The basic construction of LVDT is shown in Fig. The transformer consists of a single primary windin[g] two secondary winding S_1 and S_2 wound on a cylindrical former. The secondary windings have equal [number of] turns and are identically placed on either side of the Primary winding. The primary winding is connect[ed to an] alternating current source. A movable soft iron core is placed inside the former. The 'displaceme[nt to be] measured is applied to the arm attached to the soft iron core. In practice the core is made of high perm[eability] nickel iron which is hydrogen annealed. This gives low harmonics, low null voltage and a high sensitiv[ity. This] is slotted longitudinally to reduce eddy current losses. The assembly is placed in a stainless steel hou[sing and] the end lids provide electrostatic and electromagnetic shielding. The frequency of a.c. applied to [primary] windings may be between 50 Hz to 20 kHz.

The output of voltage of secondary, S_1, is E_{s1} and that of secondary S_2, is E_{s2} In order to convert the outp[ut of] S_1 and S_2 into a single voltage signal, the two secondary's S_1 and S_2 are connected in series opposition a[s shown] in Fig. (b). Thus the output voltage of the transducer is the difference of the two voltages.

Differential output voltage

$$E_0 = E_{s_1} - E_{s_2}$$

When the core is at its normal (NULL) position, the flux linking with both the secondary windings is eq[ual and] hence equal emfs are induced in them. Thus at null position : $E_{s_1} = E_{s_2}$. Since the output voltage [of the] transducer is the difference of the two voltages, the output voltage E_0 is zero at null position.

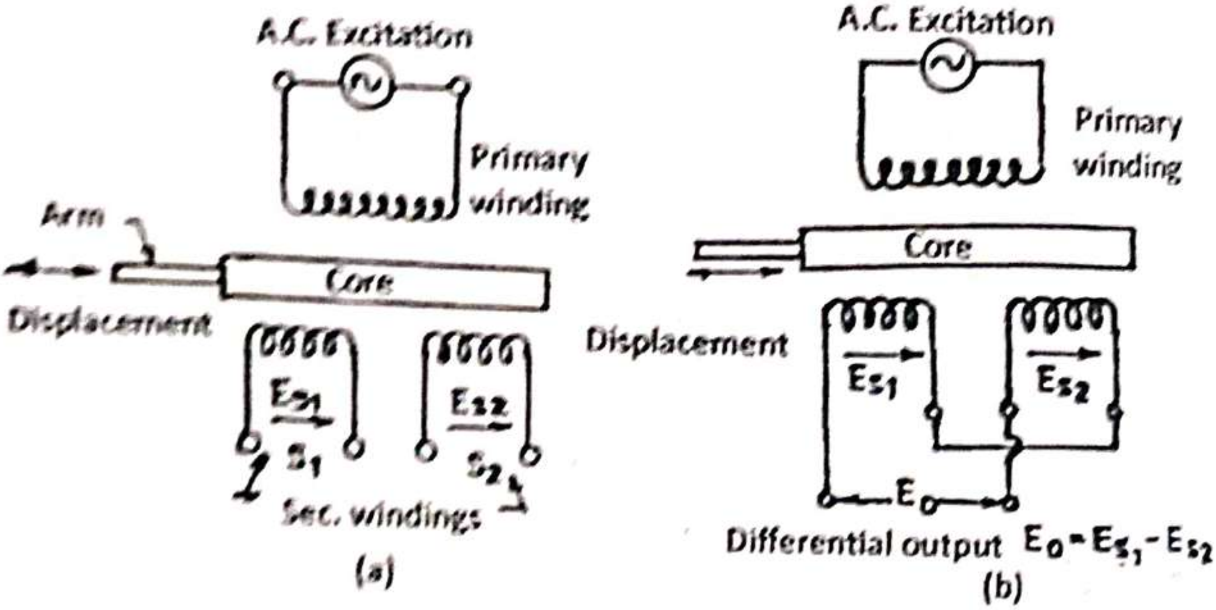


Fig. Circuits of an LVDT

Now if the core is moved to the left of the NULL position, more flux links with winding S_1 and less [with] winding S_2. Accordingly output voltage E_{s1}, of the secondary winding S_1, is more than E_{s2}, the output volta[ge of] secondary winding S_2. The magnitude of output voltage is, thus, $E_0 = E_{s_1} - E_{s_2}$ and the output voltage is in [phase] with say, the primary voltage. Similarly, if the core is moved to the right of the null position, the flux linking with winding S_2 becomes larger than that linking with winding S_1. This results in E_{s2} becoming larger than E_{s}. The output voltage in this case is $E_0 = E_{s_2} - E_{s_1}$ and is 180° out of phase with the primary voltage. Therefore, the two differential voltages are 180° out of phase with each other.

As the core is moved in one direction from the null position, the differential voltage i.e., the difference of the two secondary voltages, will increase while maintaining an in-phase relationship with the voltage from the input source. In the other direction from the null position, the differential voltage will also increase, but will be 180° out of phase with the voltage from the source. By comparing the magnitude and phase of the output (differential) voltage with that of the source, the amount and direction of the moment of the core and hence of displacement may be determined.

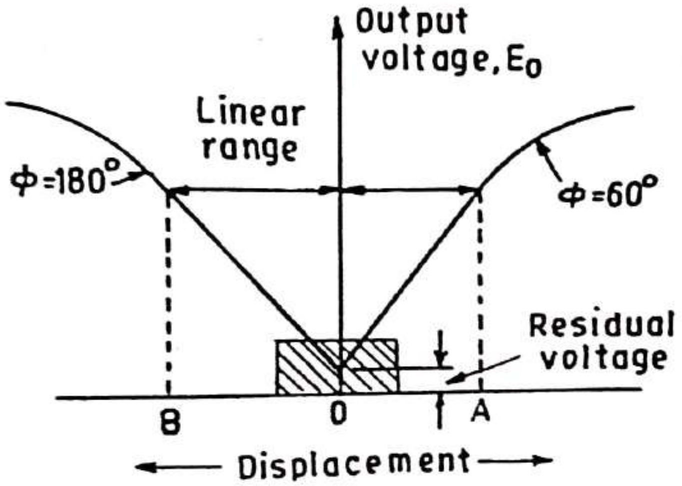


Fig. Variation output voltage with linear displacement for an LVDT.

Advantages of LVDT

1. ***High range.*** The LVDTs have a very high range for measurement of displacement. This can be used for measurement of displacements ranging from 1.25 mm to 250 mm. With a 0.25% full scale linearity, it allows measurements down to 0.003 mm. However, the dynamic response is considerably slower than the 2.5 kHz excitation signal.
2. ***Friction and Electrical Isolation.*** The LVDT has many commendable features that .make it useful for a wide variety of applications. Some of these features are unique to the LVDT and are trot available in any other transducers. The features arise from the basic fact. that LVDT is an electrical transformer with a separable non-contacting core

The friction less operation of the LVDT combined with the induction principle by which the LVDT functions is truly infinite resolution. This means that LVDT can respond to even minute motion of the core and produce an output.

Capaci...

The principle of operation of capacitive transducers is based upon the familiar equation for capacitance of a parallel plate capacitor.

$$C = \epsilon A/d = \epsilon_r \epsilon_0 A/d$$

Where

A = overlapping area of plates; m^2.

d = distance between two plates; m.

$\epsilon = \epsilon_r \epsilon_0$ = permittivity of medium; F/m.

ϵ_r = relative permittivity,

ϵ_0 = permittivity of free space; 8.85×10^{-12} F/m

A parallel plate capacitors is shown in Fig.

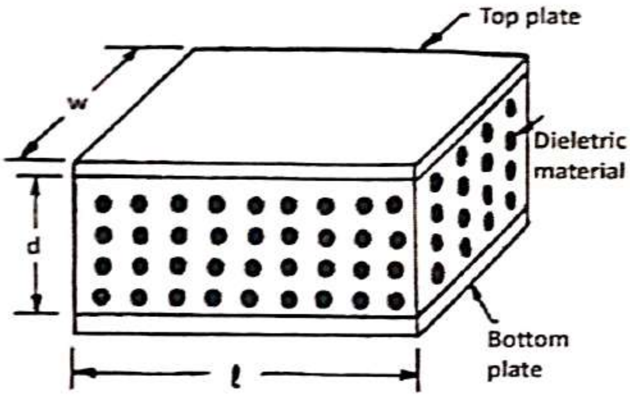


Fig. Schematic diagram of a parallel plate capacitive tran0

The capacitive transducer work on the principle of change of capacitance which may be caused by :

(i) Change in overlapping area A,

(ii) Change in the distance between the plates d , and

(iii) Change in dielectric constant $\in$.

These changes are caused by physical variables like displacement, force, and pressure in most of the cases. The change in capacitance may be caused by change in dielectric constant as is the case in measurement of liquid or gas levels.

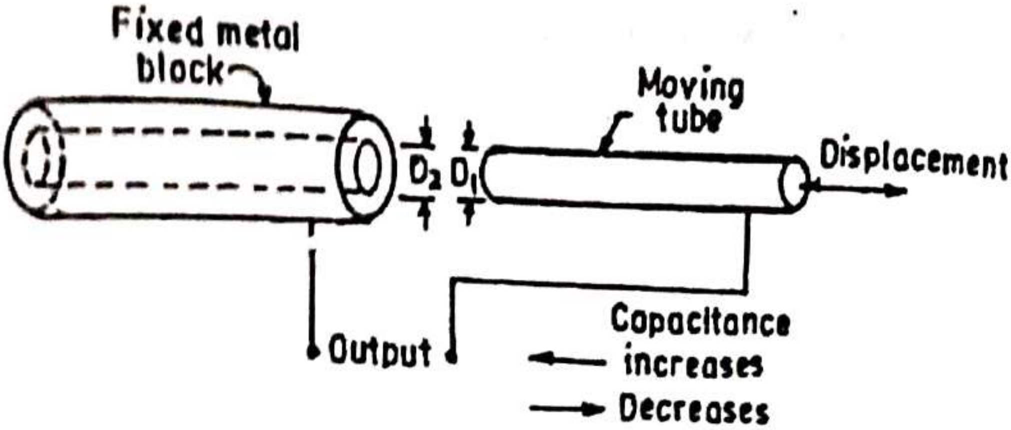
The capacitive transducers are commonly used for measurement of linear displacement. These transducer use the following effects. :

(i) Change in capacitance, due to change in overlapping area of plates, and

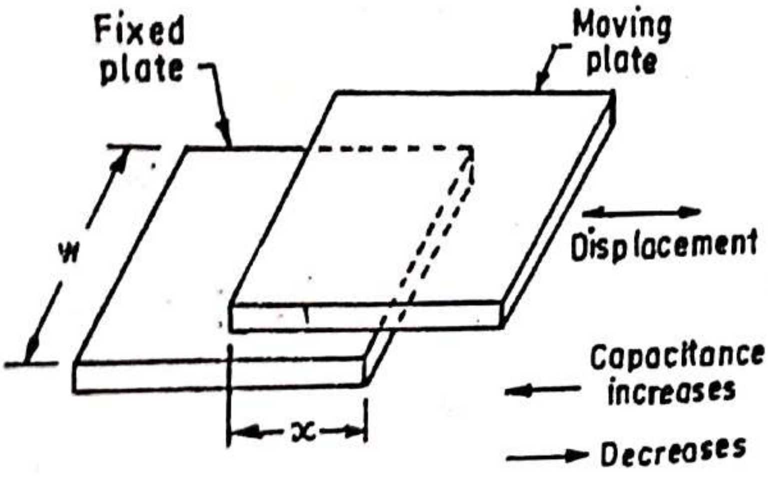
(ii) Change in capacitance due to change in distance between the two plates.

Transducers Using Change in Area of Plates.

Examining the equation for capacitance Eq. it is found that the capacitance is directly proportional to A, of the plates Thus the capacitance changes linearly with change in areas of plates. Hence this capacitive transducer is useful for measurement of moderate to large displacements say from 1 mm to cm.



(a)



(b)

Fig. Capacitive transducers working on the principle of change of capacitance with change of area.

For a parallel plate capacitor, the capacitance

$$C = \frac{\epsilon A}{d} = \frac{\epsilon xw}{d} F$$

Where x = length of overlapping part of plates ; m,

and w = width of overlapping part of plates ; m

Sensitivity $$S = \frac{\partial C}{\partial x} = \epsilon \frac{w}{d} F/m$$