

Manual

With application basics

KAS1000-series **Measuring acceleration, inclination and vibration**



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1 Application

Typical applications for the KAS1000 series sensors are:

- Inclination limiter (tilt sensor)
- Levelling
- Inclination
- Acceleration
- Vibration

Depending on the specific application 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.

Examples:

KAS1002-51A: Measuring range +/- 30°, dual axis

KAS1002-41A: Measuring range +/- 15°, single axis, highest accuracy

1.2 Inclination and angle measuring

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

Examples:

KAS1002-51A: Measuring range +/- 30°, Dual axis

KAS1002-41A: Measuring range +/- 15°, single axis, highest accuracy (Optional up to +/- 90° range possible)

KAS1001-06A: Range +/- 180°, single axis

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).

Examples:

KAS100x Versions with +/-1.7, +/-2, +/-4, +/-6, +/-12 and +/-18g measuring ranges and damping's from 50 to1000 Hz (different versions)

1.4 Vibration measuring

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

Examples:

KAS100x Versions with +/-1.7, +/-2, +/-4, +/-6, +/-12 and +/-18g measuring ranges and damping's from 50 to1000 Hz (different versions)

2 Specifications and 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 three dimensional micromechanics technology made of high purity silicon. Thanks to the optimized structure, no drifts caused by deformation must be expected, even after severe shocks (20'000g).

2.2 Repeatability and long term stability

Repeatability up to 0,01° or 0,2mg and long term stabilities of the same order can be achieved. The hysteresis (e.g. 0,01°) caused by quick temperature (e.g. from 20° to -10°C in few seconds) changes degenerates mostly to zero within a short time.

HTB Simulations has shown long-term stabilities by the pendulum from 0,036° / 0,6mg in 10 years

2.3 Resolution

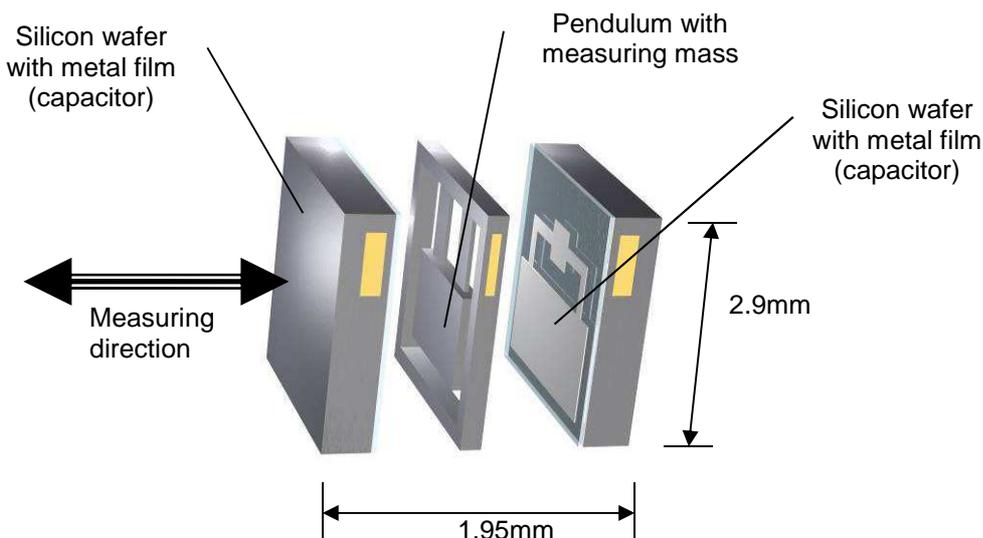
The sensing elements formed by a dual capacitor produce extremely low noise levels and a high output signal. The major part of the noise is caused by the signal conditioning circuitry. Resolutions in the order of 0,001° with averaging are possible. Standard averaging is: 100 samples over 333ms

2.4 Advantages by gas damping

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.

In Vibration sensing frequency selection are so optimal possible. Also **Resonance frequency effects** are excluded.

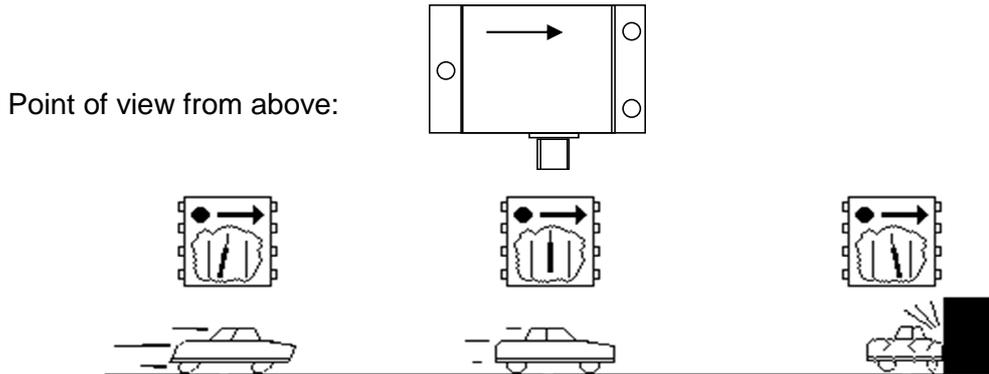
2.5 Structure of the sensing element



2.6 Functional principle

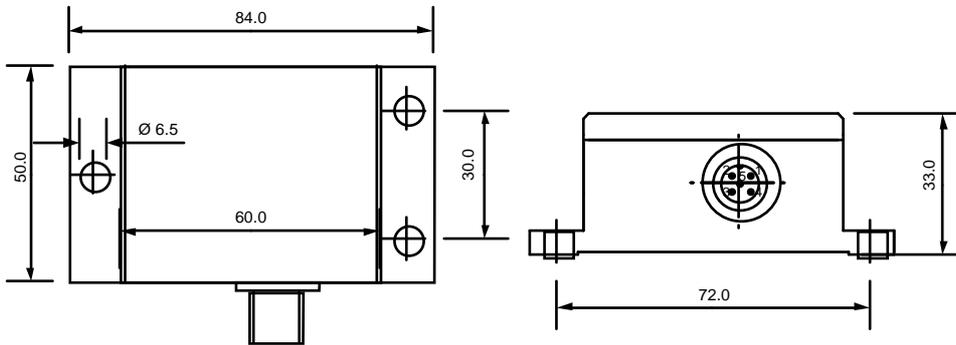
The pendulum with the measuring mass is moved in the measuring direction by a force (acceleration, inclination, vibration) acting in this direction. The movement of the measuring mass causes a change of capacitance which is registered as primary measuring signal. The output RS485 signal is proportional to the deflection, thus to the acceleration. For inclination measuring the conversion from $g = 9.81 \text{ m/s}^2$ into angular degrees is a sine function. A sensor with small measuring range ($\pm 0,5g = \pm 30^\circ$) has a higher resolution than a sensor with large ($\pm 18g$) measuring range.

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



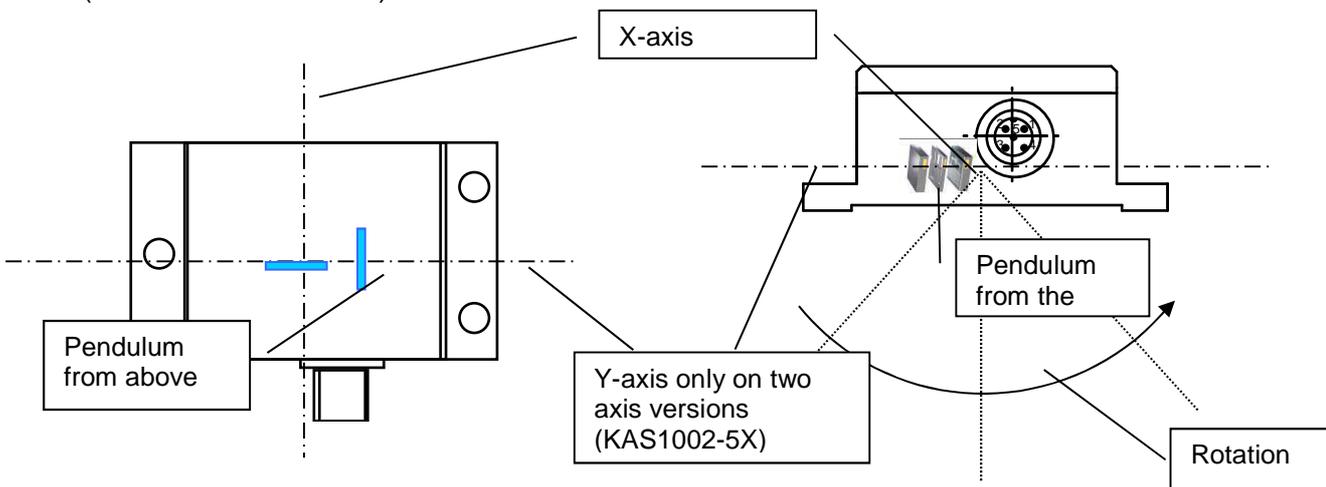
3 Mechanical mounting

3.1 Positioning for inclination measuring



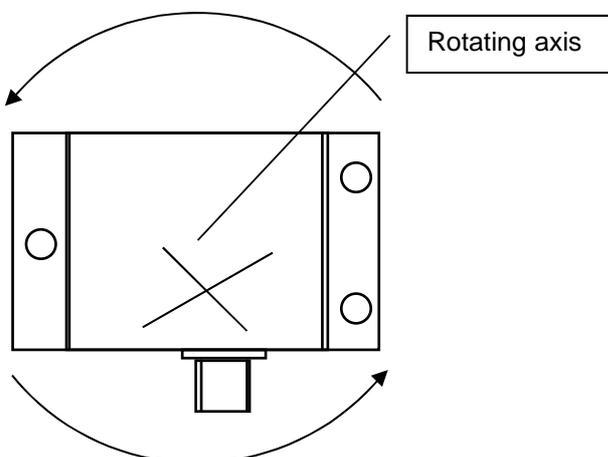
The housings are marked with a symbol indicating the measuring direction.

3.1.1 Typical Application: (Versions KAS1002-xx)



The position of the axis shown is only indicative for illustration and does not show the exact position
Position on 0g = 0° position

3.1.2 360° angle measuring (Versions KAS1001-xx)



Mounting for KAS1002xx Version

The Position on the left hand side showed can also used for one-axis of KAS1002-xx

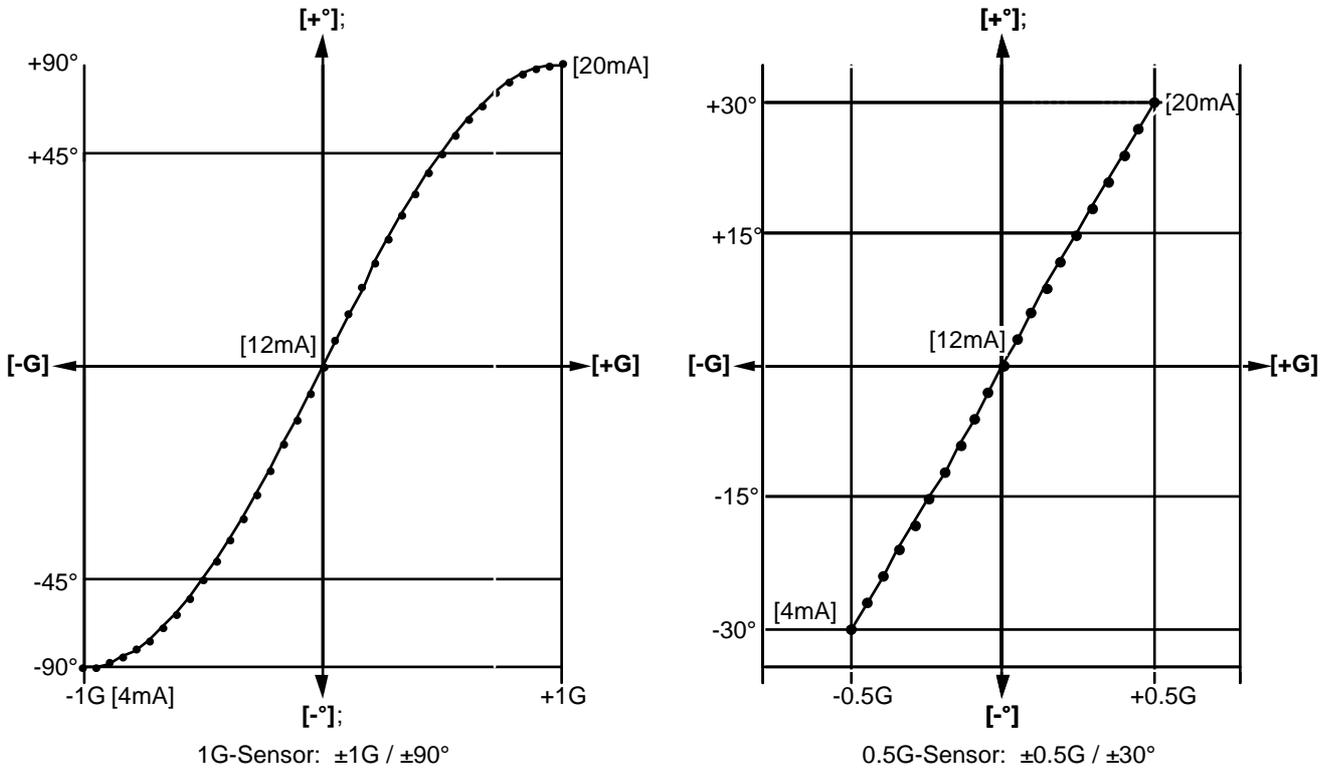
It may reduce be the precision slightly.

Shown in 0-point Position (Should be trimmed with command “*998A#” to 0 in the application)

3.2 Output signal depending on inclination (° versus g)

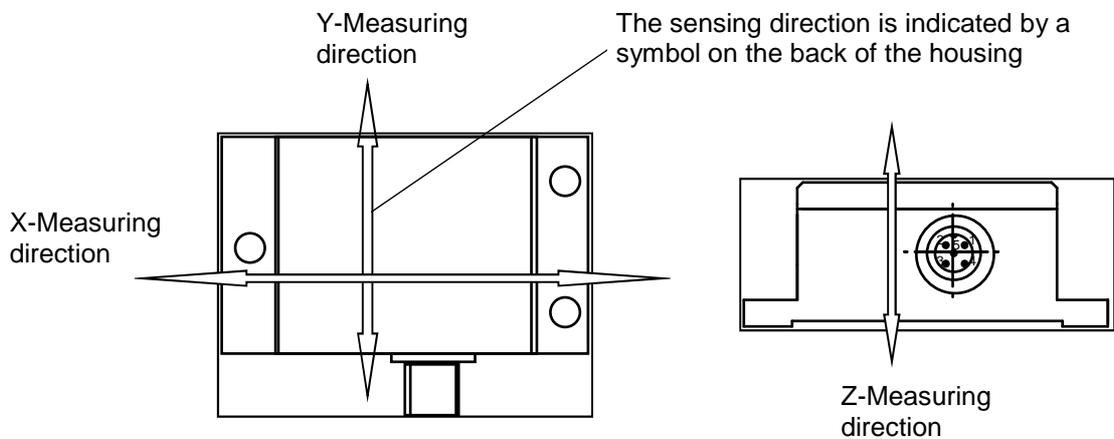
As the angle between earth gravity’s direction (always vertical) and the sensing elements’ measuring tongue changes with inclination, the relation between inclination angle and output signal is a sine function.

(Note: mA as example for the digital output)



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).

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 adjustment with command "see: zero reference angle" at the position $0g \Leftrightarrow 0^\circ$.

Thus the absolute precision increases considerably.

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/Option:

- Developed new from **KELAG developed stabilization method**.
- If simulation of temperatures in application possible, then could this dependency stored in the control-unit of the customer. The internal temperature-sensor may be a help. This command is available to request.
- Customized sensor with stored temperature coefficients: This method request expensive calibration method from each sensor.

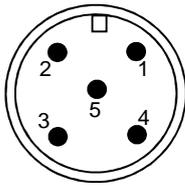
4 Electrical connection

4.1 Power supply

Input supply voltage: 9...30 (max. 36) VDC
Power consumption: 30mA

4.2 Connector and pinout

Basically the sensor is with build-in connector provided. Optionally there are also versions with build-in PUR cable available.



The interface has follow connection (connector/cable):

1	brown	Vin +
2	white	Vin GND/ RS485 GND
3	blue	RS485+
4	black	RS485-
5	grey	functionally input (for factory use only)*)
	Shield	Housing

*) on cable version it is recommend to attach this to GND

Mating connector: M12 female

assignment of connector and optionally cable version

4.3 Connection cable

(Not included in the delivery)

4.3.1 Wiring

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

4.3.2 Leak Tightness

Please use only cable with connector which guarantees IP67 or/and IP68. We recommend our *overmolded PUR-cable with connector*.

Alternatively we can offer Sensor with implemented PUR-cable with IP69 cable clamp. This version we tested 5 weeks in depth of 10m under water.

5 Communication

5.1 Default-setup



Sensor can be used with commercially available terminal-software (e.g. Hyper-Terminal)

5.2 Composition of the commands

*[**Sensor-address**][**Command-code**][Optional command parameters]#

Example: *9914# (All examples are shown with address 99)

5.3 Change baud rate

Discription	Command	Output
The new baudrate (acc. table 1... 8) will be applied (no output)	*9988R4#	

Possible baudrates:

Code	Baudrate
1	300
2	1200
3	2400
4	4800
* 5	9600
6	19200
7	38400
8	115200

* Default

5.4 Change address

Discription	Command	Output (Example)
Address will be changed from 99 to 25	*9981A25#	(New address: 25)

5.5 Product-Information

Discription	Command	Output
Show product information	*9980#	<Product-Info> <Configuration>

5.6 Selftest

Discription	Command	Output
Apply selftest	*9983#	pass/fail

In standard applications the selftest hast to be made while the sensor is on X/Y-position ~ 0°

While measuring rotating angles the sensor must be tested in position ~ 90° und ~ 180°

5.7 Reset on factory setting

Discription	Command	Output
This command resets all user parameters. However information such as product info, serial no., calibrating data etc. will not be affected Attention: The command can not be revoked.	*9989B#	RESET

5.8 Specific Application Setting

5.8.1 Poll-/Autosend mode

Discription	Command	Output
Polling mode ON (Autosend mode OFF)	*99AS#	OK
Autosend ii = repeating time in 100ms (0 ...999) BB ₁ ... BB ₆ 1 to 6 commands can be listed for one output set. e.g. *99AS10,0608# : Every 10x100ms (1sec.) X and Y axes values in °(06) and X and Y axes values in g (08) will be sent	*99ASii, BB ₁ BB ₂ ... BB ₆ #	-20.023 45.342 -0.3426 0.6433 (start of the next set)
Autosend command AH is for an easier separating of the different data sets ii = repeating time in 100ms (0 ...999) BB ₁ ... BB ₆ 1 to 5 commands can be listed for one output set. e.g. *99AS10,AH0102# : Every 10x100ms X and Y axes values in °(06) and X and Y axes values in g (08) will be sent with a “;” record separating character	*99ASii,AHBB ₁ BB ₂ ... BB ₅ #	; -20.023 45.342 -0.3426 0.6433 ; (start of the next set)

5.8.2 Setting a zero reference angle for inclination (KAS1002-52x)

Discription	Command	Output
Actual position set as X/Y-zero reference	*9900#	OK

5.8.3 Setting a zero reference angle for inclination (diff. measurement) (KAS1002-41x)

Discription	Command	Output
Actual position set as X-zero reference	*99D0#	OK

5.8.4 Setting a zero reference angle rotating angle applications (KAS1001-06x)

Discription	Command	Output
Actual position set as zero reference	*9930#	OK

5.9 Polling

Measured data can be read out in AD-converter-Counts, in g or in angular degree (°).

The data are sent without dimension unit.

Count values have 2 positions after decimal point, angular degrees have 3, g-values have 4.

5.9.1 Polling X and Y-axis results

Discription	Command	Output (Example)
Average X and Y axis counts values	*9905#	2055.00,2047.00
Average X and Y axis g values	*9906#	-0.0370,0.4560
Average X and Y axis angular degree values	*9908#	-2.453,3.678

5.9.2 Polling X -axis results

Discription	Command	Output (Example)
Average X -axis counts values	*9915#	2047.00
Average X -axis g values	*9916#	-0.0370
Average X -axis angular degree values	*9918#	-2.450

5.9.3 Polling Y -axis results

Discription	Command	Output (Example)
Average Y -axis counts values	*9925#	2047.00
Average Y -axis g values	*9926#	-0.0370
Average Y -axis angular degree values	*9928#	-2.450

5.9.4 Polling X -axis results (differential measurement)

Discription	Command	Output (Example)
Average X -axis g values	*99D6#	-0.0370
Average X -axis angular degree values	*99D8#	-2.450

5.9.5 Polling rotating angular results

Discription	Command	Output (Example)
Average angular degree values	*9938#	45.123

5.9.6 Polling sensor temperature

Discription	Command	Output (Example)
Temperature in °Celsius	*9942#	28.1

5.10 Extended command set

For most applications the commands listed above are sufficient. However there are further commands for operating KAS100x-Sensors available. Most of them are for test and calibrating purposes and need further instruction.

5.11 Errormessages

Ausgabemeldung	Ursache
OVERFLOW	Autosend outputstring to long
+++++	Sensor out of calibration specification
-----	Sensor out of calibration specification