POSITION SENSING

OBJECTIVE

Relative position sensing using an inclinometer.

DESCRIPTION OF APPLICATION EXAMPLES

In many cases the position of one end of a real or virtual arm relative to another one provides useful information. For instance in an excavator, the position or height of the bucket relative to the tractor is essential. This can be calculated from the inclination information of the different arms. This is of particular importance where there is no visual contact to the bucket (such as when it is under water) or where the positional accuracy is crucial. Position sensing makes digging easier and so it increases productivity. In addition, it reduces the risk of accidental contact damage to wires or plumbing. The use of inclinometers lowers the cost of position sensing and increases its reliability, as there are no moving parts.

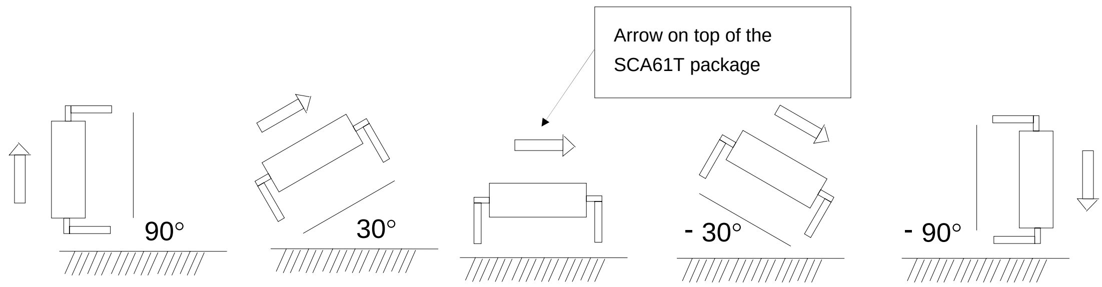
Another typical measurement task, which can be fulfilled with an inclinometer, is to measure the height of features such as mountains, buildings or trees. This is straightforward to measures once the distance to the object is known as measured e.g. by a laser beam. This kind of information is useful for construction work or when estimating volumes of trees in a specified area, for example.

RECOMMENDED PRODUCTS FOR POSITION SENSING

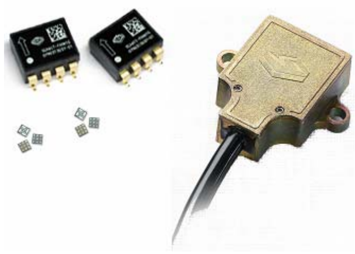
Three series are applicable. These are the SCA61T- Series is for single-axis measurements, the SCA100T-Series for dual-axis measurements and the SCA103T-Series is for highly accurate single-axis measurements. These are printed circuit board (PCB) mountable components in pre-moulded plastic packages and with the measurement direction parallel to the plane of the PCB (horizontally mounted). The two models in these series differ from each other in respect of their measuring range, e.g. SCA61T-FAHH1G with 4V/g having ±0.5g ⇔ ±30° and SCA61T-FA1H1G with 2V/g having ±1g ⇔ ±90° respectively (1g = acceleration of free fall in earth's gravity field = $9.8 m/s^2$).

PRINCIPLE OF OPERATION FOR VTI'S PRODUCTS

VTI's products are accelerometers and measure the component of earth's gravity in the measuring direction (indicated by the arrow). This means that the output is proportional to 1g * SIN (Phi), where Phi is the inclination angle relative to the 0g position.



+1g position   +0.5g position   0g position   -0.5g position   -1g position



ACCURACY CONSIDERATIONS

Main error components are:

1. Zero Point Error
   In most cases the most significant error component is the zero point error. In the range -25 … +85°C it is ±10mg (6δ limit) and the temperature dependence is typically ±0.1mg/°C. The room temperature variation can be reduced by calibration at the instrument level and the effects of the temperature dependence dealt with by using temperature compensation.

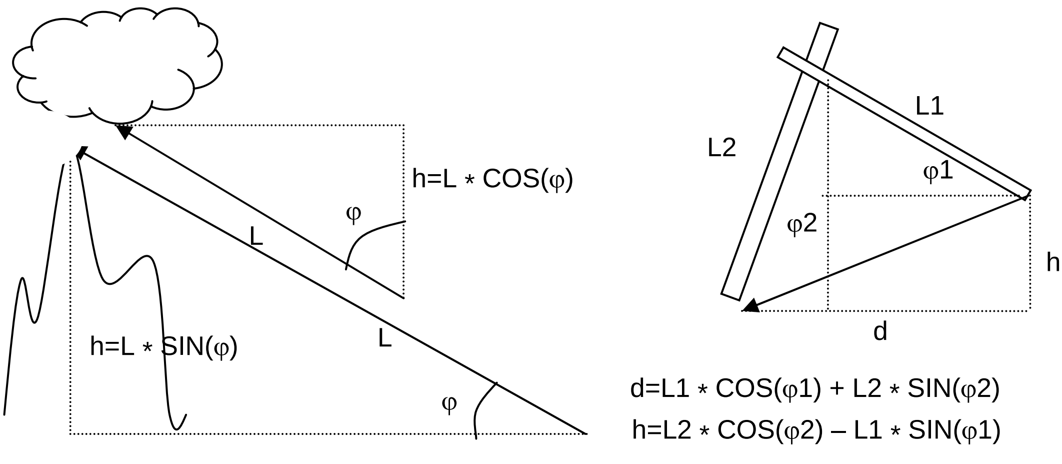
2. Error Caused by the SIN Function
   When used as an inclinometer, the output of the accelerometer is proportional to 1g * SIN (Phi + Phi0), where Phi is the inclination angle and Phi0 the internal mounting error. The internal mounting error is a maximum of ±2.9°, corresponding to ±50mg. This error is of importance when using large inclination angle amplitudes and is seen as an addendum to the non-linearity (Typically ±5mg in ±0.5g and ±10mg in ±1g).

3. Sensitivity Error
   The sensitivity error is ±1,5% (-25 …+85°C), resulting in maximum ±20mg in FAHH1G and ±40mg in FA1H1G.

4. Cross-axis Sensitivity
   The cross-axis sensitivity (4%) shows how much perpendicular acceleration or inclination is coupled to the signal. It has the same source, i.e. mounting error, as item 2).

5. Rectification of Vibration
   The effect of high frequency vibration is strongly suppressed by the over-damped sensing element (upper cut-off freq. f_{-3dB} = 2 … 10Hz). In an extreme case, high amplitude vibrations (>5g) may cause a measurable zero point shift.

6. Ratiometric Error
   For the best performance, the supply voltage should be kept at 5V or at a stable voltage in the range 4.75 … 5.25V. If the supply voltage changes, it may result in a maximum error of 2%, i.e. for FA1H1G @ +5V => 5±0.25V a maximum of 5mg error from the Vdd/2 value.



Picture 1. Application Examples

VTI Technologies Oy
Myllynkivenkuja 6
P.O.Box 27
FIN-01621 Vantaa
Finland
Tel. +358 9 8791 81
Fax. +358 9 8791 8791
sales@vti.fi

VTI Technologies Oy
Frankfurt Branch
Rennbahnstr. 72-74
D-60528 Frankfurt am Main
Germany
Tel. +49 69 6786 880
Fax +49 69 6786 8829
sales.de@vti.fi

VTI Technologies, Inc.
One Park Lane Blvd.
Suite 804 - East Tower
Dearborn, MI 48126
USA
Tel. (313) 425 0850
Fax (313) 425 0860
sales@vtitechnologies.com