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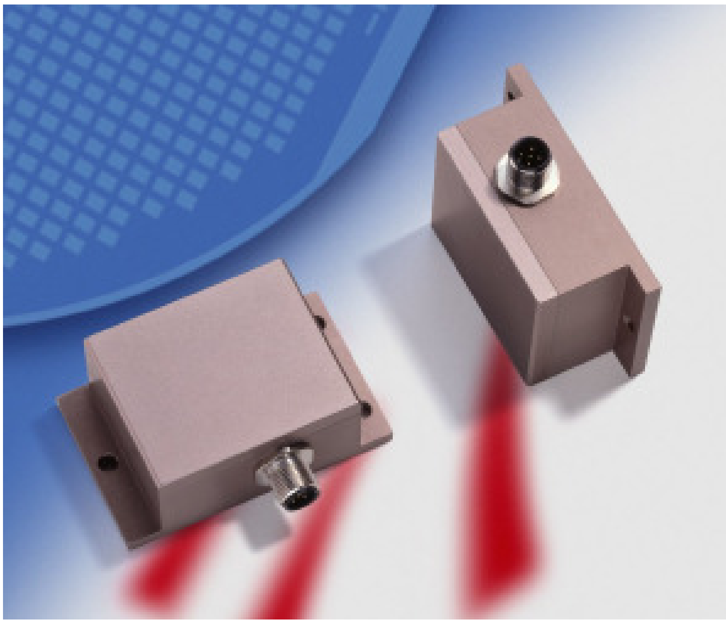
Application basics

Acceleration, inclination and vibration sensor SCA114 and SCA124 series



Contents:

1. Applications

Typical applications for the SCA series sensors are:
- inclination limiter (tilt sensor)
- levelling
- inclination
- acceleration
- vibration

Depending on the intended use the best suitable type must be selected. Please contact our product specialists for information. Phone: +41 44 806 22 00.

1.1 Tilt and levelling applications

Typical applications can be tilt limiters, levelling of machinery, apparatuses or measuring equipment, automatic levelling of jibs / booms, excavator shovels, platforms etc.

1.2 Inclination and angle measuring

Examples: inclination measuring in measuring equipment like lasers, in vehicles, robots, surgical operation tables, building and production machinery

1.3 Acceleration measuring

Applications such as shock and crash monitoring, movement monitoring and recording for fitness analysis or elderly / handicapped persons combined with alert systems, free fall detection, automobile equipment as ESP (electronic stabilising program) and ABS (anti blocking system).

1.4 Vibration measuring

Applications are for example bearing damage monitoring, theft protection, earth quake safety switch-off devices.

2 Characteristics / Technology

2.1 Shock resistance of the sensing element

The sensing elements based on capacitive measuring principle feature high precision and high shock resistance, resulting from the particular 3D micromechanics technology made of high purity silicon. Thanks to the optimized structure, no drifts caused by deformation must be expected, even after severe shocks.

2.2 Repeatability and long term stability

With SCA61T for instance repeatability up to 0,01° or 0,2mg and long term stabilities of the same order can be achieved. The hysteresis (e.g. 0,02°) caused by quick temperature changes degenerates to zero within a short time.

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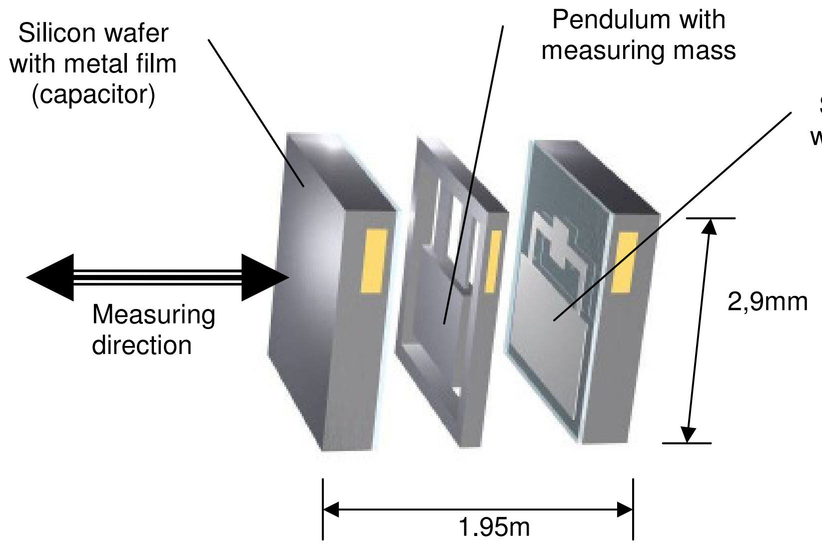
2.3 Resolution

The sensing elements formed by a dual capacitor produce extremely low noise levels and a high output signal. The major part of the noise is caused by the signal conditioning circuitry. Resolutions in the order of 0,001 ° with averaging are possible.

2.4 Reduced sensitivity to vibrations thanks to gas attenuation

Influences by vibrations may interfere with inclination measuring. The gas attenuation in the sensing element filters a good part of such interferences and in addition helps avoid overshooting of the sensing pendulum. For inclination sensors the influence of vibrations is reduced, for vibration sensors the sensor's natural resonance is damped. This means that the appropriate sensor type must be selected for each application.

2.5 Structure of the sensing element

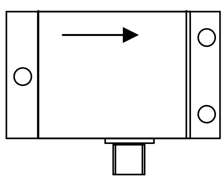


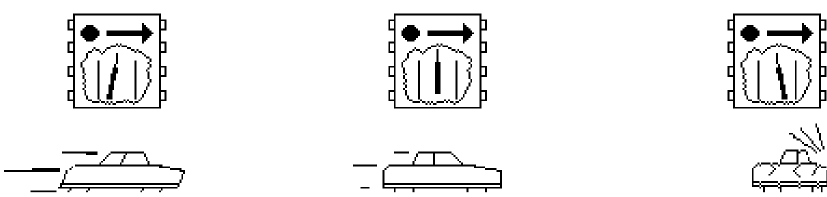
2.6 Functional principle

The pendulum with the measuring mass is moved in the measuring direction by a force (acceleration, inclination, vibration) acting in this direction. The movement of the measuring mass causes a change of capacitance which is registered as primary measuring signal. The output signal (4…20mA) is proportional to the deflection, thus to the acceleration. For inclination measuring the conversion from g = 9.81 m/s^2 into angular degrees is a sine function. A sensor with small measuring range (+/-0,5g = +/-30°) has a higher resolution than a sensor with large (+/-12g) measuring range.

Measuring principle and alignment (e.g. for acceleration / shocks)

Point of view from above:



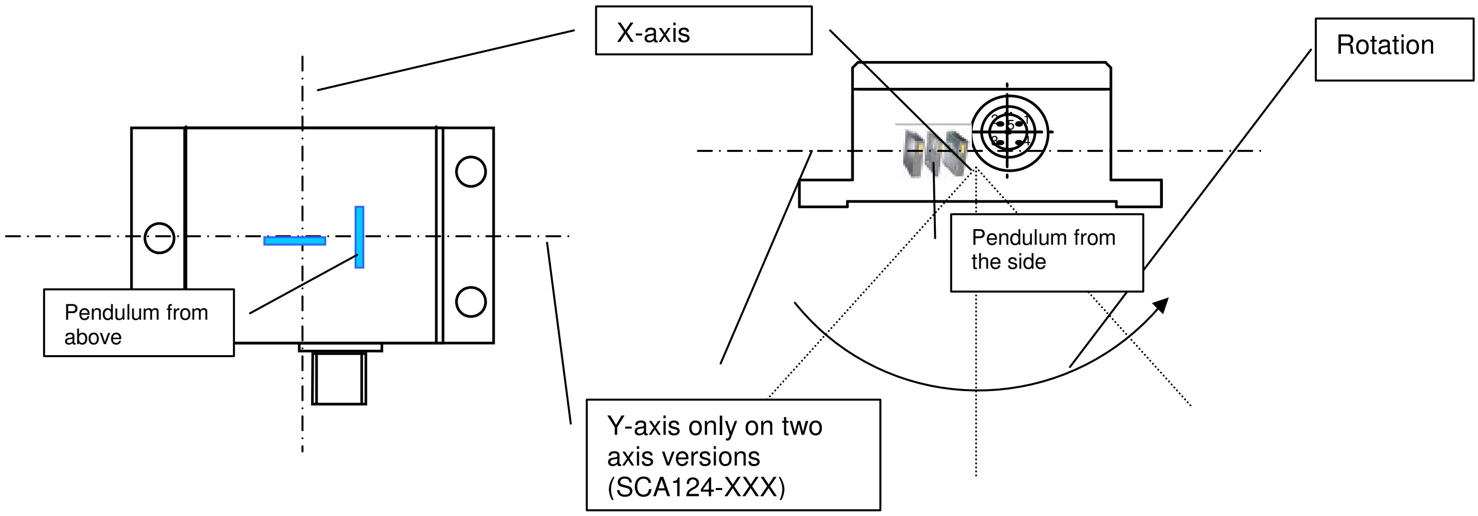


3 Mechanical mounting

The housings are marked with a symbol indicating the measuring direction.

3.1 Positioning for inclination measuring

3.1.1 Normal Application:

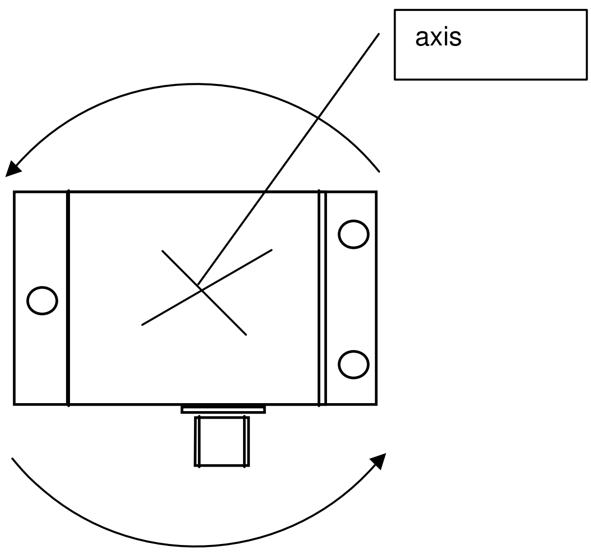


The position of the axis shown is only indicative for illustration and does not show the exact position

Position on 0g = 0° position = 12mA)

3.1.2 Special Variation:

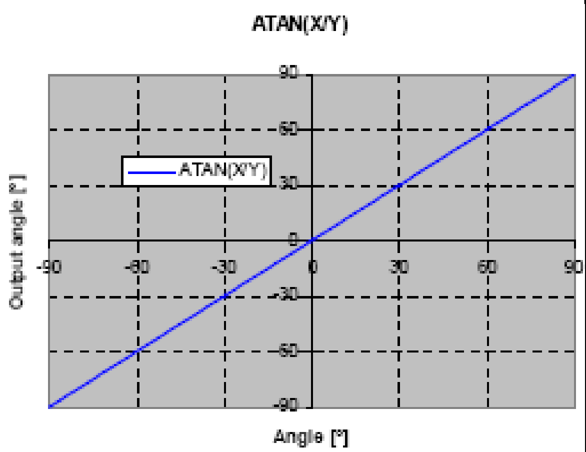
(with reduced accuracy)



360° measuring:

For a 360° rotating measuring we propose the two axis inclination-sensor (SCA124-D04FA). You can calculate as follow:

$$\alpha = \arctan\left(\frac{x}{y}\right)$$



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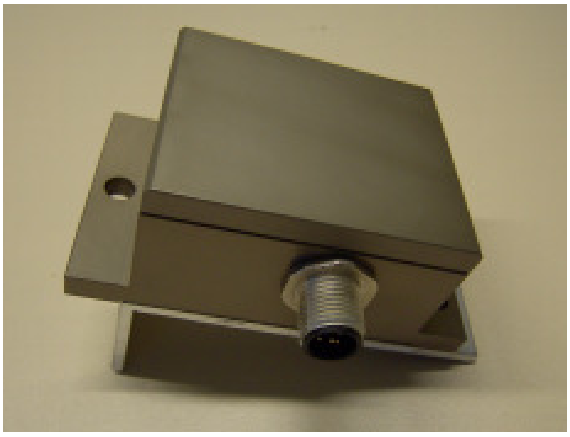
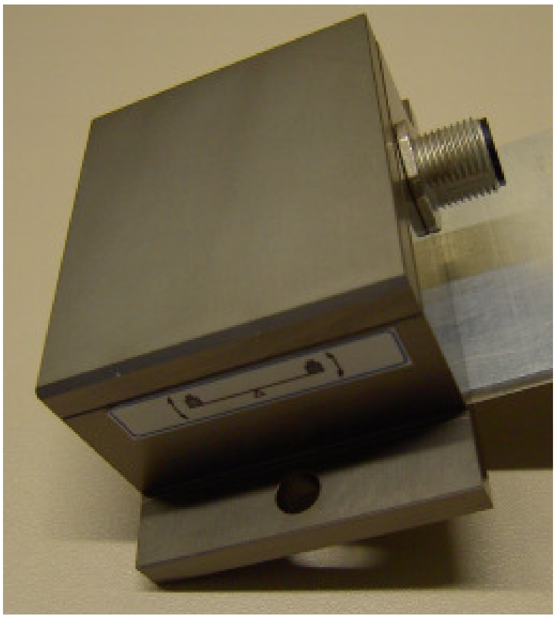
3.2 Output signal in dependency of inclination or acceleration

Follow inclination shows follow outputs: (Valid for different ranges)

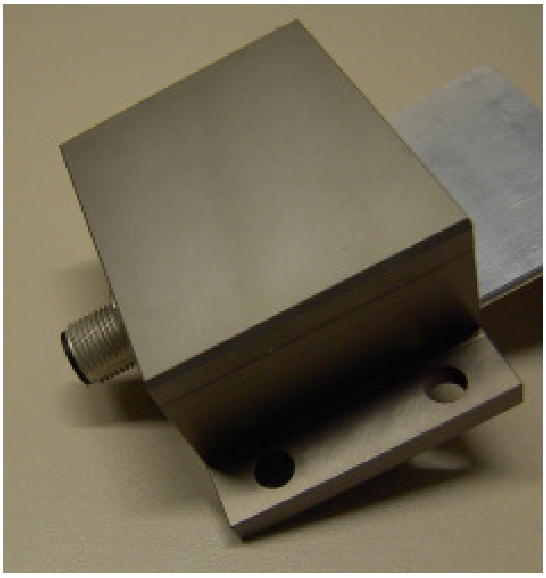


Picture for X-axis:
Inclination to the right hand side:
Signal change from 12mA (0° position) to 4mA

Picture for X-axis:
Inclination to the left hand side:
Signal change from 12mA (0° position) to 20mA

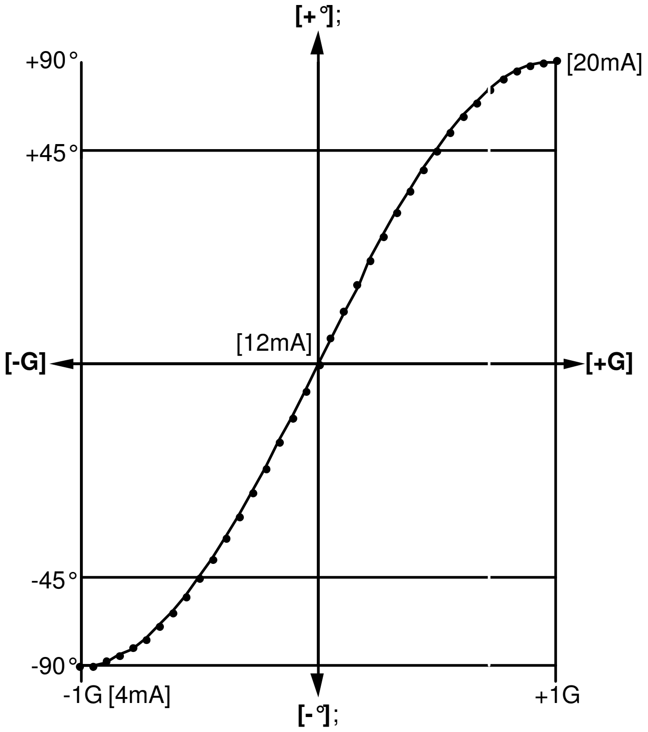


Picture for Y-axis:
Inclination to the left hand side with connector on the **right** hand side:
Signal change from 12mA (0° position) to 20mA

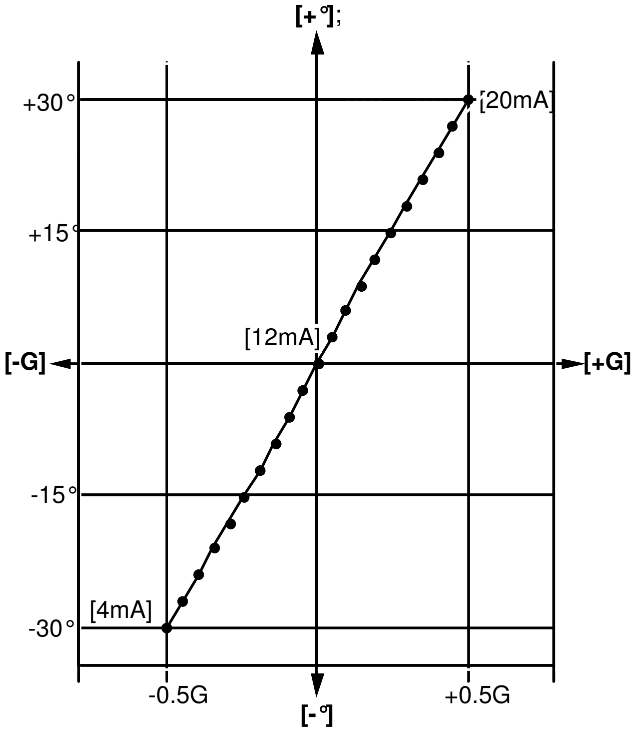


Picture for Y-axis:
Inclination to the left hand side with connector on the **left** hand side:
Signal change from 12mA (0° position) to 4mA

As the angle between earth gravity's direction (always vertical) and the sensing elements' measuring tongue changes with inclination, the relation between inclination angle and output signal is sine function.



1G-Sensor: ±1G / ±90°

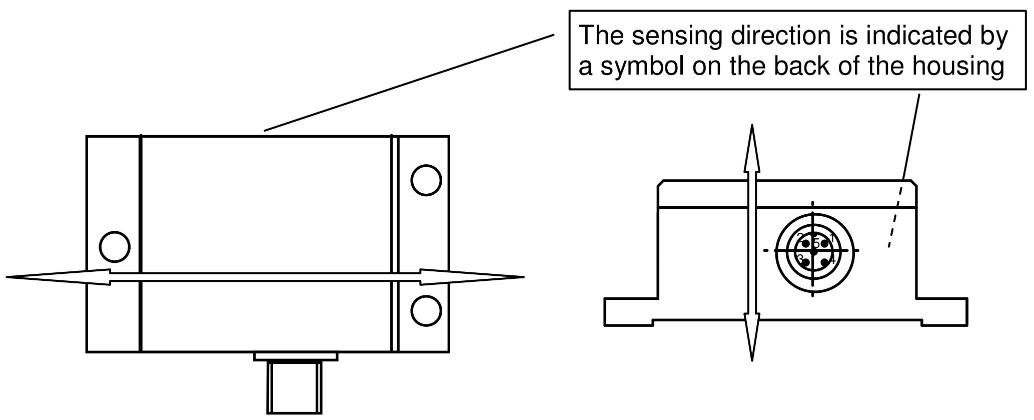


0.5G-Sensor: ±0.5G / ±30°

For horizontal acceleration, the output is linear proportional to the acceleration. (For vertical acceleration an offset of 1G is to be considered, so a G-Range higher than 1G must be selected).

(Please see also chapter 4 for calculation output to angle)

3.3 Mounting for acceleration and vibration measuring



3.4 Offset-Alignment

Caused by the integration into the application a mechanical offset between the sensor and the application may occur. For precise measuring we recommend an offset alignment at the position 0g ⇔ 12mA ⇔ 0°. The alignment will be done in the application device by matching the offset voltage. Thus the absolute precision increases considerably. (see also chapter 3.5 Temperature compensation)

3.5 Temperature compensation

Due to shrinking / dilatation of the sensing element at temperature variations the geometry of the element slightly varies. This will have an effect on the result of the measurement. Due to the symmetrical shape of the sensing element, most of this effect is automatically compensated. The remaining drift caused by temperature variation is very low, but should be compensated additionally for high precision applications.

Methods:

- External temperature-measurement with polynome calculation (available on request).
- External temperature measurement with defined calibration-points
- Customized sensor with stored temperature coefficients

For information please contact our technical consultants by phoning: +41 44 806 22 00.

4 Electronical mounting

4.1 Connector

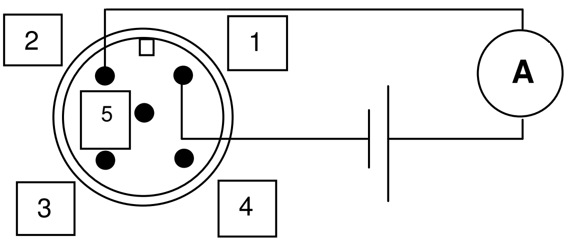


Figure 1. A current output
Mating connector: M12 female

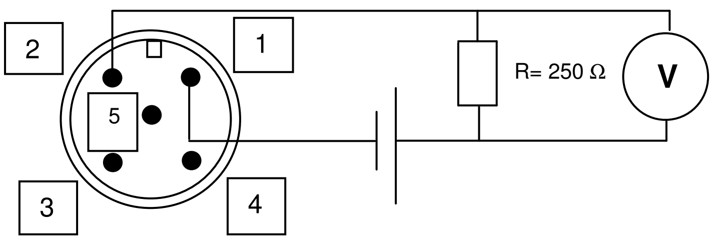


Figure 2. A voltage output

For 2….10 V output can 500 Ω and for 1…5 output can 250 Ω be used

4.1.1 Current Output

10-36 Volts supply voltage is connected to the pins 1. and 2. (polarity interchangeable). A current meter (4…20mA) needs to be added into the circuit according to Figure 1. in order to read the output . In the case of SCA124T –series product, the same connection needs to be done for the Y-axis to the pins 3. and 4.

SCA 114T/124T – D04FA: Angle (°) = arcsin((output in mA – 12)/8)
: Output in mA =12+(sin (angle(°))*8
SCA 114T/124T – D02FA: Angle (°) = arcsin((output in mA – 12)/16)
: Output in mA =12+(sin (angle(°))*16

4.1.2 Voltage Output

A 10-36 Volts supply voltage is connected to the pins 1. and 2. (polarity interchangeable). A voltage meter (1…5 V) and a 250 ohms resistor need to be added into the circuit according to Figure 2. in order to read the output. In the case of SCA124T –series product, the same connection needs to be done for the Y-axis to the pins 3. and 4.

SCA 114T/124T – D04FA: Angle (°) = arcsin(((output in V/250*1000) – 12)/8)
: Output in V =(12+(sin (angle(°))*8))*250/1000
SCA 114T/124T – D02FA: Angle (°) = arcsin(((output in V/250*1000) – 12)/16)
: Output in V =(12+(sin (angle(°))*16))*250/1000

For 2….10 V output can 500 Ω and for 1…5 output can 250 Ω be used

4.2 Cable

If you use an cable with standardized colours (like ours . 40PKabelM12 with M12 connector) follow colours are valid:

1 = brown, 2 = with, 3 = blue, 4 = black, 5 = grey

Important, please note:

1: If lead 3 and 4 not used (1-channel versions) please put it on ground. So we can avoid electronically disturbances.

2: Please use only cable which <u>guarantees IP67</u>. *For IP68 we recommend our IP68 sensors with build in PUR cable*