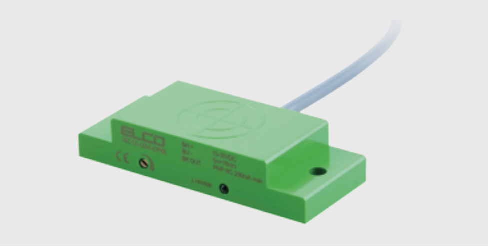
Capacitive Sensors Introduction



<< Capactive sensor

Introduction

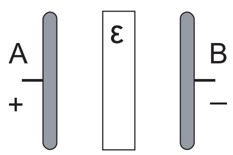
Operating Principle

The active element is formed by two metallic electrodes positioned much like an “opened” capacitor (Fig. 1). Electrodes A and B are placed in a feedback loop of a high frequency oscillator. When no target is present, the sensor’s capacitance is low, therefore the oscillation amplitude is small. When a target approaches the surface of the sensor, it increases the capacitance. This increase in capacitance results in an increased amplitude of oscillation. The amplitude of oscillation is measured by an evaluating circuit that generates a signal to turn on or off the output (Fig.2).

Switching Distance and Dielectric Constants

The switching distance of capacitive sensors is different. The maximum switching distance can be obtained by detecting metallic conductor (metal). When the metal is detected with a capacitive sensor, the attenuation coefficient for different metals is contrary to that of the inductive sensors. The switching distance of dielectric depends on the dielectric constant. The larger the dielectric constant of the object is, the longer switching distance is obtained.

The switching distance (Sr) is dependent on the dielectric constant (εr) of the target object. The maximum switching distance (100 %) is achieved with metallic objects while it is reduced with other materials in proportion to the dielectric constant of the target object.



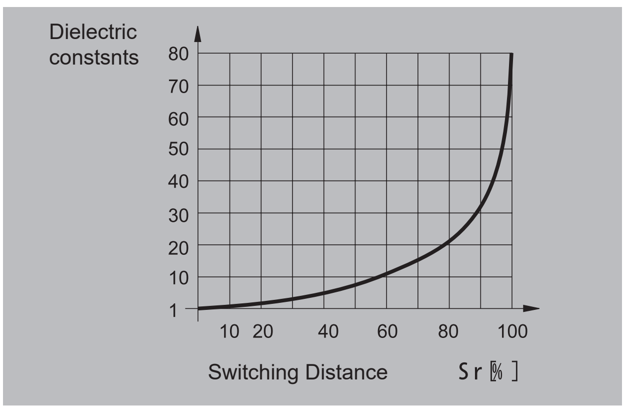


Table 1 (below) shows the dielectric constants of some important materials. As a result of the high dielectric constant value of water, wood exhibits relatively large fluctuations.Damp wood is therefore considerably better detected by capacitive sensors than dry wood.

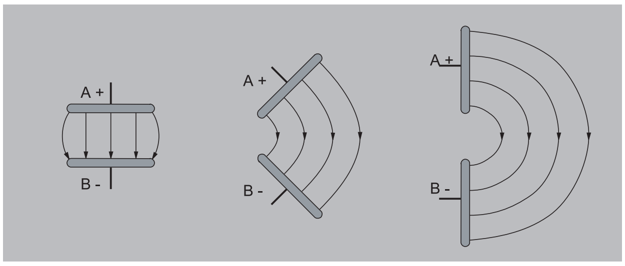


Fig.1 Sensing surface

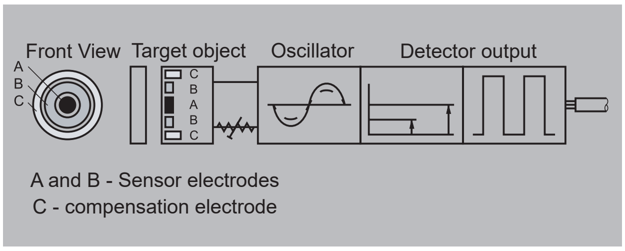


Fig.2 Capacitive Sensing - Operating principle

Table 1

Material	Dielectric constants
Air. vacuum	1
Teflon	2
Wood	2...7
Paraffin	2.2
Petroleum	2.2
Terpentine oil	2.2
Transformer oil	2.2
Paper	2.3
Polyethylene	2.3
Polypropylene	2.3
Cable compound	2.5
Soft rubber	2.5
Silicone rubber	2.8
PVC	2.9
Polystyrene	3
Celluloid	3
Perspex	3.6
Araldite	3.6
Bakelite	3.6
Quartz glass	3.7
Hard rubber	4
Oiled paper	4
Pressboard	4
Porcelain	4.4
Laminated paper	4.5
Quartz sand	4.5
Glass	5
Polyamide	5
Mica	6
Marble	8
Alcohol	25.8
Water	80

Housing material

Plastic and metal housing

Target Object

Capacitive sensors are used for non-contact and non-destructive detection of metals (metallic conductor) and nonmetals (dielectric).

Types of interaction

Capacitive sensors are actuated by both conductive and non-conductive objects. Objects made of conductive materials form a counter-electrode to the sensor's active face. This forms two capacities, CA and CB connected in series, with the electrode surfaces A and B (Fig. 3). The capacity of this serial connection is always greater than the capacity of the uncovered electrodes A and B. Metals achieve the highest switching distances due to their very high conductivity. Reduction factors for differing metals – like those of inductive sensors – must be taken into account. Actuation by objects made of non-conductive materials (insulators): when one places an insulator between the electrodes of a condenser the capacity increases with the dielectric constant ε (Fig. 4) of the insulator.

The dielectric constant of all solids and liquids is greater than air (ε air = 1; see Table 2). Similarly, objects made of non-conductive materials have an effect on the active face of a capacitive sensor by increasing the coupling capacity. Materials with greater dielectric constants achieve longer switching distances. When scanning organic materials (wood, grain, etc.) it should be noted that the achievable switching distance is very strongly influenced by the water content (εwater = 80!)

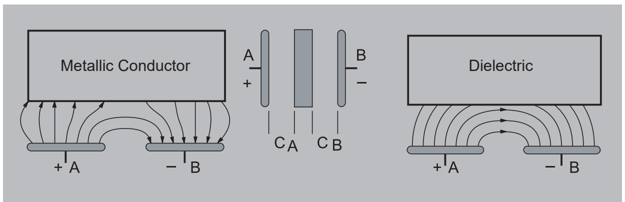


Fig.3 Fig.4

Switching distance adjustment

Almost all ELCO capacitive sensors can be adapted to specific applications by adjusting the potentiometer.

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