WORKING OF INDUCTIVE AND CAPACITIVE PROXIMITY SENSORS

SET-3

Figure 1. Inductive Proximity Switch

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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.

At the heart of an Inductive Proximity Sensor ("prox" "sensor" or "prox sensor" for short) is an electronic oscillator consisting of an inductive coil made of numerous turns of very fine copper wire, a capacitor for storing electrical charge, and an energy source to provide electrical excitation. The size of the inductive coil and the capacitor are matched to produce a self-sustaining sine wave oscillation at a fixed frequency. The coil and the capacitor act like two electrical springs with a weight hung between them, constantly pushing electrons back and forth between each other. Electrical energy is fed into the circuit to initiate and sustain the oscillation. Without sustaining energy, the oscillation would collapse due to the small power losses from the electrical resistance of the thin copper wire in the coil and other parasitic losses.

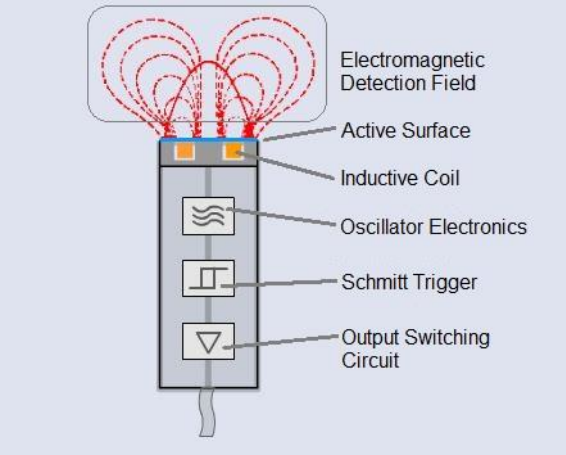

Figure 2. Internal Elements of an Inductive Proximity Sensor

The oscillation produces an electromagnetic field in front of the sensor, because the coil is located right behind the "face" of the sensor. The technical name of the sensor face is "active surface".

When a piece of conductive metal enters the zone defined by the boundaries of the electromagnetic field, some of the energy of oscillation is transferred into the metal of the target. This transferred energy appears as tiny circulating electrical currents called eddy currents. This is why inductive proxes are sometimes called eddy current sensors.

The flowing eddy currents encounter electrical resistance as they try to circulate. This creates a small amount of power loss in the form of heat (just like a little electric heater). The power loss is not entirely replaced by the sensor's internal energy source, so the amplitude (the level or intensity) of the sensor's oscillation decreases. Eventually, the oscillation diminishes to the point that another internal circuit called a Schmitt Trigger detects that the level has fallen below a pre-determined threshold. This threshold is the level where the presence of a metal target is definitely confirmed. Upon detection of the target by the Schmitt Trigger, the sensor's output is switched on.

This shows the effect of a metal target on the sensor's oscillating magnetic field. When you see the cable coming out of the sensor turn red, it means that metal was detected and the sensor has been switched on. When the target goes away, you can see that the sensor's output is switched back off.

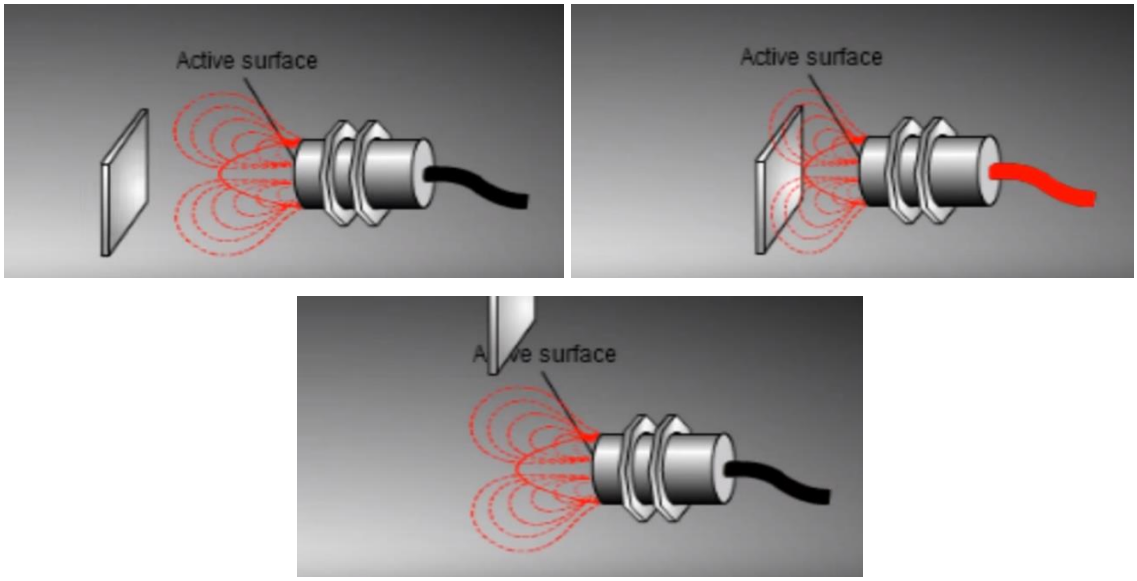

Figure 3. Working of Inductive Proximity Sensor

Capacitive Proximity Sensors

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.

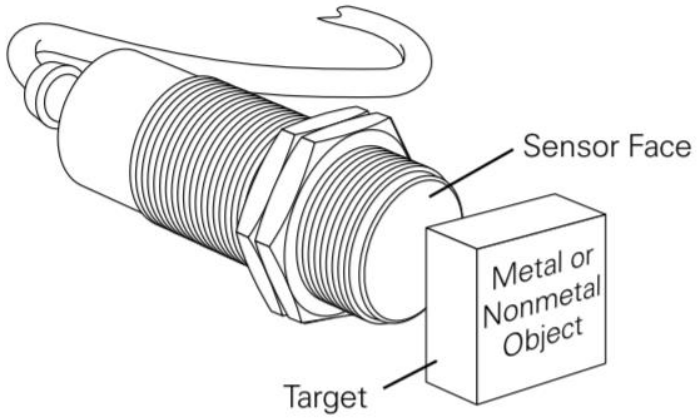

Figure 4. Capacitive Proximity Sensor

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.

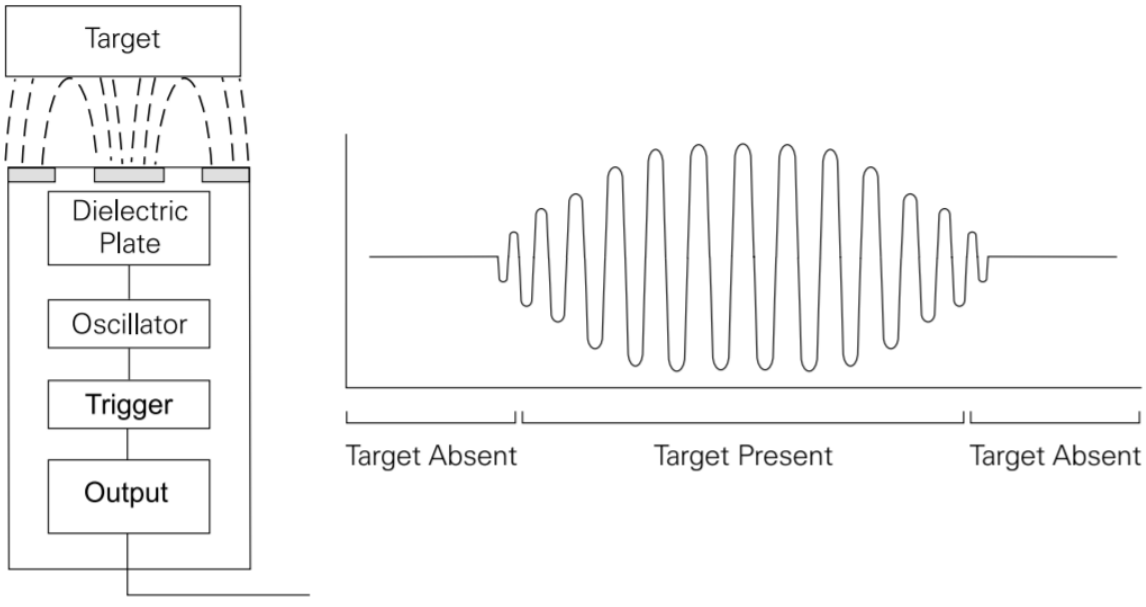

Figure 5. Working of Capacitive Proximity Sensor

The capacitive proximity sensor is similar to the inductive proximity sensor. The main difference between the two, capacitive proximity sensor produces an electrostatic field instead of a magnetic field and the sensing area of the capacitive proximity sensor can be actuated by both conductive and non-conductive materials. A capacitive proximity sensor contains a high-frequency oscillating circuit along with a sensing surface formatted by two metal plates. When an object or some type of material gets in the sensing range it disturbs the electrostatic field of the metal plates, changing the capacitance of the proximity sensor, this change results in a change of state in the operation of the proximity sensor.