



## Description

The DAS series inclinometers are range of high performance low cost dual axis tilt sensors for measurement of angle in both the pitch and roll axes. They utilise a very high performance MEMS sensor which exhibits low long term & temperature drift compared with many competitive devices. Each sensor is packaged in a small, robust, sealed Aluminium housing and is supplied with a 2m screened PUR cable (longer cables are available on request). The high resolution output voltage varies from 0.5-4.5V over the range of the sensor. There are three measurement range options available:  $\pm 10^\circ$ ,  $\pm 30^\circ$  &  $\pm 90^\circ$ , and a further two supply voltage level options: 5V (DC), or 7V to 32V (DC). These sensors are CE certified, and are manufactured and individually tested in our UK factory to guarantee performance to the stated specifications.



## Features

- Dual axis, measuring ranges :  $\pm 10^\circ$ ,  $\pm 30^\circ$  or  $\pm 90^\circ$
- Input supply options: 5Vdc or 7-32Vdc
- Sealed to IP67
- Solid state MEMS sensor
- High resolution 0.5-4.5V voltage output
- Low cost relative to performance
- Small size, 46 x 43.5 x 13.5mm
- 2 meter, 4-core PUR cable with braided screen

## 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
<b>Supply Voltage</b> DAS-XX-A Version	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.
<b>Supply Voltage</b> DAS-XX-R Version	5.00	V dc	A clean and stable input supply should be used, DAS-XX-R models are not regulated internally. For greatest accuracy, the supply voltage level must account for the resistance of the cable.
<b>Operating Current</b> DAS-XX-A Version DAS-XX-R Version	20 18	mA mA	The supply current will vary depending on the Voltage supplied to the sensor, the values shown are maximum.
<b>Operating Temperature</b>	-40 to 85	°C	This is the maximum operating temperature range.
<b>Frequency Response</b>	3	Hz	This is the frequency at which the output is 3dB less than the input value.
<b>Mechanical shock</b>	5000	G	Shock survival limit for internal sensor 5000G for 0.5ms.
<b>0° Output Level</b>	2.5	V	For optimum zero point accuracy, mounting of the part can be adjusted.
<b>Output Impedance</b>	100	$\Omega$	
<b>Output Range</b>	0.5 - 4.5	V	See page 4 for more details.
<b>Cable</b>	2	m	4 core braided screen cable with black PUR jacket.
<b>Sealing</b>	IP67	-	Seal rating applies to housing and cable gland. Gland is not designed for flexible cable installation as this may compromise seal rating.
<b>Weight</b>	90	g	Including cable.
<b>Size</b>			
Width	46.0	mm	
Length	43.5	mm	
Height	13.5	mm	



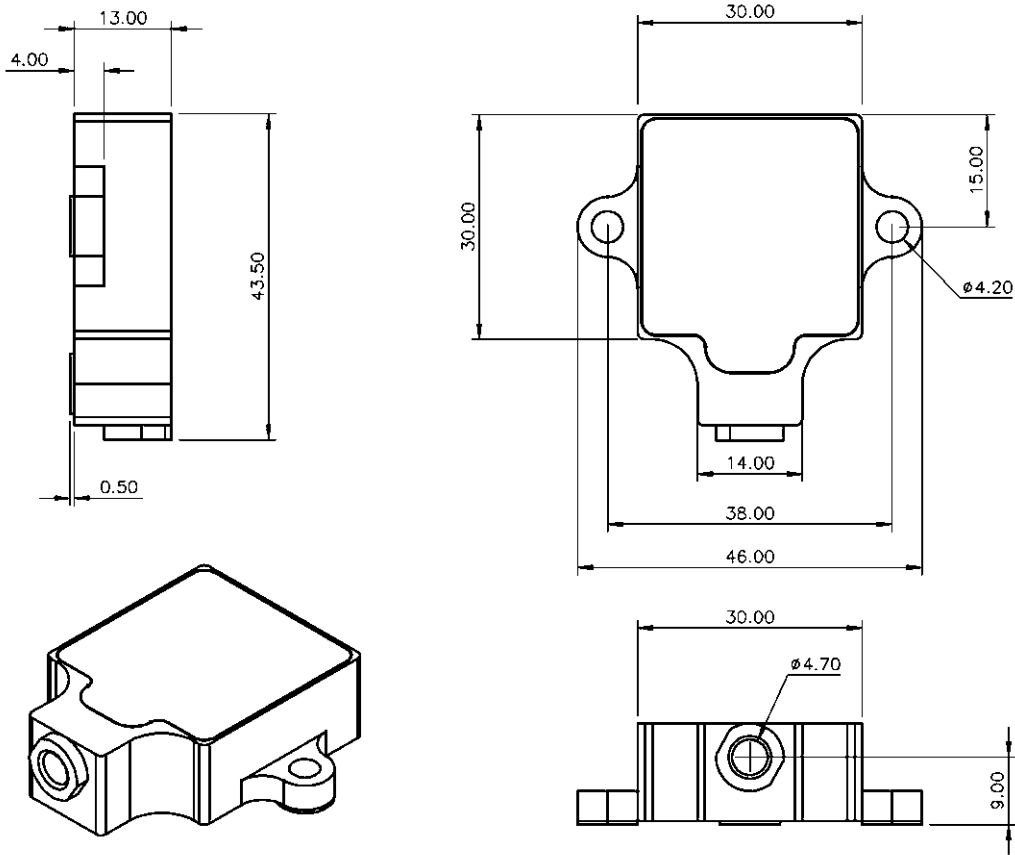
Performance & Output Specifications

Parameter	DAS-10-A	DAS-10-R	DAS-30-A	DAS-30-R	DAS-90-A	DAS-90-R	Unit
Measuring range	±10	±10	±30	±30	±90	±90	°
Zero Bias Error	±0.01	±0.01	±0.03	±0.03	±0.08	±0.08	°
Accuracy (20°C)	±0.07	±0.10	±0.07	±0.22	±0.15	±0.39	°
Sensitivity For first 1° For 1g range	201 11.518	201 11.518	70 4	70 4	35 2	35 2	mV/° V/g
Temperature Errors Zero Drift Sensitivity Drift	±0.0015 ±0.0030	±0.0015 ±0.0030	±0.0015 ±0.0030	±0.0015 ±0.0030	±0.0015 ±0.0030	±0.0015 ±0.0030	°/°C %/°C
Accuracy (-10 to 60°C)	±0.15	±0.18	±0.20	±0.35	±0.34	±0.58	°
Long Term Stability	±0.01	±0.01	±0.01	±0.01	±0.01	±0.01	°
Resolution (@3Hz bandwidth)	0.001	0.001	0.002	0.002	0.003	0.003	°

Parameter	Notes
Measuring range	Defines the calibrated measurement range.
Zero Bias Error	This is the maximum angle from the device when it is placed on a perfectly level surface. For optimum zero point accuracy, the mounting angle of the part can be adjusted.
Accuracy (20°C)	This is the <b>maximum</b> 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).
Sensitivity	This is the <b>nominal</b> amount that the voltage will change with when tilted throughout the range specified. The output is proportional to the Sine of the input, so the sensitivity changes throughout the range. 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 <b>maximum</b> 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: <b><math>E_{sd} = SD \times \Delta T \times \theta</math></b> Where: <b><math>E_{sd}</math></b> is the change in output (in degrees) due to sensitivity temperature change <b><math>SD</math></b> is the sensitivity drift specification from the above table (0.003) <b><math>\Delta T</math></b> is the change in temperature in °C <b><math>\theta</math></b> is the current angle of the inclinometer axis in question in degrees.
Accuracy (-10 to 60°C)	This is the <b>maximum</b> error between the measured and displayed value at any point in the measurement range (up to ±45°) at any temperature over the specified temperature range.
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 (@3Hz bandwidth)	Resolution is the smallest measurable change in output.

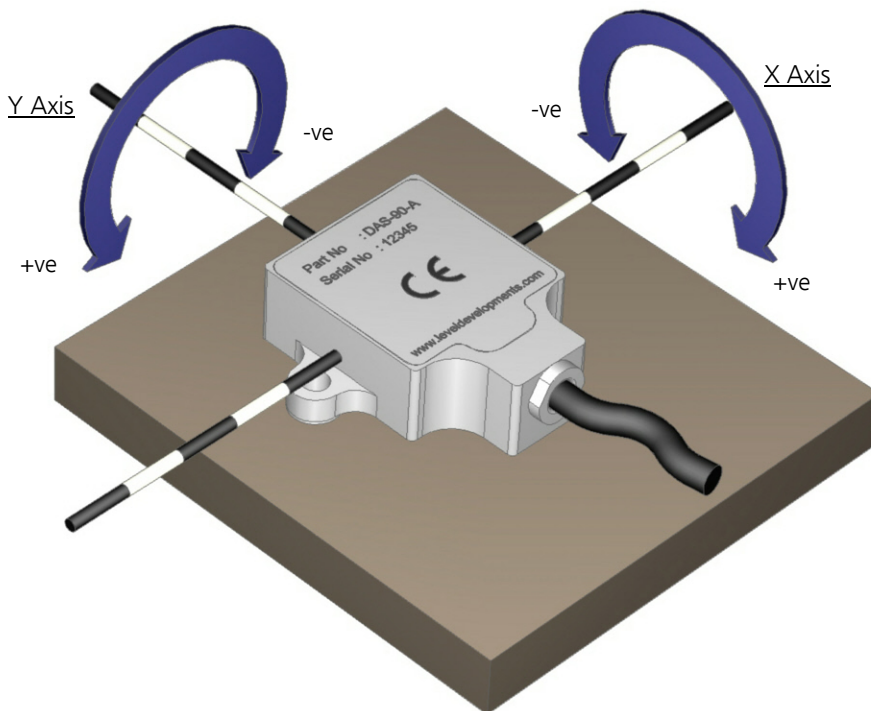


Housing Drawing



Axis Direction and Mounting Orientation and Wiring Details

Horizontal surface is the zero plane

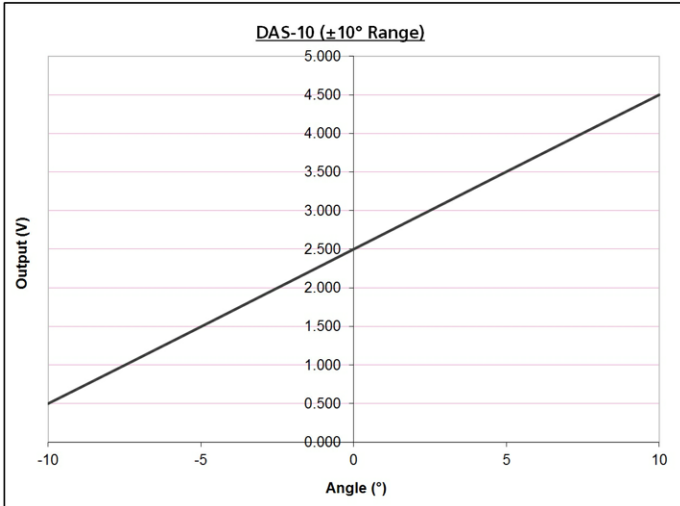


Wire Colour	Function
Red	+Ve Supply
Blue	GND
Yellow	X Axis Output
Green	Y Axis Output



### Voltage Output Change With Angle

All inclinometers measure a change in gravitational field 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 detected and converted to a voltage. In this sensor the output is linear with the change in acceleration (g), which means that the output is a Sine function of the change in angle (°). The graphs below show the output voltage vs. angle.



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

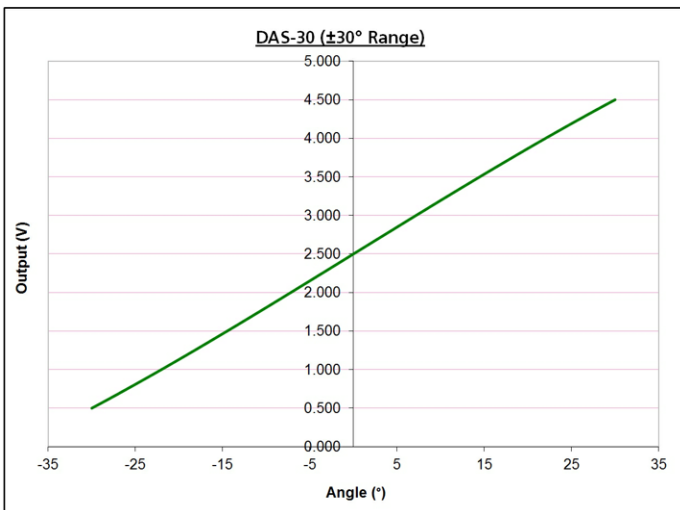
$$Angle = \sin^{-1} \left( \frac{V_{out} - V_{offset}}{Sensitivity} \right)$$

Where :

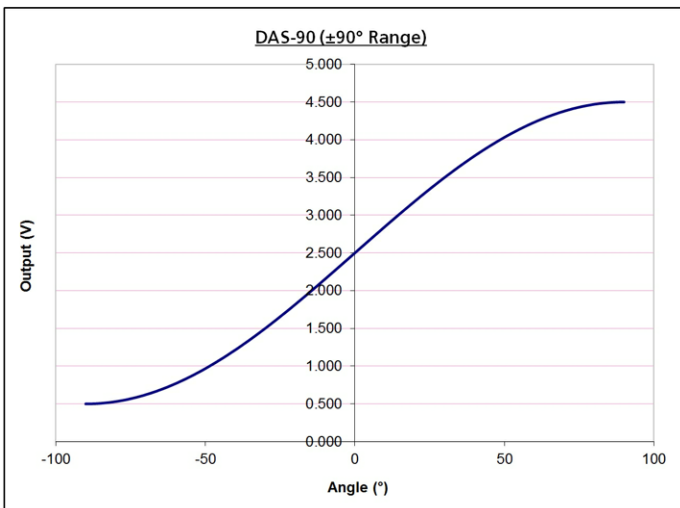
Vout = Measured voltage from the sensor

Voffset = Measured voltage from the sensor when the sensor is at 0° (usually 2.5V)

Sensitivity = Sensitivity of the device [V/g] (see specification table on page 1)



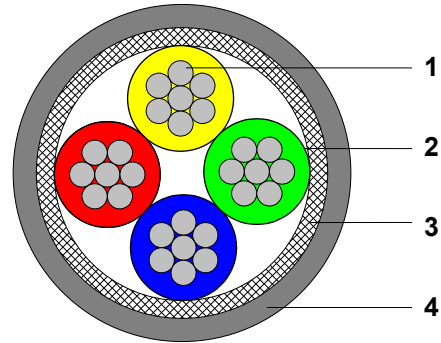
The output is very linear around the zero position, for example at ±10° the sine non linearity would only introduce an error of 0.05°. As the angle approaches 90° the sensitivity of the sensor drops significantly making measurements up to the full 90 degree range much less accurate.





**Cable Details**

1. Core wires, tin plated copper, 18x0.1mm strands per conductor (26 AWG).
2. 4 conductors, colours red, black, yellow and green. Polypropylene core insulation.
3. Braided screen of tin copper wire with minimum 85% coverage.
4. 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	40	g/m	
Operating Temperature	-40 to 85	°C	
Conductor Resistance	100	$\Omega$ /Km	Maximum resistance
Insulation Resistance	1500	M $\Omega$ /Km	Minimum resistance
Test Voltage	3	KV DC	
Voltage Rating	600	V	
Core Current Rating	2	A	At 40°C air temperature
Individual Core Diameter	1.1	mm	
Overall Diameter	4.5	mm	

Wire Colour	Function
Red	Vin
Blue	Gnd
Yellow	X Axis Output
Green	Y Axis Output

**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**

