

Electronic Clinometer

Range: $\pm 60^\circ$
Resolution: 0.001°
Choice of Outputs

The Electronic Clinometer is an extremely accurate angle measurement device. This compact and rugged sensor is ideal where space is critical and environmental conditions are serious design concerns.

The heart of the system is a patented, capacitance-based sensor with no moving parts. When rotated about its sensitive axis, this unique sensor provides an exceedingly linear variation in capacitance, which is electronically converted into angular data. The sensor and low-power CMOS electronics are encased in a rugged plastic housing ready to install as a system component or as a stand-alone device.

Designed for easy integration, with a choice of analog, ratiometric, digital or serial models, the clinometer produces an output signal corresponding to direction and magnitude of angular displacement.



Features

- CE certified**
- Just 2" in diameter**
- Rugged plastic housing**
- Extremely accurate**
- Weighs only 2 oz.**

Applications

- Wheel alignment**
- Construction equipment**
- Antenna positioning**
- Robotics**

Performance Specifications

Total Range	$\pm 60^\circ$
Linear Range	$\pm 45^\circ$
Threshold	0.001°
Linearity	
Null to 10°	$\pm 0.1^\circ$
10 to 45°	$\pm 1\%$
45 to 60°	Monotonic
Null Repeatability	0.05°
Cross Axis Error	$< 1\%$ up to 45°
Time Constant	0.3 sec
Freq. Response (-3db)	0.5 Hz
RF Susceptibility	$< \pm 2^\circ$

Environmental Specifications

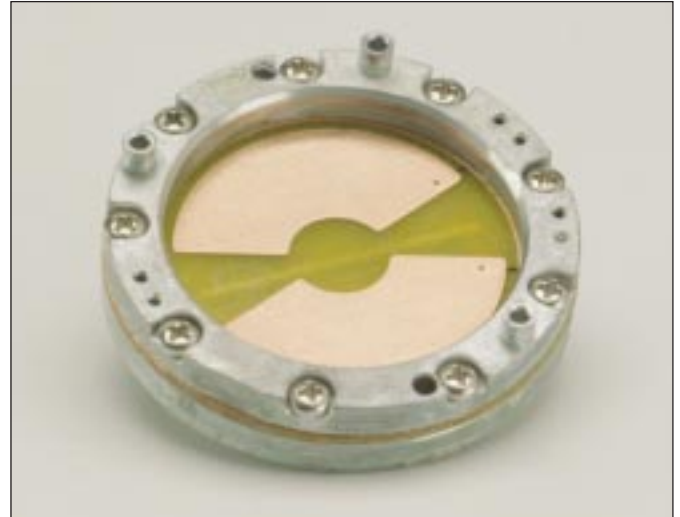
Temperature Range	
Operating	-30° to 65°C
Storage	-55° to 65°C
Temperature Coefficient	
Null	$0.008^\circ/\text{C}$
Scale Factor	$0.1\%/\text{C}$
EMC	
Emissions	EN55022 (CISPR 22) Limit B
Radiated Immunity	IEC 801-3 Level 3 10V/m
Burst Transients	IEC 801-4 Level 3 (2 kV)
ElectroStatic Discharge	IEC 801-2 Level 2 (8 kV air, 6 kV contact)
Conducted RF	MIL-STD 461D, CS114, Curve 2
Cable Length	18" standard length with flying lead terminator

Electronic Clinometer

Range: $\pm 60^\circ$
 Resolution: 0.001°
 Choice of Outputs

Design Concept

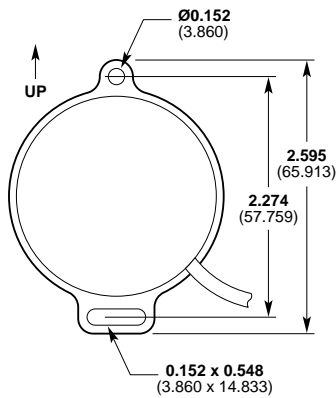
The unique design is based on a common capacitor plate sandwiched between sensor housing halves. The plate has been etched to form two variable capacitors. The assembled sensor is half filled with a dielectric liquid and inert gas. Rotation of the sensor produces a linear change in capacitance resulting in a corresponding output signal.



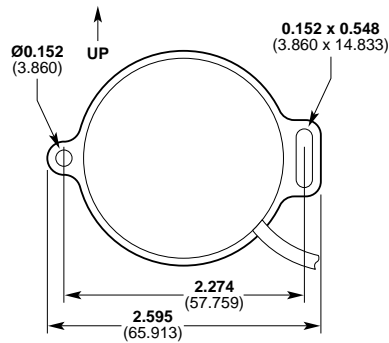
How to Order

Model Number	Description
	Ratiometric
AS-V-R	Vertical Flange
AS-H-R	Horizontal Flange
	Analog
AS-V-A	Vertical Flange
AS-H-A	Horizontal Flange
	Digital
AS-V-D	Vertical Flange
AS-H-D	Horizontal Flange
	Serial
AS-V-S	Vertical Flange
AS-H-S	Horizontal Flange

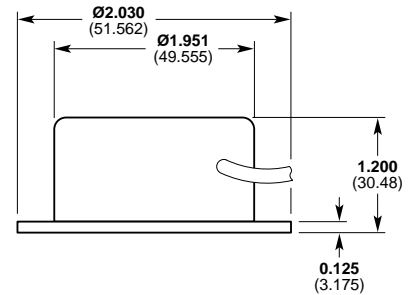
Dimensions in (mm)



Vertical Flange Mount



Horizontal Flange Mount



Electronic Clinometer

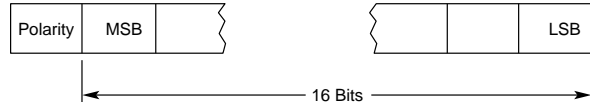
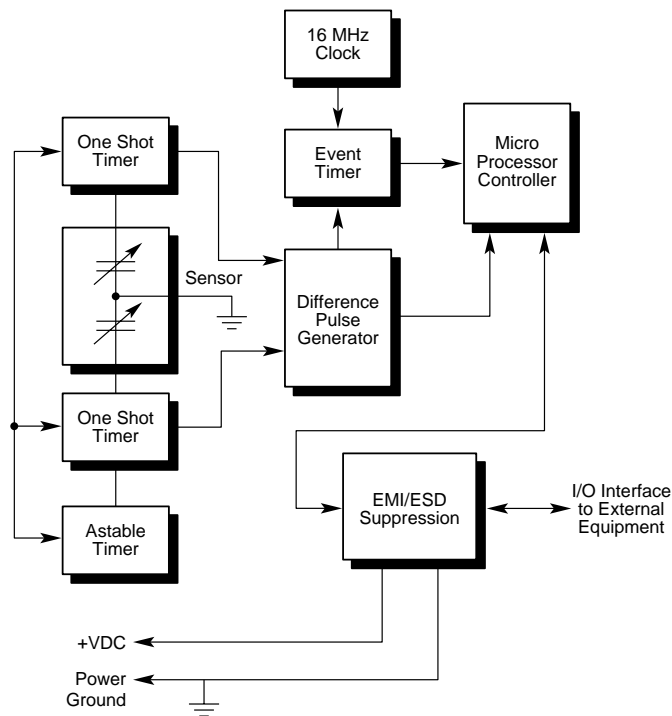
Serial Data Output

Features

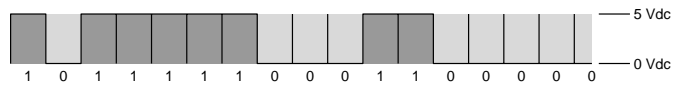
- ❑ **Microcontroller compatible**
- ❑ **Ideal for noisy environments**

The Serial clinometer is a signal conditioned sensor which resolves the angle of tilt to 16 bits of information plus a polarity bit. This device was designed to transmit data to a microcontroller or to an I/O card of a PC through a three wire interface which will work at both TTL and CMOS logic levels. Complete handshaking is used to eliminate timing and transmission problems. The standard version operates on a +5 VDC regulated power supply while an internally regulated version is available. The Serial clinometer was designed with EMI and ESD suppression circuitry on every line.

Serial I/O Block Diagram



Example
 $+31.84^\circ = 1\ 0111\ 1100\ 0110\ 0000$



Contact factory for more details.

Serial Electrical Specifications

Voltage

Voltage Supply

- Range** +5 VDC, $\pm 5\%$
- Current** 15 mA
- Scale Factor** 1000 counts/degree $\pm 10\%$
- Output** CMOS/TTL
- Level Output (0°)** 0 counts
- Binary Range** 16 bits + 1 bit polarity (serial)

Electrical Connections

Wire	Source
Black	Power ground
Red	+5 VDC
Yellow	Data
White	Request/Hold
Gray	Ready/Wait



APPLICATION NOTE

AS-x-S Inclinometer with serial output

Introduction

The serial model is a signal conditioned sensor which resolves the angle of tilt to 17 bits of data. The first data bit represents the polarity of the angle (plus or minus), while the next 16 bits resolve the angle. Scale factor is set for 1000 counts per degree, thereby allowing a direct indication of the measured angle when applying a three place decimal to the reading (i.e. 1000 counts = 1.000 degree).

Theory of Operation

The serial inclinometer has incorporated the measurement of the angle internally, which eliminates the errors associated with external measurement devices such as multi-meters, oscilloscopes and counters. The actual measurement is accomplished on board by a capacitive tilt sensor, a 16 MHz clock, and a 16 bit counter. The date is stored in three registers and is transmitted upon request. A complete handshaking routine is used to eliminate timing and transmission problems, and provides the delay times required (due to capacitance) when transmitting through cables, connectors, or multiplexers.

Interface

The serial inclinometer is designed to transmit its data to a microcontroller, or to an I/O card of a PC via a three wire interface. When connected to a microcontroller running at 1 μ s cycle speed, the conversion times were 10 milliseconds nominal. When connected to a PC through an I/O card, conversion times were 50 milliseconds nominal. It will work at both CMOS and TTL logic levels, and the data line is monitored internally to insure the correct logic level. Power requirement is +5.0vdc = +/- 5% regulated, at 15ma.

Specifications

The serial inclinometer features the same performance, environmental and EMI/ESD protection specifications as the rest of this inclinometer family.

Applications

Designed to transmit data to a microcontroller or to a PC through an I/O card, it is ideal for applications in noisy environments and/or where long cable lengths are required.

Using the Serial output format with a microcontroller

Introduction

The serial output inclinometer has been specifically designed to easily transmit its data to a microcontroller. This is accomplished through a three I/O interface. The output of the sensor resolves the angle of tilt to 17 bits of data. A complete handshaking routine is used in order to eliminate timing and transmission problems.

Procedure

The following are the communication interface steps.

STEP 1 = INITIAL CONDITIONS

The inclinometer during power up will have its ready/working line low. The user will monitor this line waiting for it to go high (25ms). The user request/hold line shall be low at this time.

STEP 2 – REQUEST DATA

User sets the request/hold line high, and monitors the ready/working line to see if the request was received.

STEP 3 – INCLINOMETER ABOUT TO WORK

Inclinometer ready/working line goes low to acknowledge request received.

STEP 4 – INCLINOMETER GOES TO WORK

User detects the ready/working line has gone low, sets the request /hold line low, and monitors the ready /working line for a high (data ready).

STEP 5 – DATA READY

Inclinometer sets ready /working line high to indicate data bit is ready for transmission.

STEP 6 – CONTROLLER READS DATA BIT

User detects ready/working line has gone high, reads the logic level value, and stores it in the appropriate register.

*The user now repeats steps 2 thru 6 sixteen additional times for a total of 17 bits of data. The first bit indicates the polarity and is high for a counter clockwise rotation. The second bit is DB15 and is the most significant bit. The following bits are DB14 thru DB0, and are in true magnitude form. With the scale factor being 1000 counts per degree, a decimal conversion of the data will give a direct indication of the angle (ie 1000 counts = 1.000 degrees).

Notes

- 1) Averaging of eight or more readings improves repeatability.
- 2) Ignoring the inclinometer for two seconds during data transmittal will cause a reset.
- 3) On power-up and reset the inclinometer delays 25ms.
- 4) The request/hold line has a pull down resistor to allow for multiplexing. This eliminates false triggering.
- 5) Inclinometer and user I/O grounds must be common.
- 6) The interface between the inclinometer and the user I/O device must be at 5 volt CMOS or TTL levels.