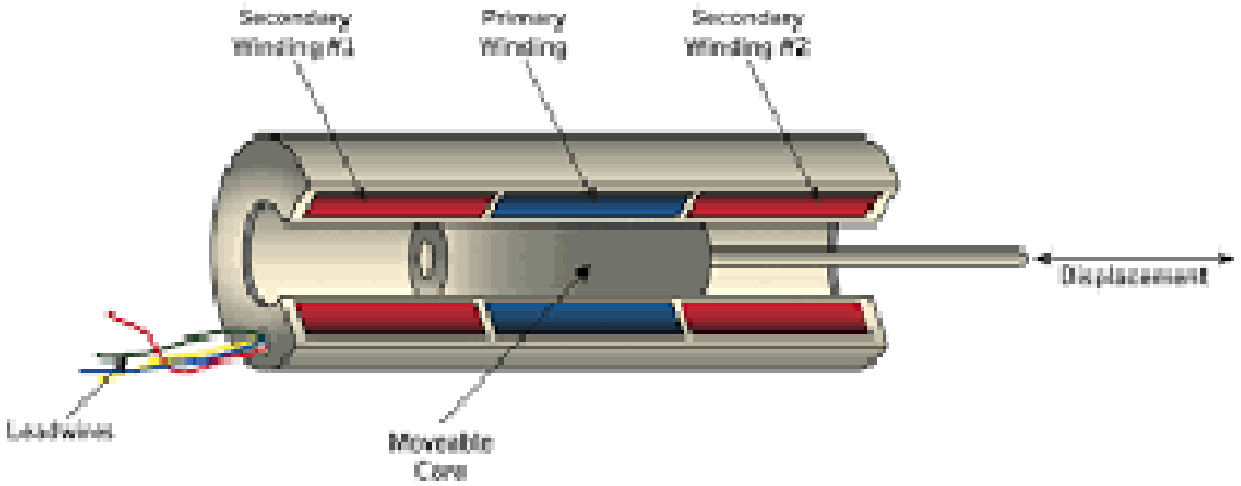
LVDT
(Linear Variable Differential Transformer)

Linear Displacement - Inductive Method

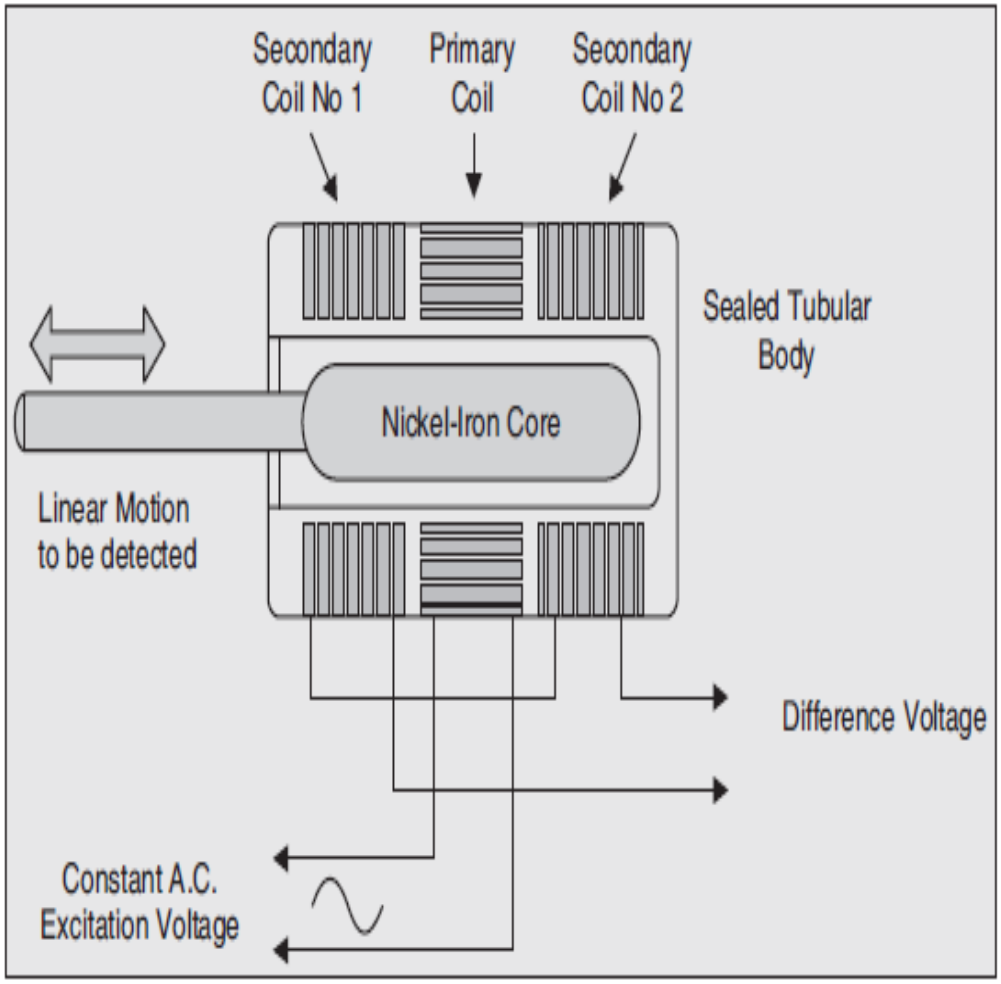
•Linear Variable Differential Transformer (LVDT) is an inductive type position sensor which works on the same principle as the AC transformer that is used to measure movement.

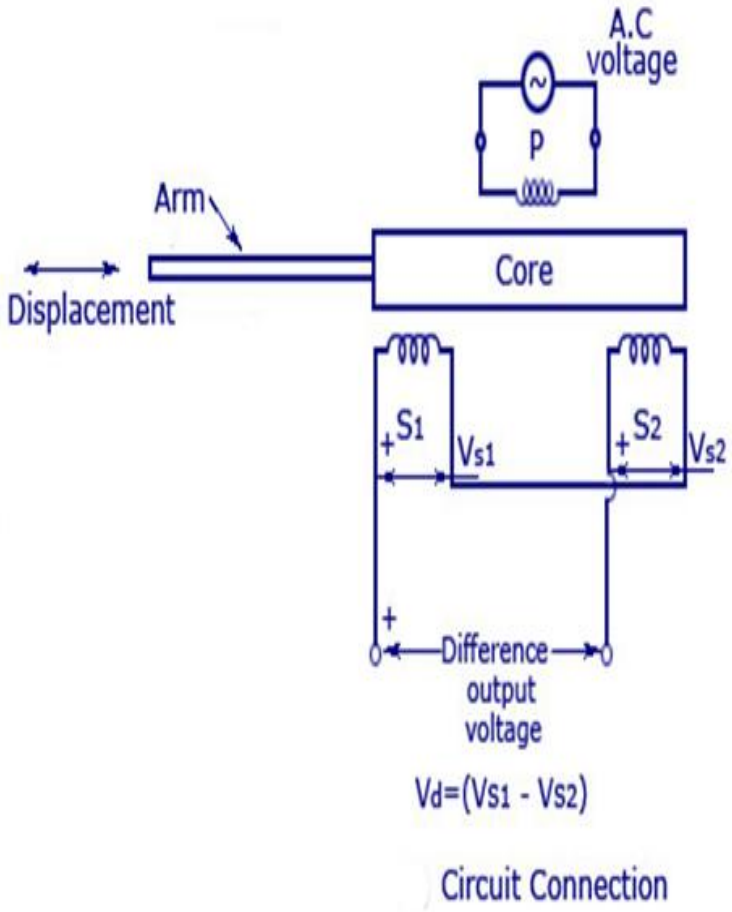
• It is a very accurate device for measuring linear displacement and whose output is proportional to the position of its moveable core.

- An LVDT consists of a central primary coil wound over the whole length of the transducer and two outer secondary coils
- A magnetic core is able to move freely through the coil



LVDT


Secondary
Coil No 1
Primary
Coil
Secondary
Coil No 2
Sealed Tubular
Body
Nickel-Iron Core
Linear Motion
to be detected
Difference Voltage
Constant A.C.
Excitation Voltage


A.C
voltage
P
Arm
Core
Displacement
S1
Vs1
S2
Vs2
+
Difference
output
voltage
Vd=(Vs1 - Vs2)
Circuit Connection

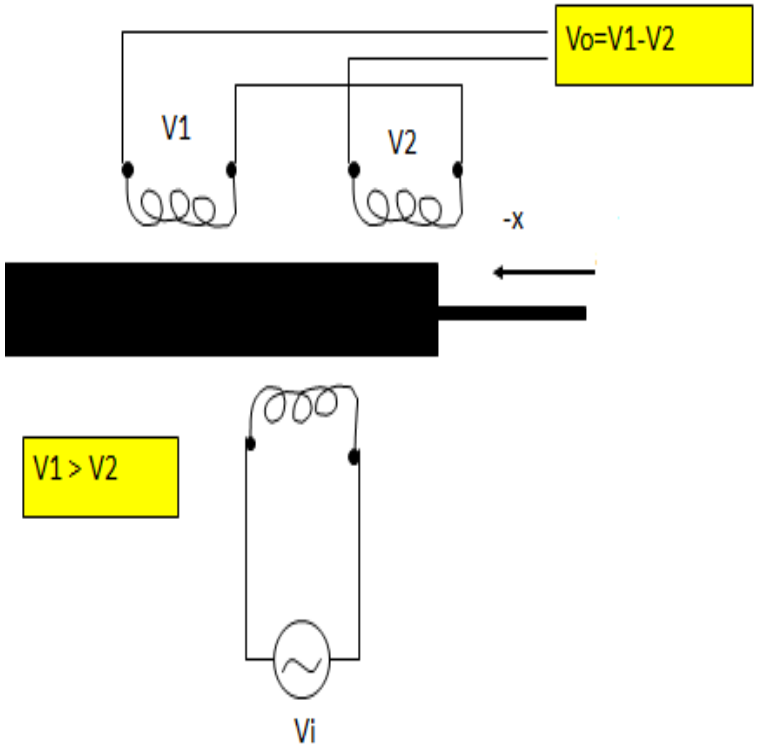
Working of LVDT

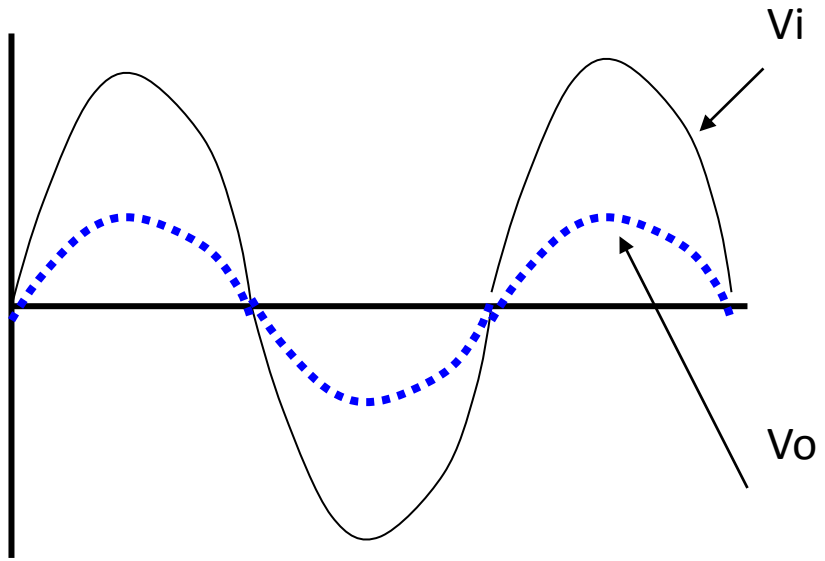
- The primary windings are energized with a constant amplitude AC signal
- This produces an alternating magnetic field which induces a signal into the secondary windings
- The strength of the signal is dependant on the position of the core in the coils
- When the core is placed in the centre of the coil the output will be zero
- Moving the coil in either direction causes the signal to increase
- The output signal is proportional to the displacement

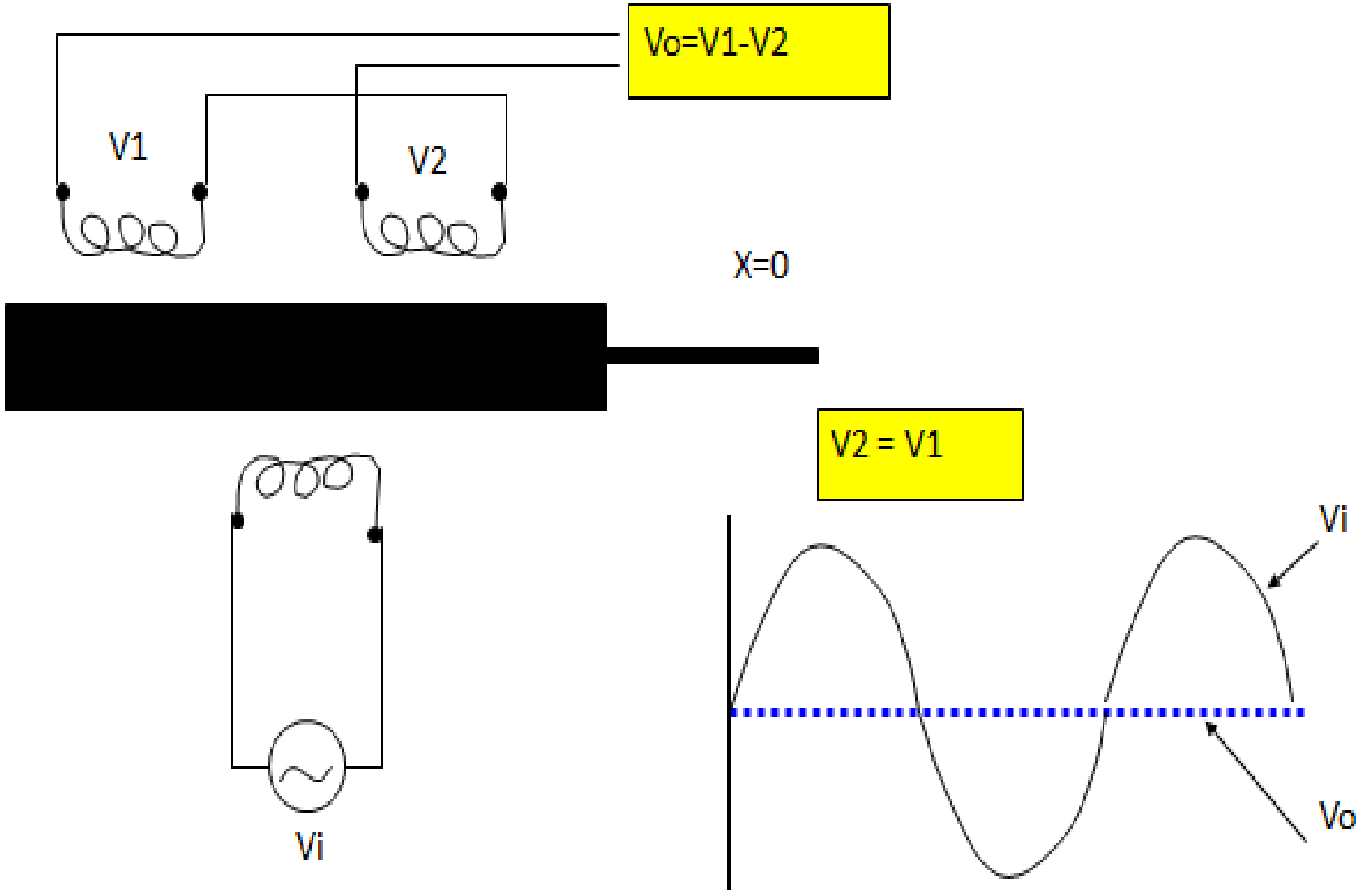
- It basically consists of three coils wound on a hollow tube former, one forming the primary coil and the other two coils forming identical secondaries connected electrically together in series but 180° out of phase either side of the primary coil.
- A moveable soft iron ferromagnetic core which is connected to the object being measured, slides or moves up and down inside the tube.
- A small AC reference voltage called the “excitation signal” is applied to the primary winding which in turn induces an EMF signal into the two adjacent secondary windings.

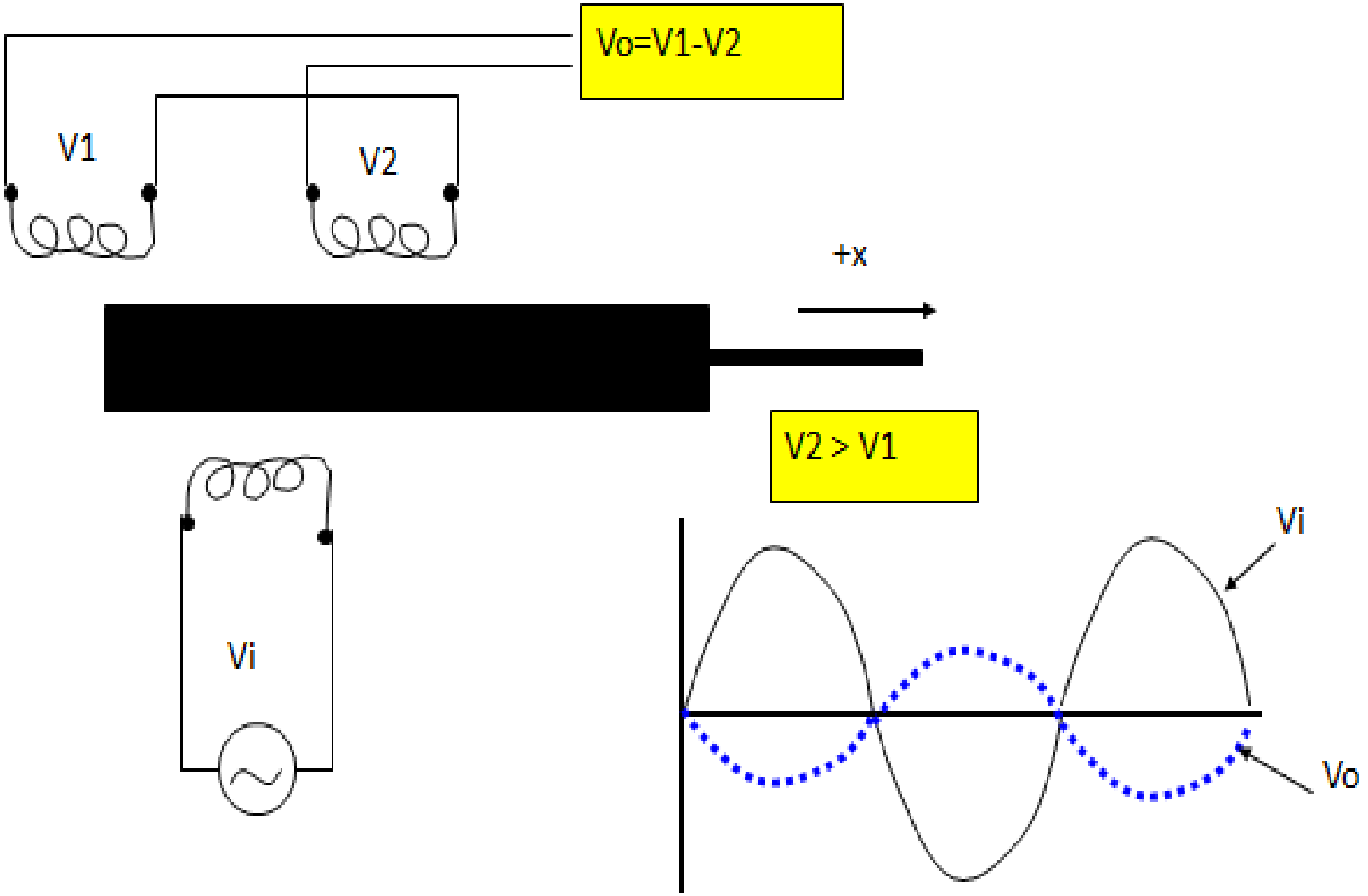
- If the soft iron magnetic core armature is exactly in the centre of the tube and the windings, the null position indicate.
- The two induced emf in the two secondary windings cancel each other out as they are 180° out of phase, so the resultant output voltage is zero.
- As the core is displaced slightly to one side or the other from this null or zero position, the induced voltage in one of the secondaries will be become greater than that of the other secondary .
- The polarity of the output signal depends upon the direction and displacement of the moving core.
- The greater the movement of the soft iron core from its central null position the greater will be the resulting output signal.
- The result is a differential voltage output which varies linearly with the core position.
- The output signal has both an amplitude that is a linear function of the cores displacement and a polarity that indicates direction of movement.
- The differential output voltage is given by,
- $V0=V1-V2$

- LVDTs are devices to measure displacement by modifying spatial distribution of an alternating magnetic field.

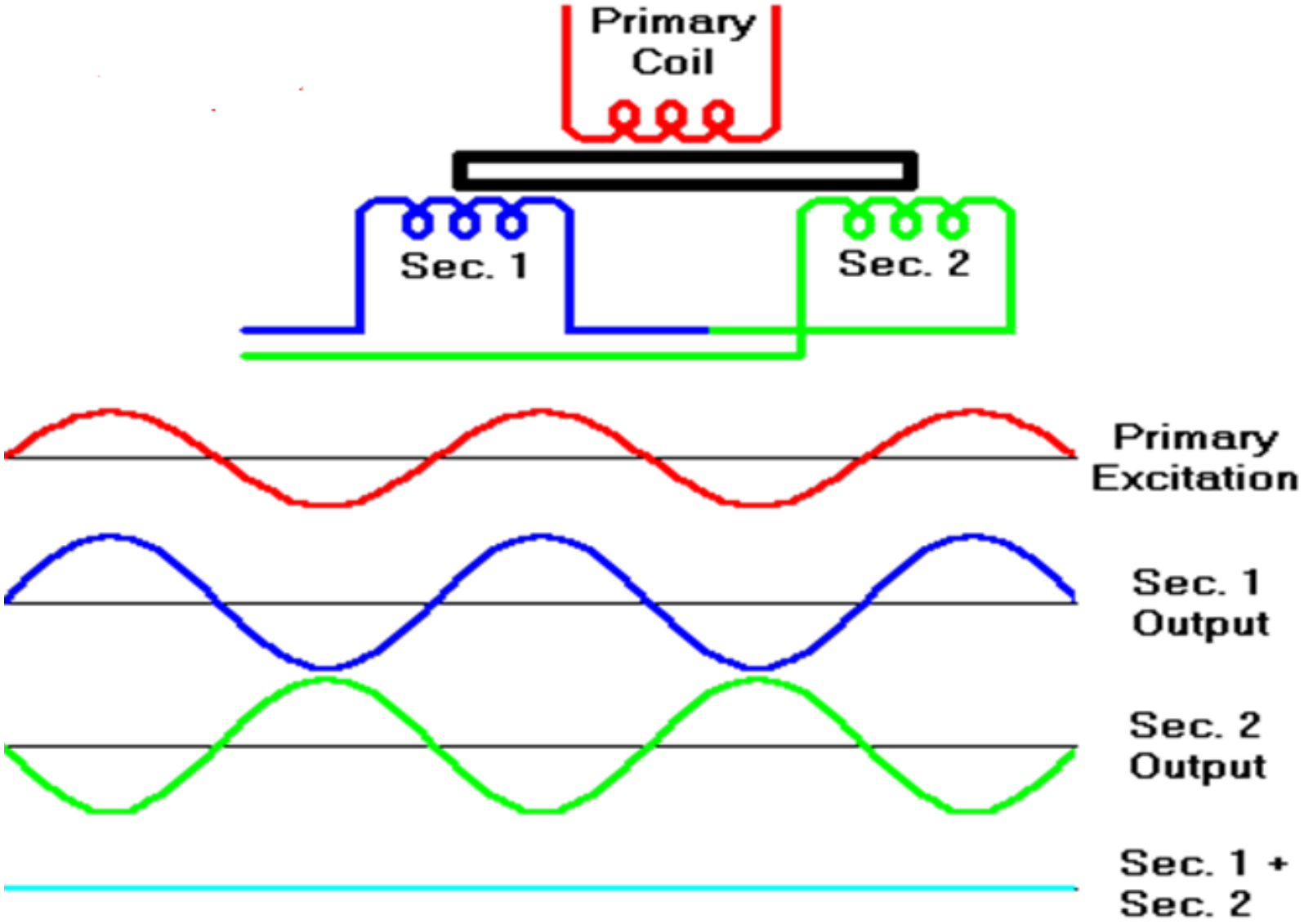




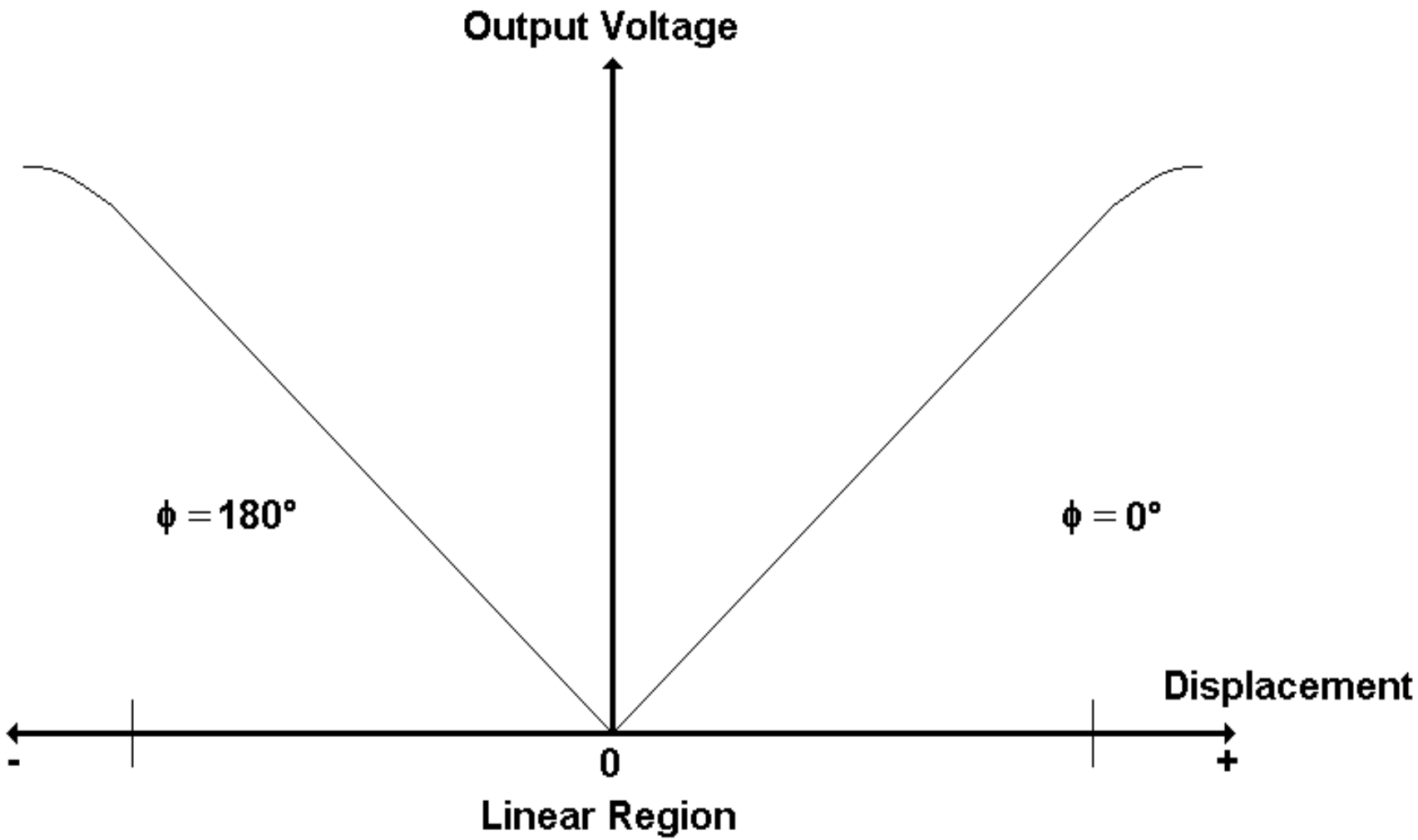

Vo=V1-V2
V1
V2
X=0
V2 = V1
Vi
Vi
Vo



So, the direction of displacement can be determined from the relative phase of the signal.


Primary
Coil
Sec. 1
Sec. 2
Primary
Excitation
Sec. 1
Output
Sec. 2
Output
Sec. 1 +
Sec. 2

Graph



Advantages

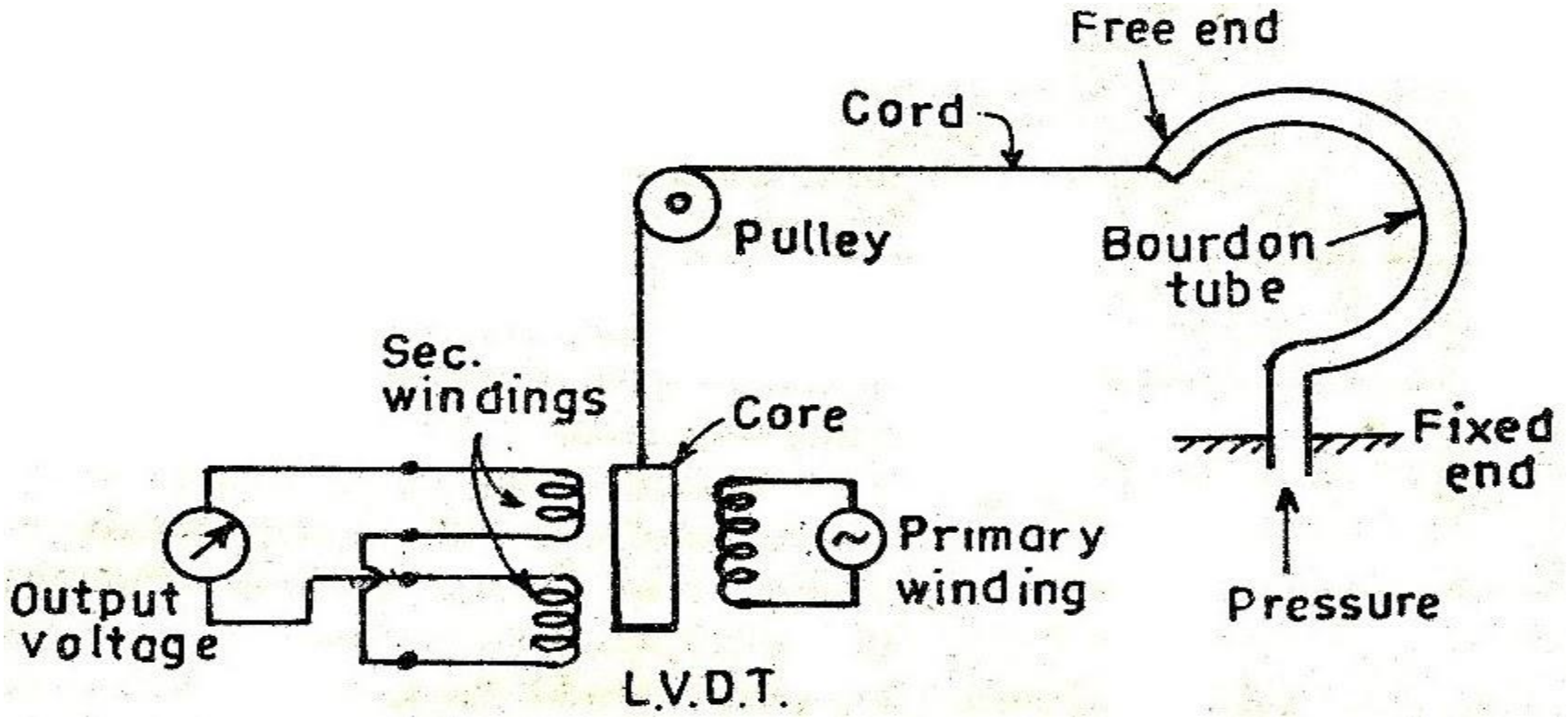
- It has low power consumption which is less than about 1 Watt.
- It is frictionless device.
- It offers high resolution .
- Higher sensitivity
- It is smaller in size.
- It is less in weight.
- It has lower hysteresis.
- It is solid and robust in construction.
- It has excellent repeatability.
- It has very low output impedance.

Disadvantages

- Large displacement is needed for small output.
- It is affected due to external magnetic field and hence the entire LVDT circuit need to be shielded to achieve desired accuracy.
- Vibrations due to displacement can affect the performance of the LVDT device.
- The performance of LVDT is affected due to increase in temperature.

Primary and secondary transducers

Example
LVDT and bourdon tube



Applications

displacement measurement, measurement of pressure, load, acceleration, force , weight etc.