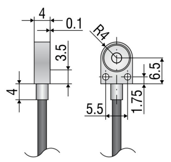
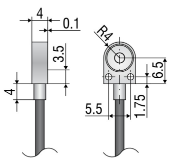
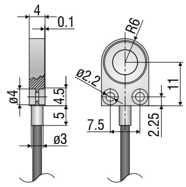






Sensor type		CSH02FL-CRm1,4	CSH05FL-CRm1,4	CSH1FL-CRm1,4
Article No.		6610075	6610085	6610072
Measuring range	reduced	0.1 mm	0.25 mm	0.5 mm
	nominal	0.2 mm	0.5 mm	1 mm
	extended	0.4 mm	1 mm	2 mm
Linearity [1]		≤ ±0.05 µm	≤ ±0.09 µm	≤ ±0.2 µm
		≤ ±0.025 % FSO	≤ ±0.018 % FSO	≤ ±0.02 % FSO
Resolution [1] [2]	static 2 Hz	0.15 nm	0.38 nm	0.75 nm
	dynamic 8.5 kHz	4 nm	10 nm	20 nm
Temperature stability	Zero [5]	-37.6 or 2.4 nm/°C	-37.6 or 2.4 nm/°C	-37.6 or 2.4 nm/°C
	Sensitivity	-2.4 nm/K	-6 nm/K	-12 nm/K
Temperature range	Operation	-50… +200 °C	-50… +200 °C	-50… +200 °C
	Storage	-50… +200 °C	-50… +200 °C	-50… +200 °C
Humidity [3]		0 % … 95 % r.H.	0 % … 95 % r.H.	0 % … 95 % r.H.
Dimensions [4]		10.5 × 8 × 4 mm	10.5 × 8 × 4 mm	17 × 12 × 4 mm
Active measuring area		Ø2.6 mm	Ø4.1 mm	Ø5.7 mm
Guard ring width		1.9 mm	1.2 mm	2.4 mm
Minimum target diameter		Ø7 mm	Ø7 mm	Ø11 mm
Weight (incl. cable and connector)		28 g	28 g	30 g
Material	Housing	1.4104 (magn.)	1.4104 (magn.)	1.4104 (magn.)
Connection	Cable integrated	Ø2.1 mm×1.4 m radial	Ø2.1 mm×1.4 m radial	Ø2.1 mm×1.4 m radial
Mounting		2x thread M2	2x thread M2	2x screw M2 DIN 84A

FSO = Full Scale Output   CSH Sensors are matched to controller with standard cable length

[1] Valid with reference controller, relates to standard measuring range

[2] RMS value of the signal noise

[3] Non condensing

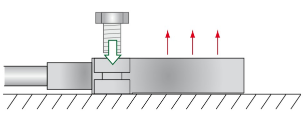
[4] Without cable, bend protection and crimp

[5] In the case of a sensor mounting on the top or underside

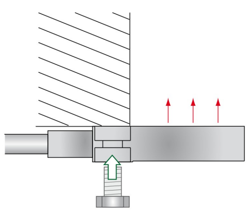
Mounting flat sensors

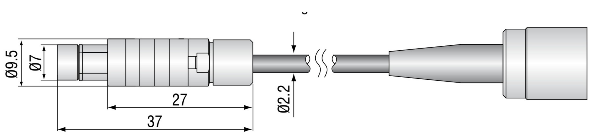
The flat sensors are attached using a threaded bore for M2 (for the sensors CSH02FL and CSH05FL) or using a through-hole for M2 bolts. The sensors can be bolted on top or below.

Screw connection from above on the underside



Screw connection from below on the sensor top side





Influence of tilting the capacitive sensor

In the case of tilting of the capacitive sensor, a measurement error must be assumed as the geometric conditions of the field for the target change. In fact, the average distance of the sensor remains constant; however, the edge areas move closer or further away from the target. This results in field distortions, which affect the capacity C according to the following model:

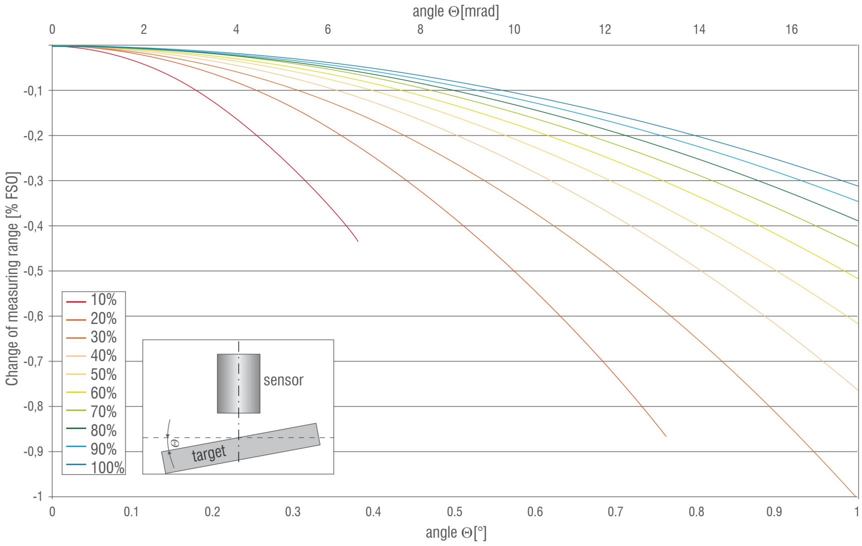
$$C_d(\Theta)=C_d(0)*[1+(\frac{1}{4})*(\frac{R^2}{d^2})*\tan^2\Theta]$$

$$\Delta_x=100*(\frac{d}{d_{MAX}})*\{\frac{1}{[1+(\frac{R^2}{4d^2})*\tan^2\Theta]}-1\}$$

C	*capacity*
Θ	*tilt angle*
R	*measurement area radius*
d	*working distance sensor-target*
d_{MAX}	*sensor measuring range*
Δx	*signal change*

Results are based on internal simulations and calculations. Please ask for detailed information.

Angle dependence with different offset distances (sensor CS02)



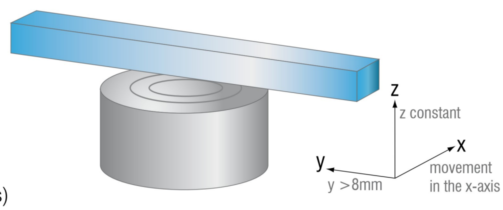
Example illustration of the influence using the CS02 sensor as an example, consideration of a tilt angle of max. 1° for different sensor distances.

In the case of 10% distance in the sensor axis, there is already contact between sensor housing and target at 0.38°; in the case of 20% distance, the contact is at 0.76°. The simulation can be performed for all sensors and installation conditions; tilt angles around a decentralized tilt point can also be calculated.

Measurement on narrow targets

The influence of the target width on the measurement signal is shown using the example of a CS05 sensor. A target extended in the y-axis, narrowed in the x-axis has been varied in different parameters:

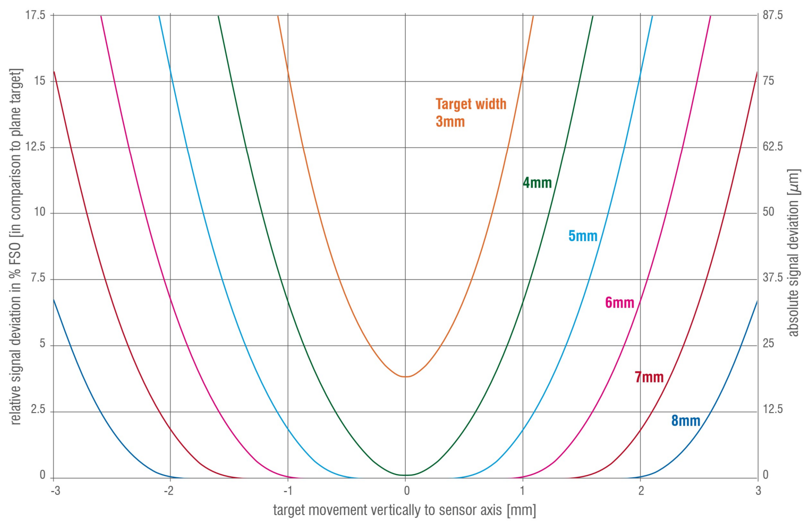
- target-sensor distance (z-axis): 0.25mm (measuring range center)
- width of the target in the x-axis: 3 ... 8mm (21 values)
- displacement of the target in the x-axis (vertical to the sensor axis): 0 ... 3mm (13 values)

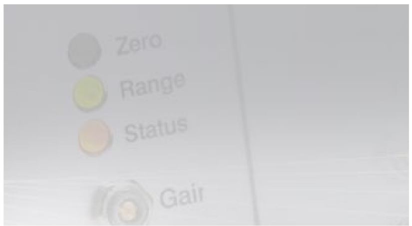


In each case, the capacity between electrode and target and its reciprocal (this is proportional to the sensor signal of the controller) were calculated. The diagram shows the deviations from the capacity values for a flat target (large opposite sensor in x and y axes) depending on the target width and displacement. The smaller the distance between sensor and target, the narrower the target can be. In the example, a centrally placed target with a width of 5mm is sufficient to achieve a stable signal in the center of the measuring range. This proves that the field does not spread beyond the sensor diameter.

Results are based on internal simulations and calculations. Please ask for detailed information.

Signal deviation at 50% FSO [0.25mm]





Force effects on the target

The capacitive measuring principle is reactionless. In specific cases, the force can be calculated with the following formula:

$$F=\frac{C*U^2}{(2*d)}=constant$$

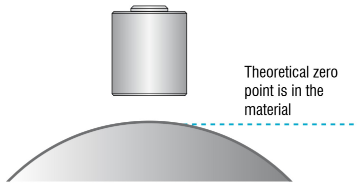
$$F=\frac{\epsilon_0*\epsilon_R*A*E^2}{2}=constant$$

$$F=\frac{1}{2}*E*Q=constant$$

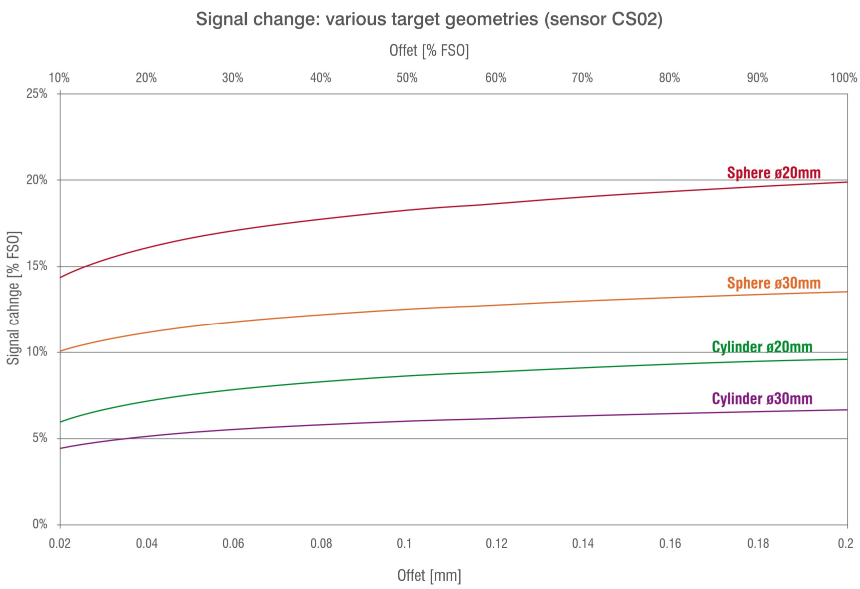
Using the example of a CS1 sensor, which is operated using the DT6230/DT6500 system, a force of approx. 0.23μN is produced. The force however is dependent on the selection of sensor and electronics, not on the sensor's position over the measuring range. The DT6110/6220 systems operate using lower measuring currents, whereby the electrical field and the electrical voltage are lower so that the force is only 0.01μN and so measurement without feedback is assumed.

Measurements on spheres and shafts

In practice, it is often necessary to measure curved surfaces. A classic example is shaft runout measurements, where a cylindrical target is measured. Compared to a flat target, there are either more or less significant measured value deviations depending on the bending radius in doing so. This is caused by various effects, e.g. concentration of the field lines at the highest point or a capacity increase due to a larger measuring spot.



In reality, it can be assumed that the bending radius results in a virtual zero point, i.e., the sensor value 0 can no longer be achieved. Due to the integrating function of the capacitive senor over the measurement surface, the virtual, average measuring plane lies behind the surface line. For example, this means that with a 200μm sensor and a roller with an external diameter of 30mm and a gap clearance of 20μm, almost 5% more is indicated, i.e. approx. 30μm. As this effect can be calculated, corresponding characteristics can be calibrated in the evaluation electronics.



Results are based on internal simulations and calculations. Please ask for detailed information.

Consideration of the conductivity requirements

In order to achieve a linear output signal across the complete measuring range, certain requirements for the target or the counter electrode must be complied with.

The impedance in the ideal plate capacitor can be shown in the equivalent circuit diagram by a capacitor and a resistor connected in parallel. For measurement against metals, the Ohm part can be disregarded; the impedance is only determined by the capacitive part.

Conversely, only the Ohm part is considered for measurements against insulators. In between, there is the large range of semiconductors. Most semiconductors can be measured very well as electrical conductors. The requirement is that the capacitive part of the total impedance is still significantly larger (>10x) than the ohmic part. This is almost always the case for silicon wafers irrespective of the endowment.

Nevertheless, semiconductors with poor conductivity (e.g. GaAs) can also be measured as conductors under certain circumstances. However, various adjustments are required for this, e.g. reduction of the operating frequency or a temporary, partial increase of the conductivity.

Relation between conductivity and suitability of materials