

# TRANSDUCERS – I

## Introduction:

The primary objective of process control is to control the physical parameters such as temperature, pressure, flow rate, force, level etc. The system used to maintain these parameters constant, close to some desired specific value is called **process control system**.

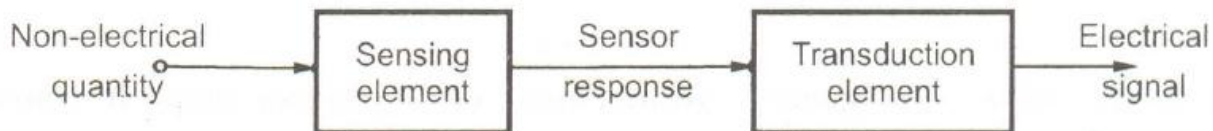
These parameters may change because of internal and external disturbances hence a constant corrective action is required to keep these parameters constant or within the specified range. It consists of four elements,

1. Process
2. Measurement
3. Controller
4. Control element.

A device which converts a physical quantity into the proportional electrical signal is called a transducer.

The electrical signal produced may be a voltage, current or frequency. A transducer uses many effects to produce such conversion. The process of transforming signal from one form to other is called transduction. A transducer is also called pick up.

The transduction element transforms the output of the sensor to an electrical output, as shown in the Fig.



## Transducer elements in cascade

The common range of an electrical signal used to represent analog signal in the industrial environment is 0 to 5 V or 4 to 20 mA. In industrial applications, nowadays, 4 to 20 mA range is most commonly used to represent analog signal. A current of 4 mA represents a zero output and current of 20 mA represents a full scale value i.e. 5 V in case of voltage representation. The zero current condition represents open circuit in the signal transmission line. Hence the standard range is offset from zero.

Many a times, the transducer is a part of a circuit and works with other elements of that circuit to produce the required output. Such a circuit is called signal conditioning circuit.

## Passive transducer:

In electrical circuits, there are combinations of three passive elements : resistor, inductor and capacitor. These three passive elements are described with the help of the primary parameters such as resistance, self or mutual inductance and capacitance respectively. Any change in these parameters can be observed only if they are externally powered. We have studied that the passive transducers do not generate any electrical signal by themselves and they require some external power to generate an electrical signal.

The transducers based on variation of parameters such as resistance, self or mutual inductance capacitance, due to an external power are known as passive transducers. Hence resistive transducer, inductive transducer and capacitive transducer are the basic passive transducers.

**Resistive transducer:**

In general, the resistance of a metal conductor is given

$$R = \frac{\rho L}{A}$$

where  $\rho$  = Resistivity of conductor ( $\Omega$  m)

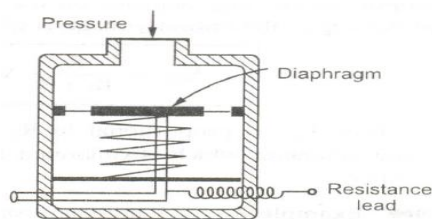
L = Length of conductor (m)

A = Area of cross-section of conductor ( $m^2$ )

by,

The electrical resistive transducers are designed on the basis of the methods of "arintioll of anyone of the quantities in above equation; such as change in length, change in iueil of cross-section and change in resistivity.

The sensing element which is resistive in nature, may be in different forms depending upon the mechanical arrangement. The change in pressure can be sensed by Llsing ~nsitive resistive elements. The resistance pressure transducers may use Bellow, Diaphragm or Bourdon tube.



(b) Diaphragm type