Proximity Sensors

■ INDUCTIVE

Principle of operation

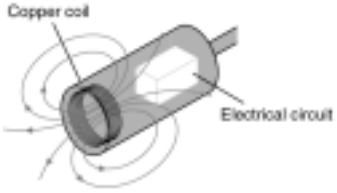
An inductive proximity sensor consists of a coil wound around a ferrite core at the sensing head. A high oscillation frequency is applied to the coil, generating an electro-magnetic field. This is monitored by internal circuitry.

When a metallic object travels toward the field, electric currents are created in the object (eddy currents). As the target approaches the sensing face the currents increase in size.

These currents cause a transformer-like effect, as a result the energy in the detecting coil lessens and the oscillations reduce. As the object moves in closer the oscillation finally stops.

The monitoring circuitry detects the stopping of the oscillations and then switches the output on. The object has now been detected.

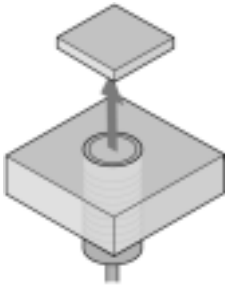
Because the operating principle uses an electromagnetic field, proximity sensors excel over the likes of photoelectric sensors in environmental resistance. Water, oil or dirt generally have no influence on the operation of the sensor making the use on machine tools etc. common-place.



Shielded sensors

Shielded sensors are made with a shielding plate around the ferrite core. This has the effect of limiting the electromagnetic field to the front of the head.

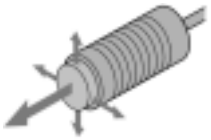
The sensor can be mounted flush in metal surfaces. This gives the advantage of mechanical protection, along with sensing directly adjacent to the sensing face.



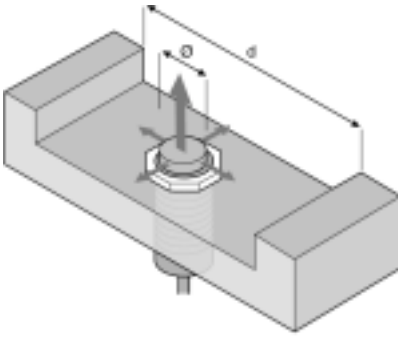
This limits the sensing range, but the sensor can be mounted with ease in a surrounding metal with no reduction in sensing performance.

Unshielded sensors

Unlike the shielded sensor there is no shielding around the ferrite core. The difference between shielded and unshielded sensors can easily be seen.



This gives a greater sensing range than the equivalent diameter shielded proximity sensor. For the same diameter, the range is generally doubled.

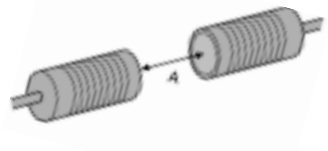


Since the field extends to the side of the proximity switch it can be influenced by metals in this area. Thus the sensor cannot be flush mounted. To avoid any problems when mounting this type, follow these guidelines to avoid the effects of surrounding metal:

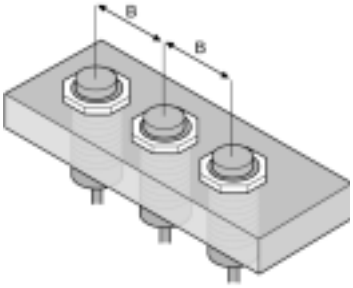
Dimension (d) - (as a minimum)
(d) ≥ 3 x diameter (Ø) of proximity switch
e.g. for an M30 unshielded proximity sensor.
(d) ≥ 3 x 30 mm = 90 mm

Using more than one proximity sensor

If proximity sensors are mounted close together they can interfere with each other's operation. This effect is termed "Mutual interference". This can occur if they are placed face to face, or side by side.



To prevent problems occurring when mounting proximity switches the distances in the following chart should be used as a guidance.



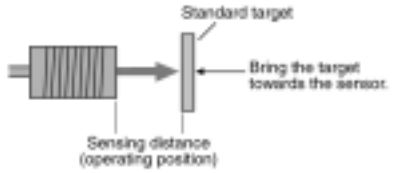
Type	Dimen.	M8	M12	M18	M30
Shielded	A	20 mm	30 mm	30 mm	100 mm
	B	15 mm	20 mm	20 mm	70 mm
Unshielded	A	80 mm	120 mm	120 mm	300 mm
	B	60 mm	100 mm	100 mm	200 mm

Another solution is to order adjacent sensors with a different oscillating frequency. These are indicated on data sheets where available.

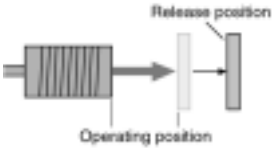
Sensing distance

The sensing distances quoted in the specifications for the proximity sensors are based on a standard target. This target (known as a standard object) is a square plate of mild steel 1 mm thick, a primarily ferrous object.

When the target reaches the point where the sensor operates, this is the sensing distance.



The sensor will release (i.e. turn off) at a point slightly further from the sensing face.

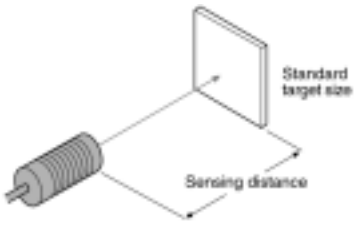


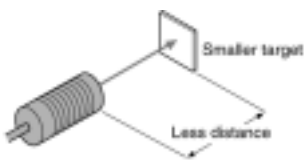
Sensing distance versus target size and material

The sensing ranges quoted are against a standard mild steel object. If however a different metal is used, the sensing range will be reduced. The following table gives approximate reduction in sensing distance for different metals.

Metal	% Reduction
Mild steel	100
Iron	100
Stainless steel	70
Lead	50
Brass	40
Aluminum	30
Copper	25

The sensing range will also be affected if the object to be sensed is smaller than the standard target. This has the effect of reducing the sensing range. (If the thickness increases there is no effect on the sensing range.)





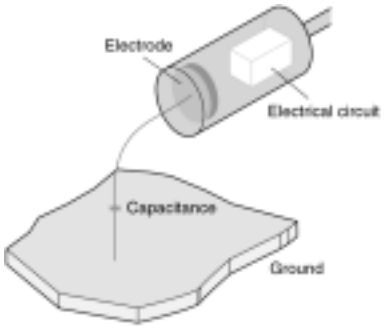
Influence of plating

Metals with different types and thicknesses of plating affect the detecting distance of inductive sensors. The effect will vary depending upon the type and thickness of the plating material.

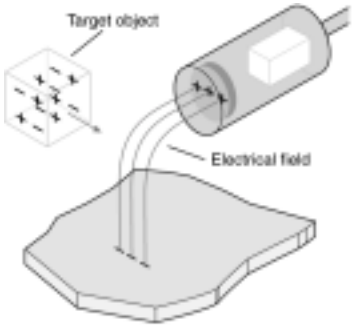
■ CAPACITIVE

Principle of operation

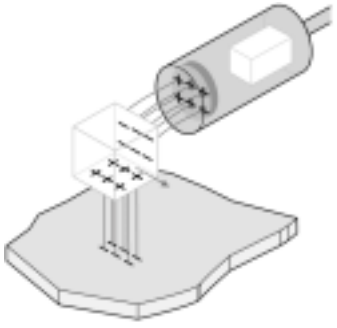
A capacitive proximity sensor is not too dissimilar in principle to an inductive proximity sensor. It mainly differs in that it uses a plate shaped electrode instead of a coil. When operating, an electrostatic capacitive field is formed between the electrode and ground. Thus there is a capacitance in between the sensor and ground. (In practice the supply line is in effect the ground.)



When there is no target object in the area of the sensor the field formed is stable.



When a target object nears the capacitive proximity sensor its positive and negative charges (normally neutralized) separate. The negative charges in the target are attracted to the positive charge of the electrode, and this positive charges to ground. As the negative charge is now nearer to the electrode, the electrostatic capacitance of the electrode increases. This is detected by the sensor and the target has been detected.



■ NOMENCLATURE

Part Number

E2 ❑ -❑ ❑ ❑ ❑ ❑ ❑ ❑ - ❑ - ❑
TL -❑ ❑ ❑ ❑ ❑ ❑ - ❑ - ❑

Key *1 2 3 4 5 6 7 8 9 10*

Key	Subject	Character	Description
1	**Product family**	E2- TL-	Proximity sensor
2	**Series (for E2❑)**	C E F J K Q S T	Inductive type sensor with separate amplifier Inductive type sensor, metal body Inductive type sensor, plastic body Capacitive type sensor with separate amplifier Capacitive type sensor Limit switch style with plug-in construction Subminiature block style Short length block style
3	**Sensor body shape (for TL-❑)**	C M N Q W X YS	Cylindrical body, not threaded Basic switch shape Square body or limit switch style Small square body Flat package Cylindrical threaded body Limit switch style
4	**Sensing distance**	1R5 2 5 10 20 25	1.5 mm 2 mm 5 mm 10 mm 20 mm 25 mm
5	**Shielding**	Blank M	Shielded Unshielded
6	**Power source and output type**	B C D E F H Y	DC, three-wire, PNP open collector DC, three-wire, NPN open collector DC, two-wire DC, three-wire NPN with pull-up resistor DC, three-wire PNP with pull-down resistor DC, with complementary PNP and NPN outputs AC, two-wire with SCR output
7	**Output status**	1 2 3 4	Normally open (NO) Normally closed (NC) Complemetary Selectable NO or NC
8	**Special type code**	5	Alternative oscillating frequency
9	**Special type code**	53	AC sensor with short-circuit protection
10	**Special type code**	Blank P1 5M 10M	Standard cable length, 2 m (6.56 ft) Micro-Change® style plastic receptacle for connector 5 m (16.4 ft) cable length 10 m (32.8 ft) cable length