with 1Hz Damping Filter)	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.
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 from 0° to ±45°, while at room temperature (20°C). This value includes non-linearity & cross axis errors. Accuracy ≥45° to ≤90° is not guaranteed.
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. 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.
Sensitivity Drift	
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.



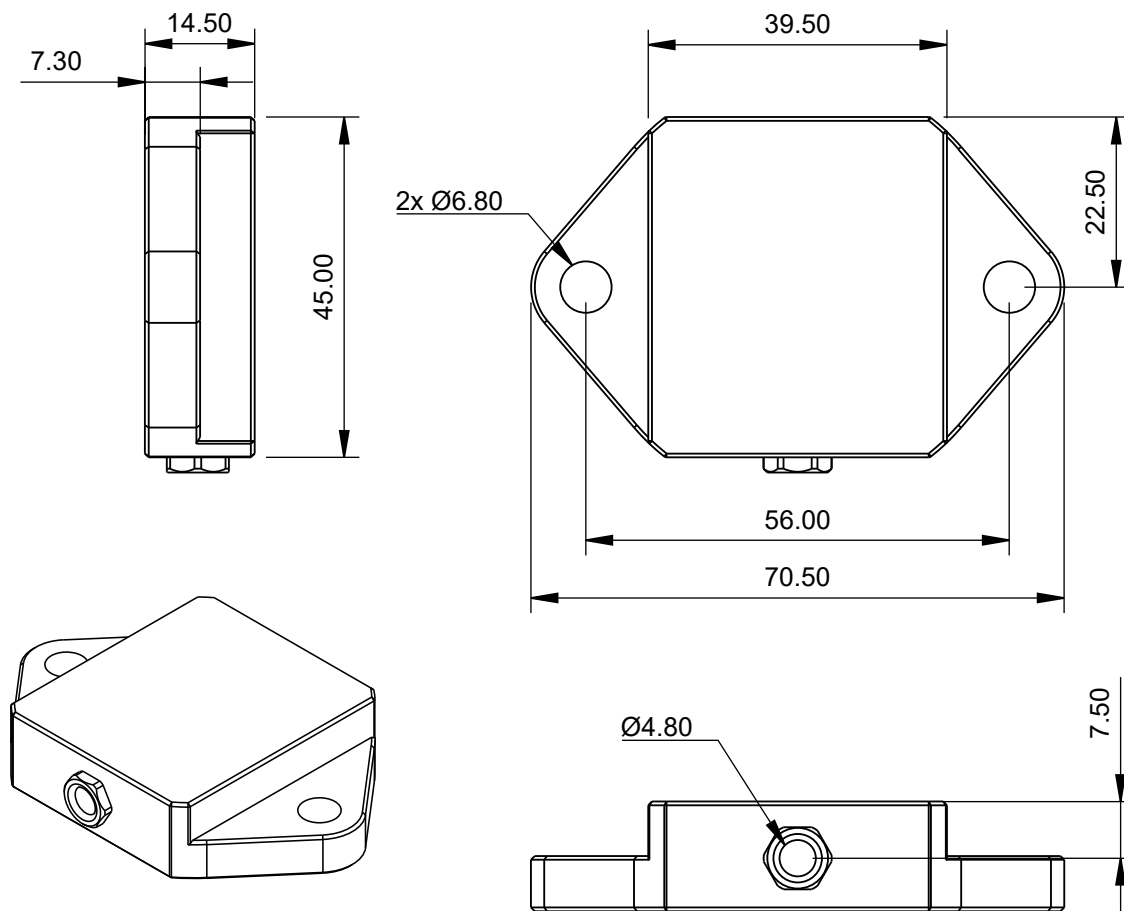
Temperature Performance and Optional Temperature Compensation

All inclinometer sensors can be influenced by temperature-induced zero-bias drift. The TDR-2-CANJ 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.





Housing Drawing



Axis Direction and Mounting Orientation

Horizontal surface is the zero plane



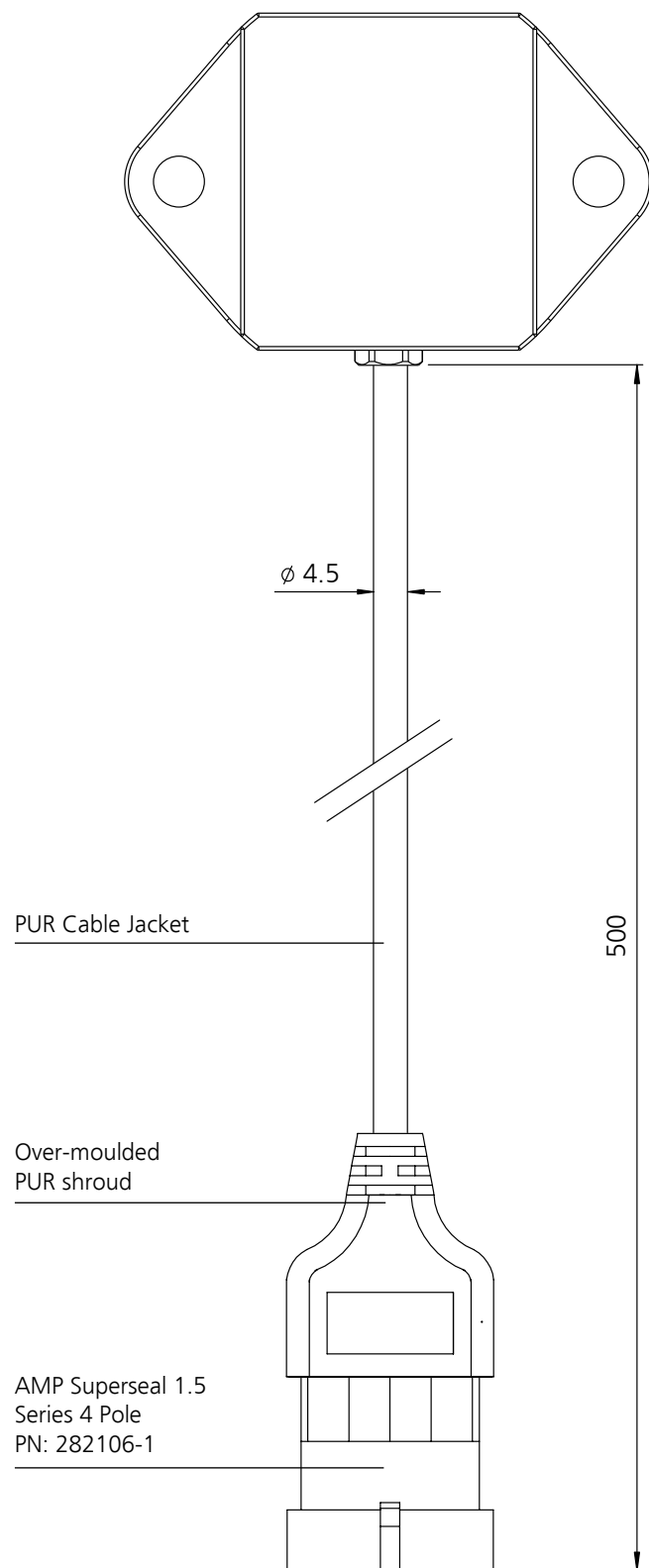
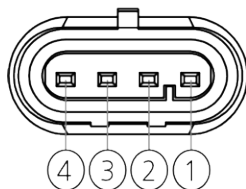


Cable and Connector Details

Parameter	Value
Connector description	AMP 282106-1 Male
Connector make-up	Connector boot
Overall length	0.5 meters
Connector seal rating	IP67
Braided	Yes
Braid type	Tin plated Copper
Jacket material	PUR
Jacket diameter	4.5mm
Wire Gauge	24 AWG
Conductor strands	41x0.08mm

Pin Number	Internal Wire Colour	Function
1	Blue	+ve Supply (7-32Vdc)
2	Brown	GND
3	White	CAN_H
4	Black	CAN_L

AMP male connector
View from front:





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:

TDR-2 - Dual Axis Inclinometer, $\pm 90^\circ$ range

- 1 - No additional temperature compensation
2 - Temperature compensation over -10 to 60°C

CANJ - Multi-drop communications interface, SAE J1939 CAN2.0B compliant

- 1 - Source Address 0xC2 (Fixed)
2 - Source Address default 0xC0, Range: 0x80-0xF7

Example:

The part number *TDR-2-2-CANJ-2* has the following configuration:

- Dual axis, DOG2 compatible inclinometer, with $\pm 90^\circ$ measurement range
- Additional temperature compensation = Yes
- CAN physical communications interface with J1939 protocol
- Default address is 0xC0, user-configurable from 0x80 to 0xF7