

A capacitor sensor is a type of proximity sensor that detects nearby objects via an electric field strength effect formed by the sensor. These sensors are similar to radar in that they can detect electrical components while monitoring and via insulating materials such as plastic or wood.

This article discusses capacitive sensors in detail. Read on to learn more about its properties, working, types, uses, advantages and disadvantages.

What is Capacitive Sensor?

A capacitive proximity sensor is an electronic device that can simply detect and measure various things such as movement, chemical properties, displacement, and [electric field](#), and indirectly detect many other variables that can be converted into [dielectric constant](#) or motion such as acceleration, [pressure](#), fluid composition, and fluid level. The capacitive sensor will generate an electrical field from the sensor's detecting end in order to detect these targets. This sensor can detect any object that can disrupt the electrical field.

Formula

A [capacitance](#) sensor consists of two metal plates divided by a distance 'd' and an area 'A'. As a result, the capacitance 'C' between two junctions can be calculated using the following expression.

$$C = \epsilon_0 \times \epsilon_r \times \frac{A}{h}$$

Where,

C = capacitance within Faradays

ϵ_r = Insulator's relative dielectric constant

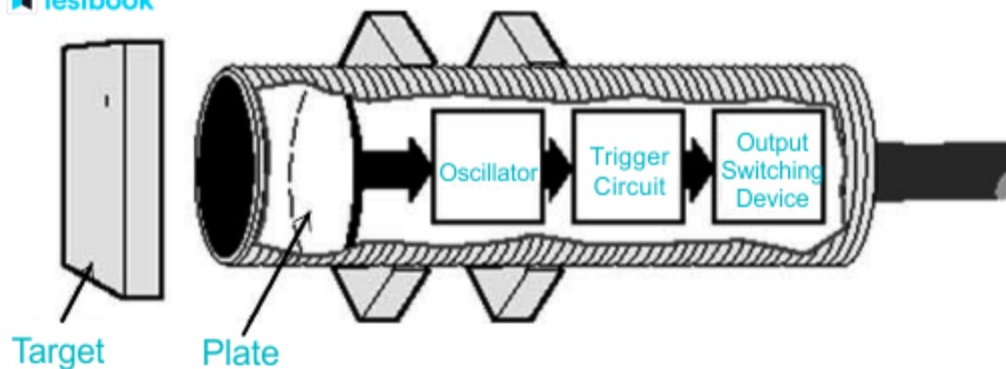
ϵ_0 = dielectric constant for free space

A = overlapping area of two plates

h = width of the gap between two plates.

Components of Capacitive Sensor

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The sensor body, sensing face, indicator light, and cable or cable connection end are the four main components of capacitive proximity sensors.

- **Sensor's Body:** The circuitry that allows the sensor to function is housed within the sensor's body.
- **Sensing Face:** The detecting face is the portion of the sensor that can detect targets.
- **Light Indicator:** The indicator light is located on the sensor's opposite end from the sensing face. This light illuminates when a goal is within the sensing range of the sensor and turns off if the target is outside of the sensing range.
- **Sensor Connection:** These sensors can be acquired with a cable just now attached or with a connector into which the cable screws.

Properties of Capacitive Sensor

The following must be considered characteristics of capacitive proximity sensors:

- They can detect non-metallic targets.
- They can detect lighter weight or small objects that mechanical limit switches cannot detect.
- They have a high switching rate for quick response in object-counting applications.
- They can aid in the detection of liquid targets via non-metallic barriers.
- They have a protracted operational life due to their virtually infinite number of operating cycles.

Capacitive Sensor Working Principle

A capacitive sensor works in the same way that a standard capacitor does. In this sensor, a metal sheet within the detecting face is connected properly to an oscillator circuit, and the detected target can act as the [capacitor's](#) next plate. In contrast to an inductive sensor, which produces magnetic waves, a capacitive proximity sensor produces an electrostatic field.

The capacitive sensor's diagram is shown above. This sensor consists of a high-frequency oscillator and a sensing surface formed by two metal electrodes. When an object comes close to the sensor surface, it enters the electrical force of the electrodes and changes the capacitance of the oscillator.

As a result, once it reaches a certain amplitude, the oscillator circuit might very well begin to oscillate and change the sensor's output condition. When the target moves away from the capacitive proximity sensor, the oscillator's amplitude decreases, causing the capacitive sensor to return to its original position.

These sensors easily detect an object's superior [dielectric constant](#). As a result, sensing of the substance within non-metallic vessels is possible because the dielectric of the liquid is much higher than that of the container. As a result, the sensor is able to observe the container and detect the liquid. They must operate in an environment with relatively constant [temperature](#) and humidity.

Types of Capacitive Sensors

Analog



- The analog capacitive sensor functions similarly to standard capacitive sensors, but it provides additional benefits depending on how it is used.
- In comparison to other applications, these sensors are excellent for material selection, thickness monitoring, and concentration difference.

Miniature



- The said type of capacitive sensor is accessible in a wafer or cylindrical shape, allowing it to be placed in the smallest of spaces.
- These sensors are primarily used to constantly monitor machine processes, as well as work as detectors for job counting.
- Small sensor heads require an external amplifier to provide the best fit in tight spaces.

- As a result, the [potentiometer](#) on this external amplifier allows for sensitivity adjustment.

High Temperature



- High-Temperature capacitive sensors are used in applications where the sensor head is subjected to extreme temperatures.
- Even in the most extreme conditions, these sensors can detect liquids, temperature levels, and bulk goods even when in direct contact with hot materials and temperatures.

Cylindrical



- The said cylindrical capacitive sensor is bigger than miniature sensors ranging from 6.5 to M12 and M12 to M30.
- This sensor has a variable sensing distance, a variety of housing widths, and flush and non-flush mounting options.
- These sensors primarily detect level or provide contact-free closeness detection directly through a container wall.

Capacitive Sensor Advantages and Disadvantages

The advantages and disadvantages of capacitive sensors are as follows.

Advantages

- They can detect non-metallic targets and can detect through certain types of containers.
- It is simple to build and adjustable.
- It can identify dense targets as well as liquids.
- It is less expensive.
- It has greater sensitivity and can operate with a small amount of force.
- It can be used to measure force, pressure, and humidity, among other things.
- It has a high resolution and a wide frequency response.

Disadvantages

- It is extremely sensitive to changing environmental conditions like temperature and humidity. This will have an effect on performance.
- Capacitance measurement is more difficult than resistance measurement.
- Capacitive proximity sensors are less accurate than inductive sensors.

Capacitive Sensor vs Inductive Sensor

Sr. No.	Capacitive Sensor	Inductive Sensor
1.	An electric field is used by capacitive sensors to detect objects.	A magnetic field is used by inductive sensors to detect objects.
2.	The object does not have to be conductive to be detected by the capacitive sensor.	An object has to be conductive to be detected by an inductive sensor.
3.	These sensors detect both metals and non-conductive materials.	This sensor detects metallic objects.
4.	It operates at a lower switching frequency.	It operates at a faster switching frequency.
5.	A capacitive sensor has a detection range of 2 to 50mm.	An inductive sensor has a detection range of 0.8 to 100mm.

Applications of Capacitive Sensor

The capacitive sensor's applications include the following.

- They detect things that are conductive but lack dielectric, such as air.
- All such sensors are most commonly used to detect changes in the position of a conductive target. However, these detectors can also be quite useful in measuring density, existence, thickness, and the location of non-conductors.
- Position, proximity, velocity, displacement, fluid level, and [humidity](#) are all detected or measured using capacitive sensors.
- Active sensor touch screens are being used as input devices in cell devices, tablets, digital sound players, and other devices.
- These sensors take the place of mechanical buttons.

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