5.3. Humidity Sensor

Humidity Sensor is one of the most important devices that has been widely in consumer, industrial, biomedical, and environmental etc. applications for measuring and monitoring Humidity.

Types of Humidity Sensors

Capacitive Humidity Sensors

Resistive Humidity Sensors

Thermal Conductivity Humidity Sensors

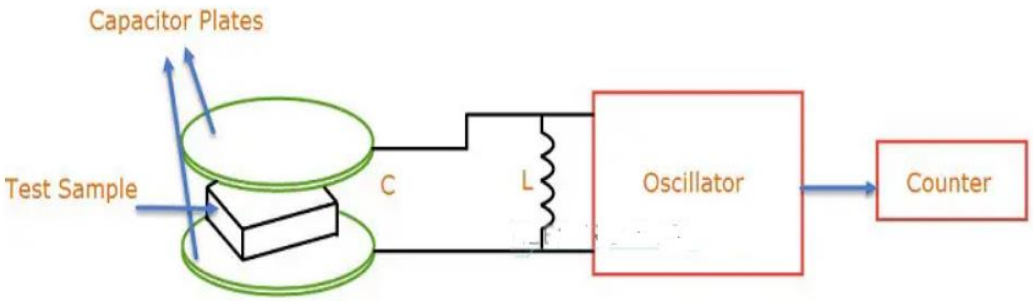
Capacitive Humidity Sensors

Humidity Sensors based on capacitive effect or simply Capacitive Humidity Sensors are one of the basic types of Humidity Sensors available.

They are often used in applications where factors like cost, rigidity and size are s of concern. In Capacitive Relative Humidity (RH) Sensors, the electrical permittivity of the dielectric material changes with change in humidity.

Working of Capacitive Relative Humidity (RH) Sensors

A simple Capacitive RH Sensor can be made from an air filled capacitor as the moisture in the atmosphere changes its permittivity. But for practical applications, air as a dielectric is not feasible. Capacitive RH Sensor is shown in figure.



The space between the capacitor plates is usually filled with an appropriate dielectric material (isolator), whose dielectric constant varies when it is subjected to change in humidity.

The common method of constructing a capacitive RH sensor is to use a hygroscopic polymer film as dielectric and depositing two layers of electrodes on the either side.

Another way to use the capacitive RH sensors is to observe the changes in the frequency of the oscillator constructed using a capacitor with RH sensitive test subject as dielectric. This setup is often employed in pharmaceutical products.

The test samples like medical tablets are placed between two plates (which form the capacitor electrodes) to form a capacitor in the LC Oscillator circuit. The frequency of the oscillator changes with humidity surrounding the test sample.

The construction of a thin thermostat polymer film based capacitive RH Sensor. It is fabricated on a silicon substrate. On this substrate, two metal electrodes made of either aluminium, platinum or chromium are deposited. The shape of these electrodes is carved out such that, the electrodes form an interdigitized pattern.

On top of this layer, a dielectric layer is deposited. The following image shows a top and cross section view of the capacitive humidity sensor. Note that two temperature sensitive resistors are deposited on the same substrate to provide temperature compensation.

Advantages of Capacitive Humidity Sensors

- The output voltage is near linear.
- They provide stable results over long usage.
- Can detect wide range of RH.

Disadvantages of Capacitive Humidity Sensors

- The distance from the sensor and signalling circuit is very limited.

Applications of Capacitive Humidity Sensors

Capacitive Humidity Sensors are used in a wide range of applications including but not limited to:

- HVAC Systems
- Printers and Fax Machines
- Weather Stations
- Automobiles
- Food Processing
- Refrigerators, Ovens and Dryers

5.4. Medical sensors

The sensors used to diagnose, monitor or treat diseases in medical domain are known as medical sensors.

Types of medical sensors

There are functions of different types of medical sensors as described below for various applications.

➨**Temperature probes**: Used for body temperature measurement. This helps in providing better medication and treatment of patients. They are called as thermometers.

➨**Force sensors**: Used in kidney dialysis machines.

➨**Airflow sensors**: Used in anesthesia delivery systems, laparoscopy, heart pumps etc.

➨**Pressure sensors**: Used in infusion pumps and sleep apnea machines. Most of the pressure sensors are integrated with embedded systems. They are used for medical diagnosis, blood pressure monitoring, infusion pumps etc.

➨**Implantable pacemaker**: It is a real time embedded sensor system which delivers a synchronized rhythmic electric stimulus to the heart muscle in order to maintain effective cardiac rhythm.

➨**Oximeter**: It measures the fraction of oxygen saturated hemoglobin relative to the total hemoglobin count in the blood.

➨**Glucometer**: It measures approximate blood glucose concentration.

➨**Magnetometer**: It specifies direction of user by examining the changes in the earth's magnetic field around the user.

➨**Electrocardiogram sensor**: It measures the electrical activity of the heart. It is called as ECG sensor.

➨**Heart rate sensor**: It counts the number of heart contractions per minute.

➨**Electroencephalogram sensor**: It measures the electrical activity of the brain.

➨**Electromyogram sensor**: It records electrical activity produced by skeletal muscles.

➨**Respiration rate sensor**: It counts how many times the chest rises in a minute.

5.5. Neural sensors

Devices that can be used to study, monitor, or control the nerves and muscles and to remotely monitor neural activity are called Neural sensors

Neural sensors detect electrical or chemical signals from the nervous system. They're used to study brain activity, treat neurological disorders, or control prosthetics and brain-computer interfaces (BCIs).

Types of Neural Sensors

1. Electroencephalography (EEG) Sensors

- **What it does:** Measures electrical activity on the scalp.
- **Use cases:** Brain-computer interfaces, epilepsy detection, sleep studies.

2. Electrocorticography (ECoG) Sensors

- **What it does:** Measures electrical activity directly from the brain surface.
- **Use cases:** Seizure localization, BCI research.

3. Intracortical Microelectrodes

- **What it does:** Detects activity from individual neurons.
- **Use cases:** High-precision brain-machine interfaces.

4. Local Field Potential (LFP) Sensors

- **What it does:** Measures the summed electrical activity of groups of neurons.
- **Use cases:** Deep brain stimulation, Parkinson’s disease treatment.

5. Magnetoencephalography (MEG) Sensors

- **What it does:** Detects magnetic fields produced by neural activity.
- **Use cases:** Brain mapping, epilepsy surgery planning.

6. Functional Near-Infrared Spectroscopy (fNIRS)

- **What it does:** Measures blood oxygenation in the brain.
- **Use cases:** Cognitive neuroscience, mental workload analysis.

7. Chemical Neural Sensors

- **What it does:** Detects neurotransmitters (e.g., dopamine, serotonin).
- **Use cases:** Research in mood, behavior, and neurological diseases.