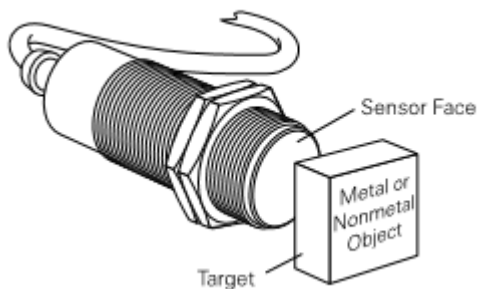
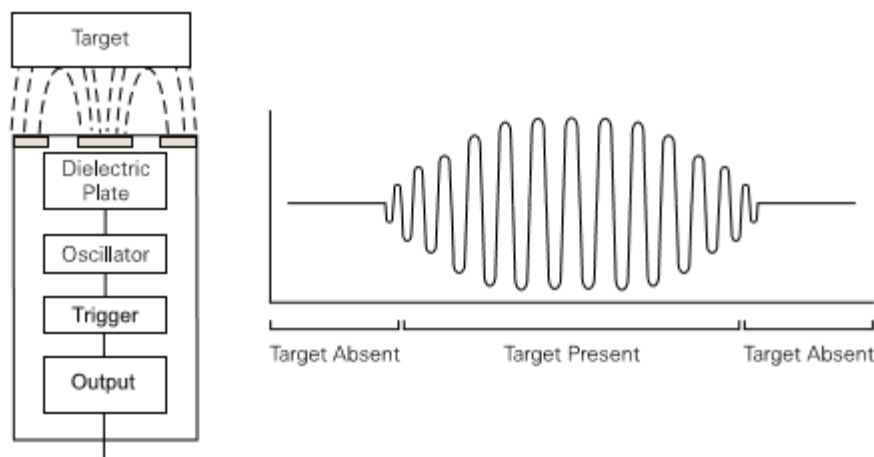


# Capacitive Proximity Sensors Theory of Operation

Capacitive proximity sensors are similar to inductive proximity sensors. The main difference between the two types is that capacitive proximity sensors produce an electrostatic field instead of an electromagnetic field. Capacitive proximity switches will sense metal as well as nonmetallic materials such as paper, glass, liquids, and cloth.

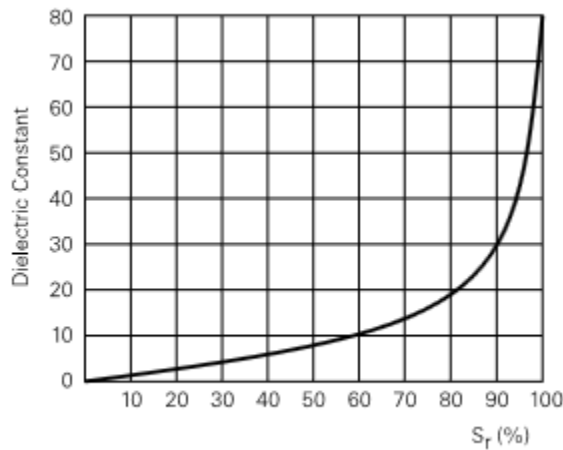


The sensing surface of a capacitive sensor is formed by two concentrically shaped metal electrodes of an unwound capacitor. When an object nears the sensing surface it enters the electrostatic field of the electrodes and changes the capacitance in an oscillator circuit. As a result, the oscillator begins oscillating. The trigger circuit reads the oscillator's amplitude and when it reaches a specific level the output state of the sensor changes. As the target moves away from the sensor the oscillator's amplitude decreases, switching the sensor output back to its original state.



**Standard Target and the Dielectric Constant**

Standard targets are specified for each capacitive sensor. Standard target is usually defined as metal and/or water. Capacitive sensors depend on the dielectric constant of the target. The larger the dielectric number of a material the easier it is to detect. The following graph shows the relationship of the dielectric constant of a target and the sensor's ability to detect the material based on the rated sensing distance ( $S_r$ ).



### Detection Through Barriers

One application for capacitive proximity sensors is level detection through a barrier. For example, water has a much higher dielectric than plastic. This gives the sensor the ability to “see through” the plastic and detect the water.

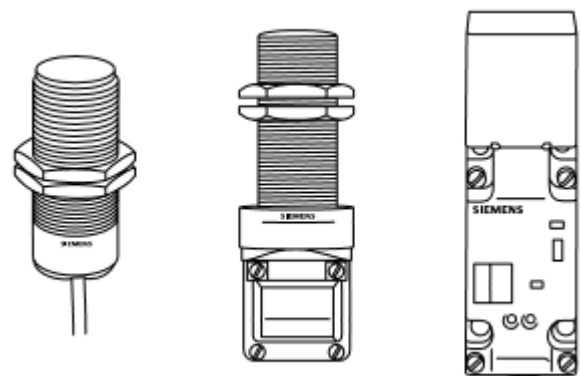
### Shielding

All Siemens capacitive sensors are shielded. These sensors will detect conductive material such as copper, aluminum, or conductive fluids, and nonconductive material such as glass, plastic, cloth, and paper. Shielded sensors can be flush mounted without adversely affecting their sensing characteristics. Care must be taken to ensure that this type of sensor is used in a dry environment. Liquid on the sensing surface could cause the sensor to operate.

## Capacitive Proximity Sensor Family

The 3RG16 product family identifies the Siemens capacitive proximity sensor. Units are available in DC or AC versions. Electronic controls such as SIMATIC® PLCs or relays can be controlled directly with the DC voltage version. In the case of the AC voltage version the load (contactor relay, solenoid valve) is

connected with the sensor in series directly to the AC voltage. Sensors are available with two-, three-, and four-wire outputs.

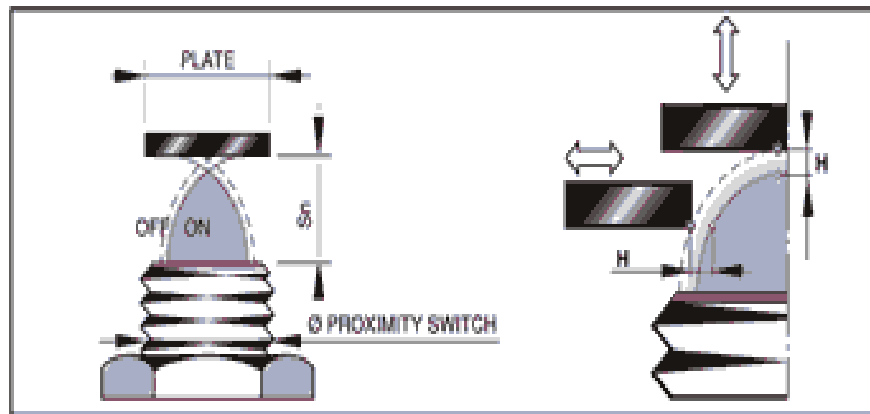


Capacitive Sensor  
Selection Guide

Housing Dimension (mm)	Material	Shielded Unshielded	Sn (mm)	Operating Voltage	Wires
18	Plastic	Shielded	5	10-65 VDC	3
30	Metal	Shielded	10	20-250 VAC	3
	Plastic	Shielded	10	20-250 VAC	2
	Metal	Shielded	10	10-65 VDC	4
	Plastic	Shielded	10	10-65 VDC	4
40	Plastic	Shielded	20	20-250 VAC	2
	Plastic	Shielded	20	10-65 VDC	4
40x40 (Limit Switch Style)	Plastic	Shielded	20	20-250 VAC	2
	Plastic	Shielded	20	10-65 VDC	4
20x20 (Flat Pack)	Metal	Shielded	5	10-30 VDC	3

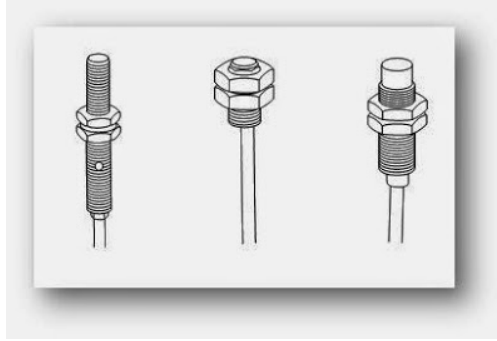
# OPERATING PRINCIPLES FOR INDUCTIVE PROXIMITY SENSORS

Inductive proximity sensors are used for non-contact detection of metallic objects. Their operating principle is based on a coil and oscillator that creates an electromagnetic field in the close surroundings of the sensing surface. The presence of a metallic object (actuator) in the operating area causes a dampening of the oscillation amplitude. The rise or fall of such oscillation is identified by a threshold circuit that changes the output of the sensor. The operating distance of the sensor depends on the actuator's shape and size and is strictly linked to the nature of the material (Table 1).



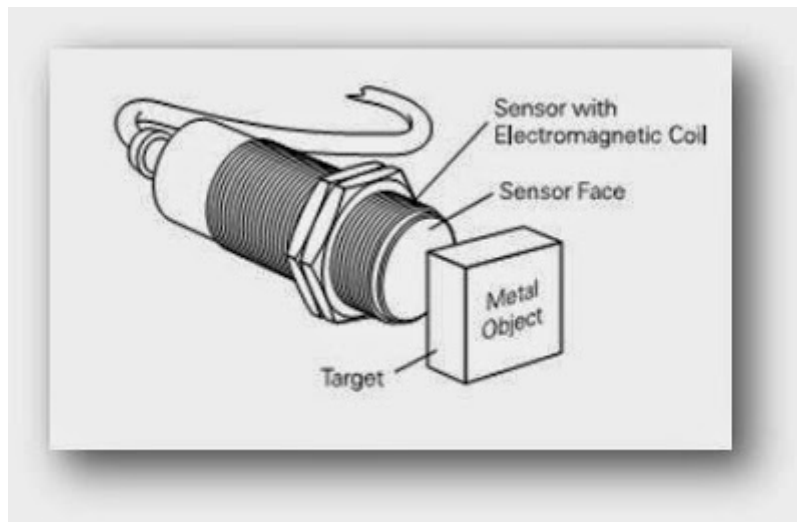
## Theory or Operation of Inductive Proximity Sensors

Inductive proximity sensors are available in a variety of sizes and configurations to meet varying applications. Specific sensors will be covered in more detailed in the following section.



## Electromagnetic Coil and Metal Target

The sensor incorporates an electromagnetic coil which is used to detect the presence of a conductive metal object. The sensor will ignore the presence of an object if it is not metal.



Inductive proximity sensors are operated using an Eddy Current Killed Oscillator (ECKO) principle. This type of sensor consists of four elements: coil, oscillator, trigger circuit, and an output. The oscillator is an inductive capacitive tuned circuit that creates a radio frequency. The electromagnetic field produced by the oscillator is emitted from the coil away from the face of the sensor. The circuit has just enough feedback from the field to keep the oscillator going.

When a metal target enters the field, eddy currents circulate within the target. This causes a load on the sensor, decreasing the amplitude of the electromagnetic field. As the target approaches the sensor the eddy currents increase, increasing the load on the oscillator and further decreasing the amplitude of the field. The trigger circuit monitors the oscillator's amplitude and at a predetermined level switches the output state of

the sensor from its normal condition (on or off). As the target moves away from the sensor, the oscillator's amplitude increases. At a predetermined level the trigger switches the output state of the sensor back to its normal condition (on or off).

