EEE1024: Fundamentals of Electrical and Electronics Engineering

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Module -6 Syllabus

- **Measuring Instruments:**

  Classification of instruments, Working principle of PMMC, MI, Digital & Smart Meters, Ammeter, Voltmeter & wattmeter.

- **Sensors:**

  Transducers classification& selections, Resistive, Inductive and capacitive sensors, Optical and Digital sensors.

SENSORS

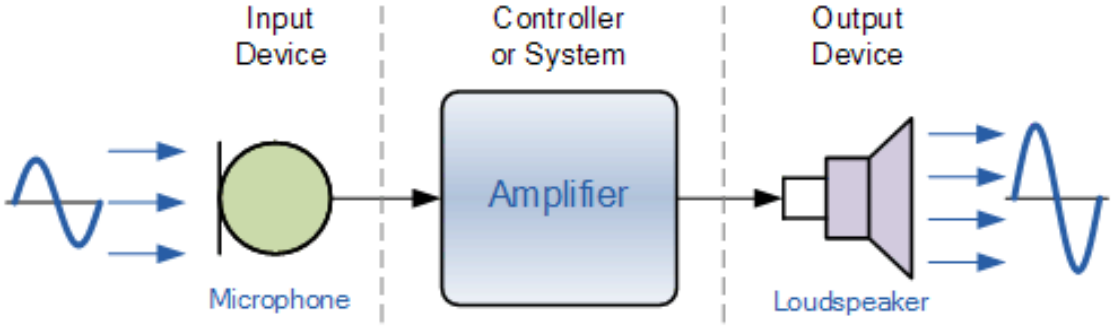
TRANSDUCERS

Transducer = **Sensor** + **Actuator**

Are used to sense a wide range of different energy forms such as movement, electrical signals, radiant energy, thermal or magnetic energy

Are used to switch voltages or currents.

Electrical **Transducers** are used to convert energy of one kind into energy of another kind



Common Transducers

Quantity being Measured	Input Device (Sensor)	Output Device (Actuator)
Light Level	Light Dependant Resistor (LDR) Photodiode Photo-transistor Solar Cell	Lights & Lamps LED's & Displays Fibre Optics
Temperature	Thermocouple Thermistor Thermostat Resistive Temperature Detectors	Heater Fan
Force/Pressure	Strain Gauge Pressure Switch Load Cells	Lifts & Jacks Electromagnet Vibration

Quantity being Measured	Input Device (Sensor)	Output Device (Actuator)
Position	Potentiometer Encoders Reflective/Slotted Opto-switch LVDT	Motor Solenoid Panel Meters
Speed	Tacho-generator Reflective/Slotted Opto-coupler Doppler Effect Sensors	AC and DC Motors Stepper Motor Brake
Sound	Carbon Microphone Piezo-electric Crystal	Bell Buzzer Loudspeaker

Classification of Sensors - I

***ACTIVE** sensors*

They require an external power supply to operate, called an *excitation signal* which is used by the sensor to produce the output signal.

Example – Strain gauge

- ***Strain gauges*** are pressure-sensitive resistive bridge networks that are external biased (excitation signal is a voltage).
- Output voltage is produced in proportion to the amount of force and/or strain being applied to the sensor.

***PASSIVE** sensors*

They not need any additional power source or excitation voltage. Instead a passive sensor generates an output signal in response to some external stimulus.

Example – Thermocouple

- **Thermocouple** generates its own voltage output when exposed to heat.
- Passive sensors are direct sensors which change their physical properties, such as resistance, capacitance or inductance etc.

Classification of Sensors - II

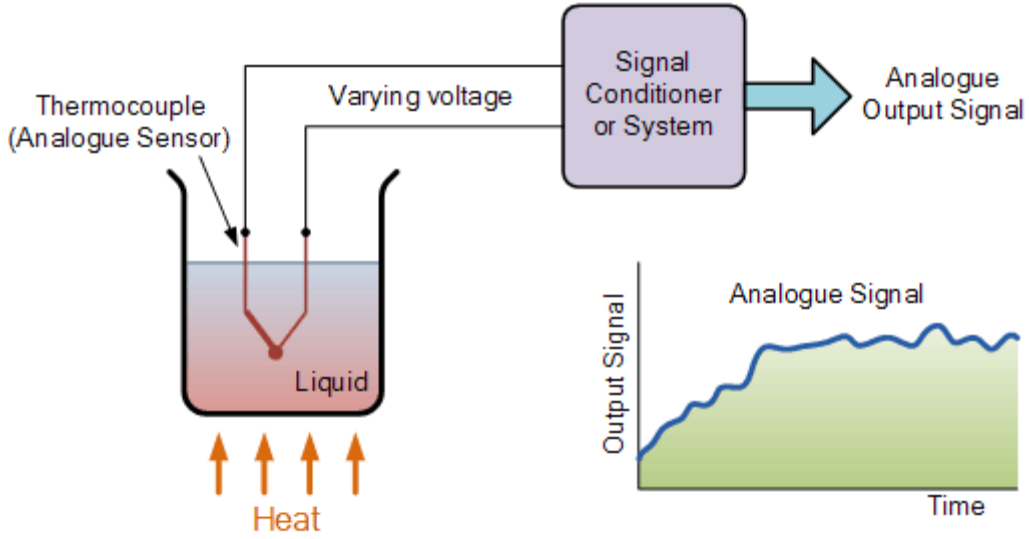
DIGITAL *sensors*

- They produce discrete digital output signals or voltages that are a digital representation of the quantity being measured.
- Digital sensors produce a Binary output signal in the form of a logic “1” or a logic “0”, (“ON” or “OFF”).

ANALOG *sensors*

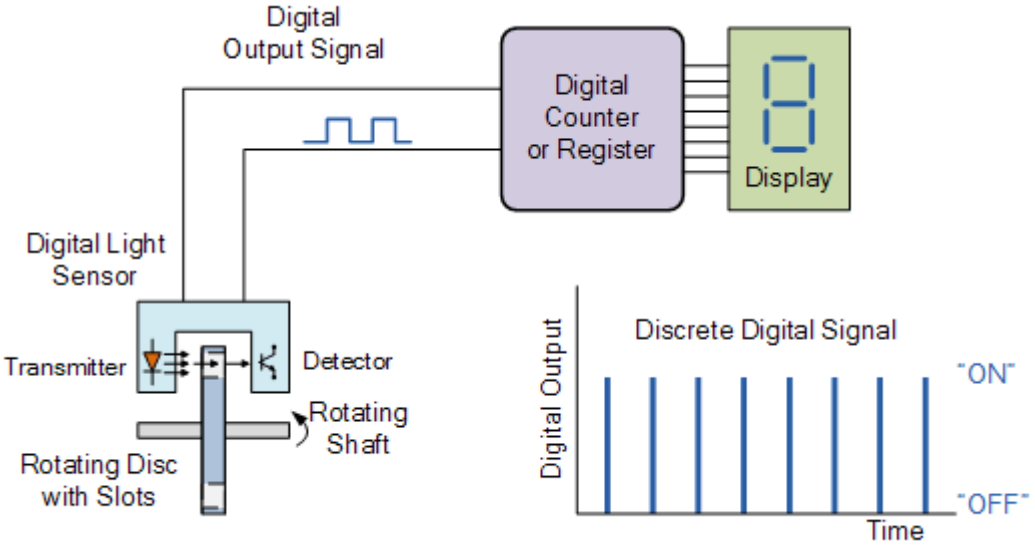
- They produce a continuous output signal or voltage which is generally proportional to the quantity being measured.
- Physical quantities such as Temperature, Speed, Pressure, Displacement, Strain etc. are all analogue quantities as they tend to be continuous in nature.

Example of Analog Sensors



- The temperature of a liquid can be measured using a **thermocouple** which continuously responds to temperature changes as the liquid is heated up or cooled down.
- These signals tend to be very small in value from a few uV to several mV, so some form of amplification is required.
- These sensors have a slow response and/or low accuracy.
- But these analogue signals can be easily converted into digital signals for use in micro-controller systems by the use of analogue-to-digital converters, or ADC's.

Example of Digital Sensors



- Speed of the rotating shaft is measured by using a digital LED/Opto-detector sensor.
- The disc which is fixed to a rotating shaft (for example, from a motor or robot wheels), has a number of transparent slots within its design.
- As the disc rotates with the speed of the shaft, each slot passes by the sensor in turn producing an output pulse representing a logic “1” or logic “0” level.
- These pulses are sent to a register of counter and finally to an output display to show the speed or revolutions of the shaft.

Classification of Sensors - III

Primary *sensors*

- A primary transducer consists of both mechanical and electrical devices.
- The mechanical parts of the LVDT transducer are responsible for converting the mechanical movement of the object into mechanical signals.

Secondary *sensors*

- Secondary sensors are the components of the sensor that convert the mechanical displacement into electrical data

LVDT - Linear Variable Differential Transformer

Classification of Sensors - IV

Resistive *sensors*

- The transducer whose resistance varies because of the environmental effects.
- The change in resistance is measured by the ac or dc measuring devices.

Capacitive *sensors*

- Capacitive proximity sensors are non-contact devices that can detect the presence or absence of virtually any object regardless of material.
- They utilize the electrical property of capacitance and the change of capacitance based on a change in the electrical field around the active face of the sensor.

Inductive *sensors*

- A inductive proximity sensor can detect metal targets approaching the sensor, without physical contact with the target.
- Non-metallic targets cannot be detected!

Selection of Transducers

Factors are to be considered while selecting a transducer are ->

1. Operating Principle : Resistive, inductive, capacitive, optical etc.

2. Operating range : The range should be appropriate for measurement to get a good resolution.

3. Accuracy : The accuracy should be as high as possible or as per the measurement.

4. Range : The transducer can give good result within its specified range, so select transducer as per the operating range.

5. Sensitivity : It should be more sensitive to the output or sensitivity should be as per requirement.

6. Loading effect : The transducer's input impedance should be high and output impedance should be low to avoid loading effect.

7. Errors : The error produced by the transducer should be low as possible.

8. Environmental compatibility : The transducer should maintain input and output characteristic for the selected environmental condition.

Acknowledgements

1. https://www.electronics-tutorials.ws/io/io_1.html
2. https://www.polytechnichub.com/selection-criteria-transducer/
3. https://www.positek.com/