18ECO133T

Sensors and Transducers

UNIT V

Session 4: SLO - 2

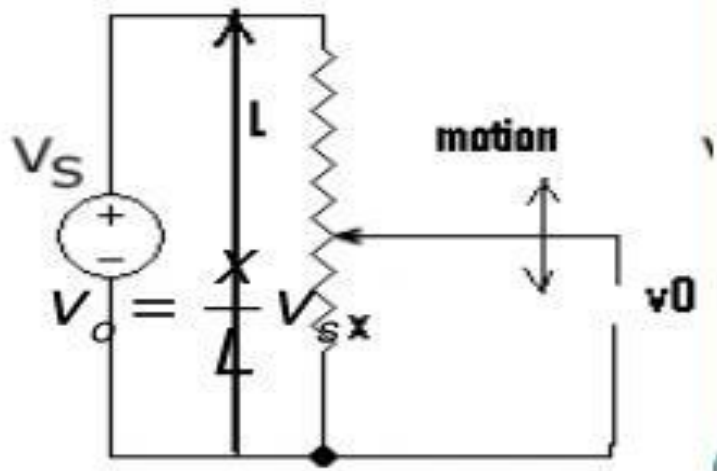
Longitudinal Displacement

Potentiometer or longitudinal displacement

Theory of Operation:

The sensor consists of a length "L" of resistance wire attached across a voltage source "V_s". The wiper is pushed up or down by moving target, for which displacement "x" is required to be measured. V_o is the output voltage representing displacement in terms of volts and is given by:

$$v_o = \frac{x}{L} v_s$$

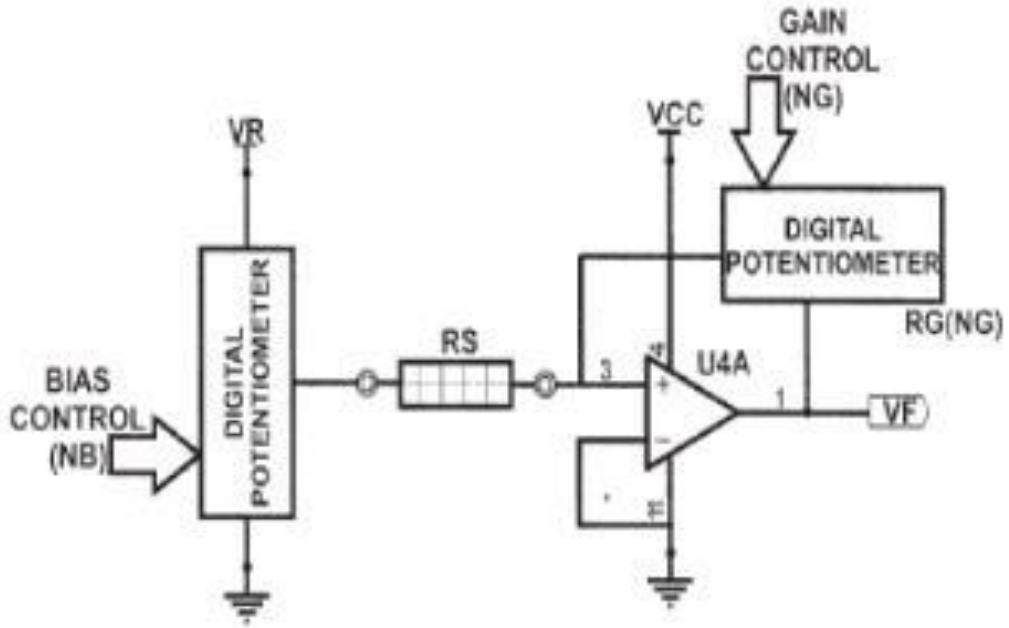


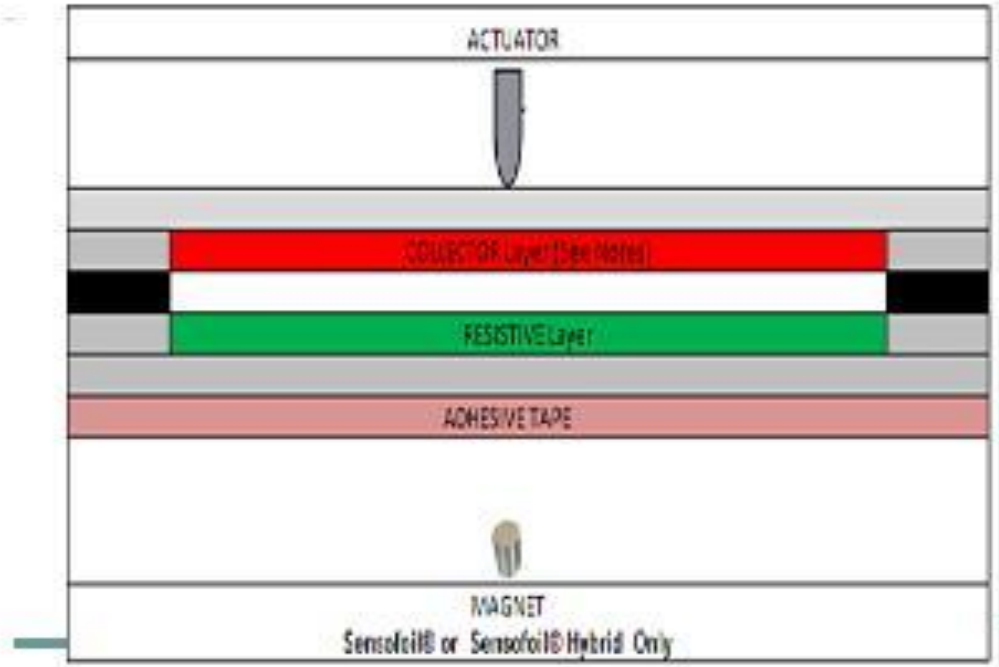
Wire-Wound Potentiometer

The resistance of the wire wound potentiometer increases in step manner as the wiper moves from one position to the adjacent turn. This step change in resistance limits the resolution of the potentiometer to L/n, where n is the numbers of turns. The resolution ranges from 0.05 to 1 percent are common. Therefore such potentiometer are not suitable for precise and finer movements.

Thin film potentiometer

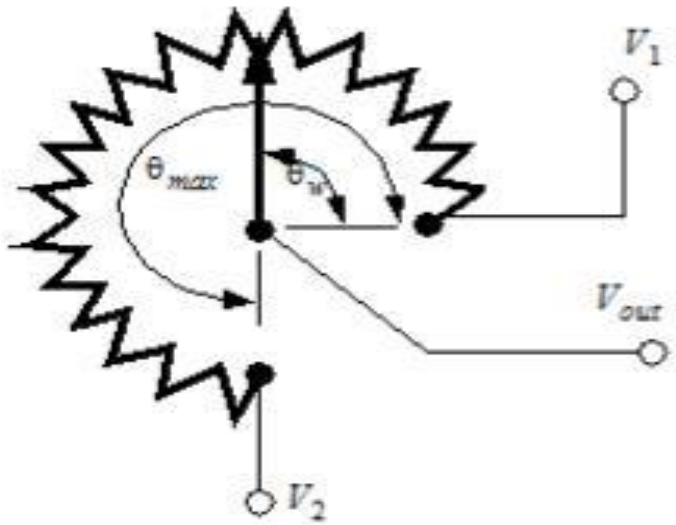
The film resistance on an insulating substrate exhibits high resolution, lower noise, and longer life. For example a resistance of 50 to 100 Ohm/mm can be obtained with the conductive plastic film





Thin Film Potentiometer

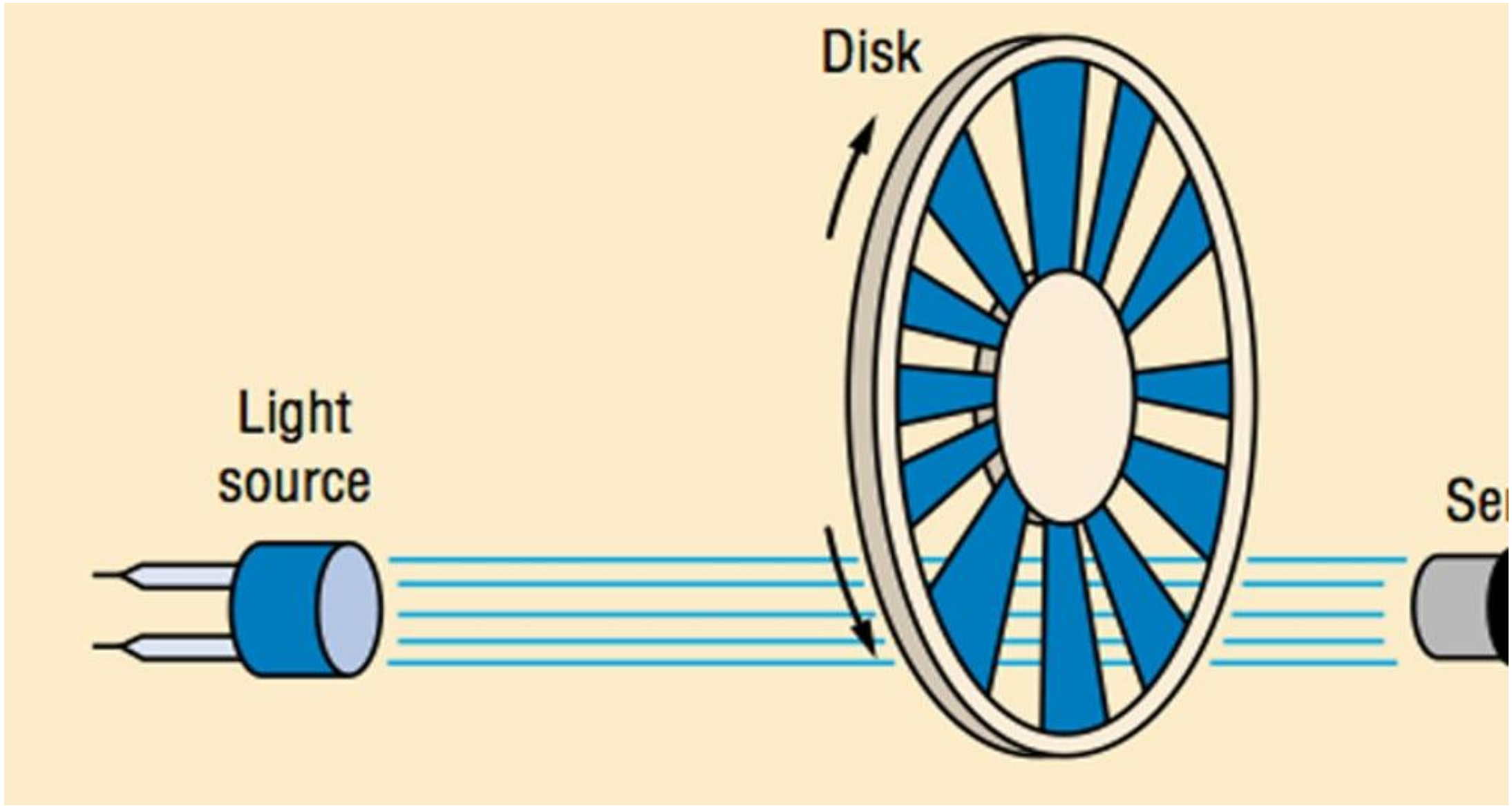
Thin Film potentiometer are introduced to improve resolution. Movement can be nearly continuous rather than in steps.



$$V_{out} = (V_2 - V_1)\left(\frac{\theta_w}{\theta_{max}}\right) + V_1$$

Thin Film Potentiometer

For angular Movements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ACCELEROMETER

- An accelerometer is a device that measures the vibration, or acceleration of motion of a structure.
- The force caused by vibration or a change in motion (acceleration) causes the mass to "squeeze" the piezoelectric material which produces an electrical charge that is proportional to the force exerted upon it.

PRINCIPLE

The working principle of an accelerometer is based on PIEZO-ELECTRIC EFFECT (due to accelerative forces) and on the DISPLACEMENT SENSING (based on displacement of mass).

HOW IT WORKS

In most of the cases working of an ACCELEROMETER is based on voltage generation and its further calculations which leads to the determination of acceleration where as some other involve the measurement of displacement of mass.

TYPES OF ACCELEROMETER

There are basically two types of accelerometer frequently used for measurement of acceleration:-

- PIEZO ELECTRIC ACCELEROMETER
- DISPLACEMENT SENSING OR SEISMIC TYPE ACCELEROMETER

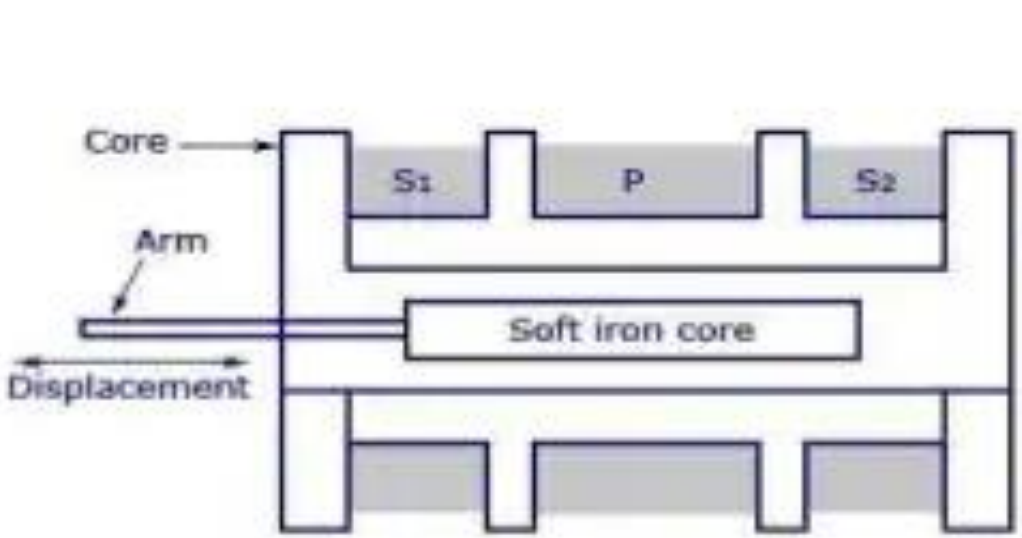
1. Linear Variable Differential Transformer

- The device consists of a primary winding (P) and two secondary windings named S1 and S2.
- Both of them are wound on one cylindrical former, side by side, and they have equal number of turns.
- Their arrangement is such that they maintain symmetry with either side of the primary winding (P).
- A movable soft iron core is placed parallel to the axis of the cylindrical former.
- An arm is connected to the other end of the soft iron core and it moves according to the displacement produced.
- The pressure range is 250 Pa - 70 MPa with a sensitivity of 0.35 MPa.

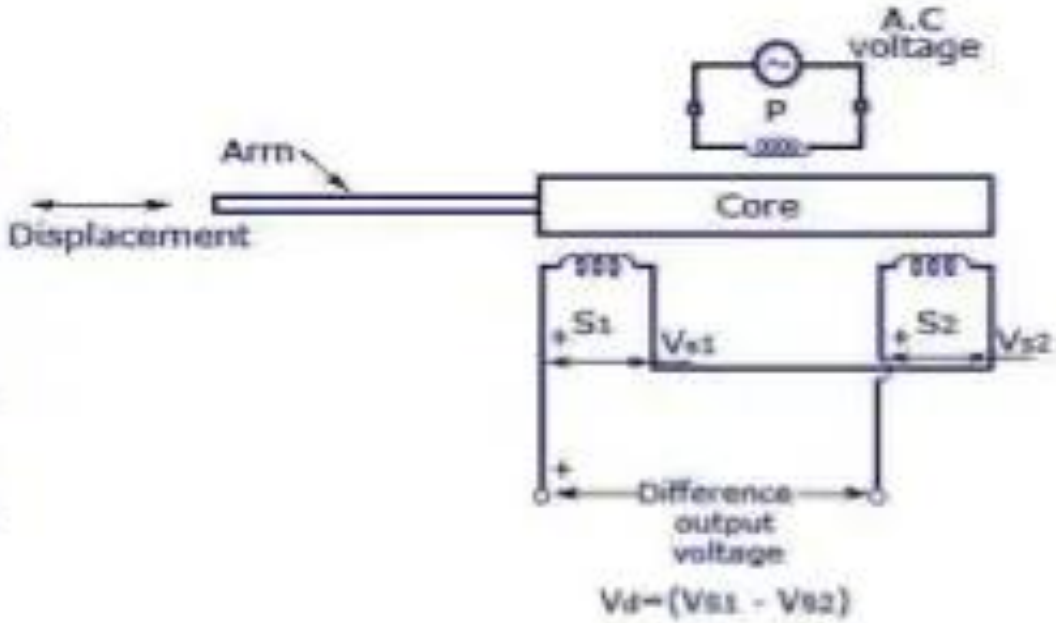
Working Principle of LVDT

- AC voltage with a frequency of (50-400) Hz is supplied to the primary winding. Thus, two voltages VS1 and VS2 are obtained at the two secondary windings S1 and S2 respectively.
- The output voltage will be the difference between the two voltages (VS1-VS2) as they are combined in series.
- Null Position – This is also called the central position as the soft iron core will remain in the exact centre of the former. Thus the linking magnetic flux produced in the two secondary windings will be equal. The voltage induced because of them will also be equal. Thus the resulting voltage VS1-VS2 = 0.
- Right of Null Position – In this position, the linking flux at the winding S2 has a value more than the linking flux at the winding S1. Thus, the resulting voltage VS1-VS2 will be in phase with VS2.

- Left of Null Position – In this position, the linking flux at the winding S2 has a value less than the linking flux at the winding S1. Thus, the resulting voltage VS1-VS2 will be in phase with VS1.
- VS1-VS2 will depend on the right or left shift of the core from the null position.
- The resulting voltage is in phase with the primary winding voltage for the change of the arm in one direction, and is 180 ° out of phase for the change of the arm position in the other direction.
- The magnitude and displacement can be easily calculated or plotted by calculating the magnitude and phase of the resulting voltage.
- The LVDT is connected to a diaphragm or bellow and with changes of pressure, the position of the LVDT changes, producing current output from where the pressure difference can be evaluated.



Construction of LDVT



Circuit Connection

Construction and Circuit Connection of LVDT

Advantages of LVDT:

- It possesses high sensitivity
- Very rugged in construction and therefore tolerant towards shock and vibration
- Stable and easy to align
- Offers infinite resolution
- Low hysteresis, hence repeatable

Disadvantages of LVDT:

- Relatively large core displacement
- Sensitive to stray magnetic fields
- Affected by temperature