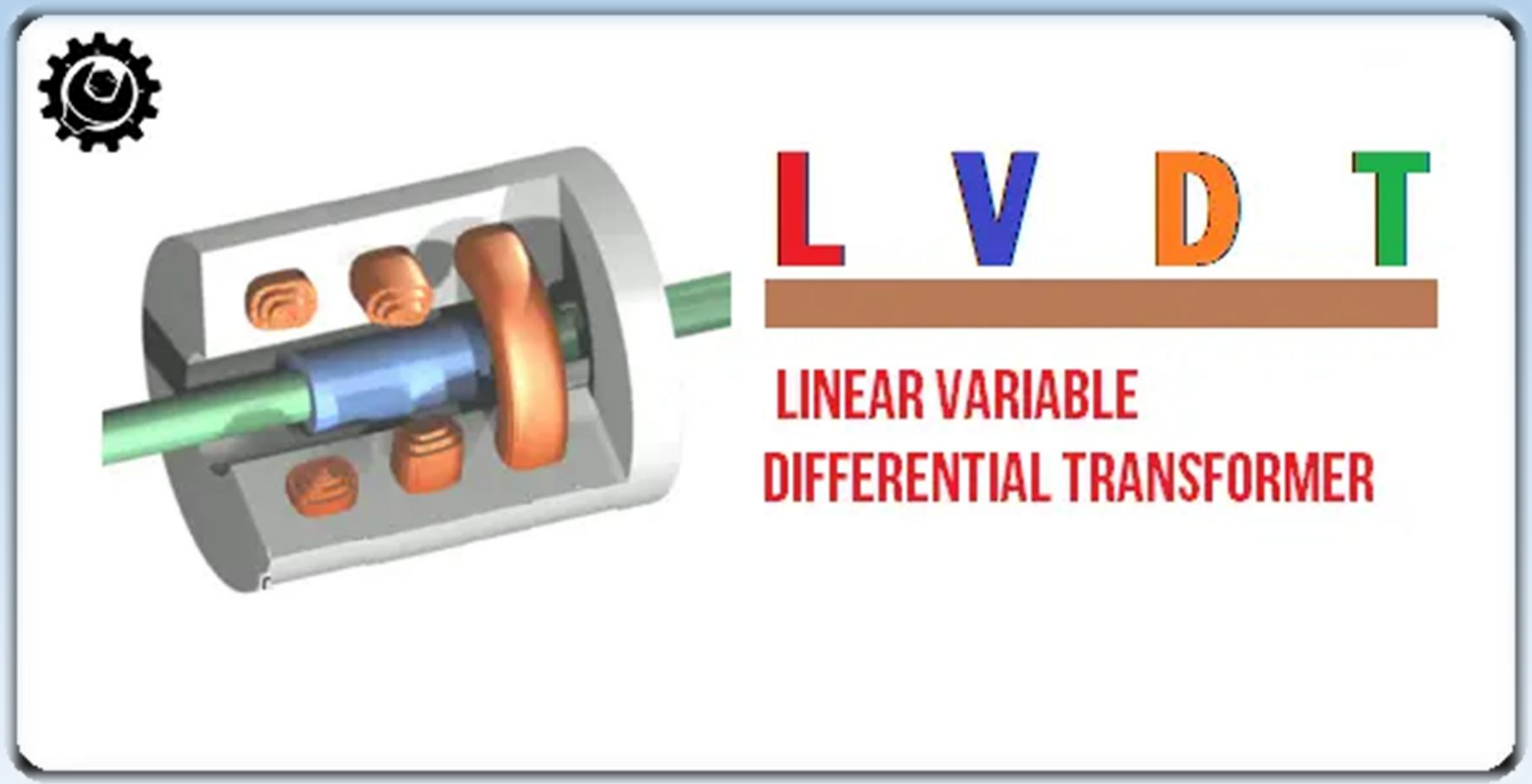
LVDT

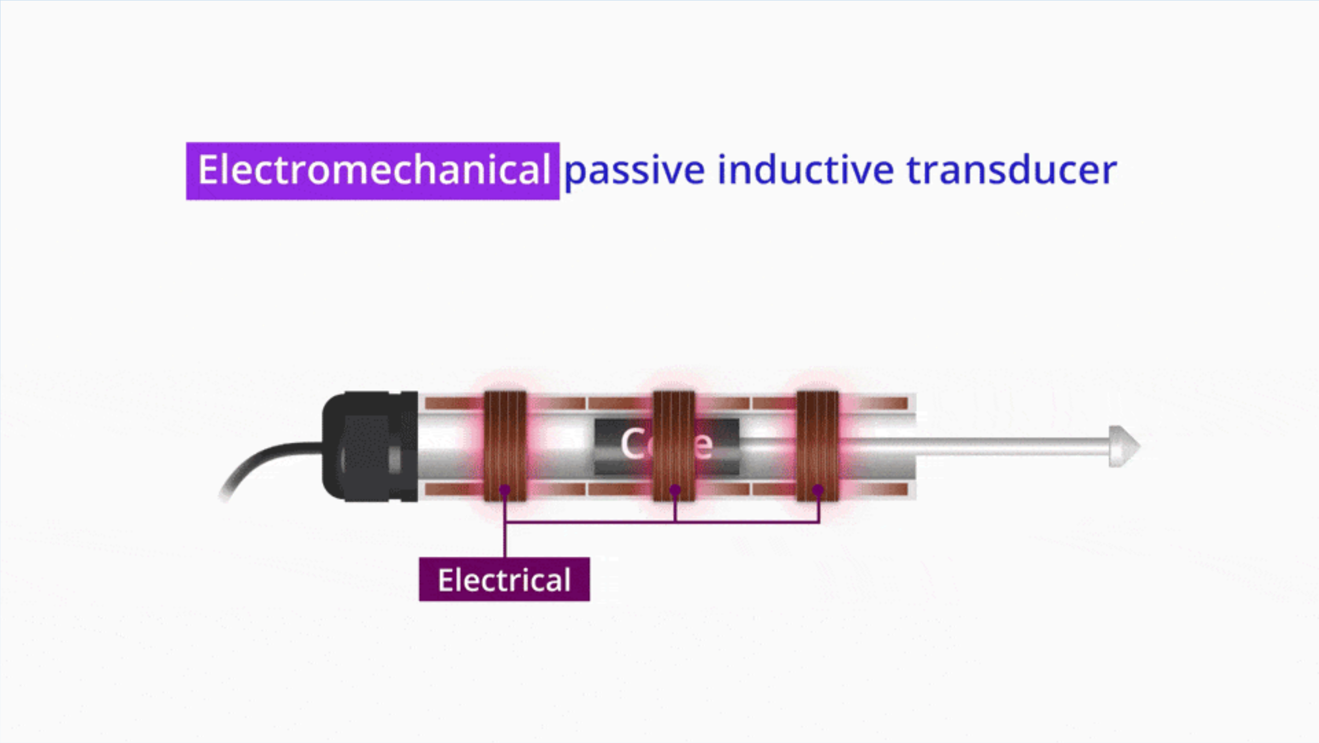


LVDT

INTRODUCTION :

Linear Variable Differential Transformer (LVDT)

An LVDT can be defined as an **electromechanical passive inductive transducer**.



LVDT

INTRODUCTION :

Linear Variable Differential Transformer (LVDT)

- ***Linear*** — It measures Linear displacement
- ***Variable*** — It has movable core and position is variable
- ***Differential*** — Difference between 2 secondary coils ~ voltages
- ***Transformer*** — 1 – primary coil and 2 secondary coils

LVDT

Linear Variable Differential Transformer (LVDT)

INTRODUCTION :

- An **LVDT (Linear Variable Differential Transformer)** is an **electromechanical transducer** that converts **linear displacement** (position) into an **electrical signal**.

Input
Linear Displacement
→
LVDT
→
Output
Electrical Signal

- It is widely used in measurement and control systems due to its **high accuracy**, **reliability**, and **frictionless operation**.

- An LVDT can be defined as an **electromechanical passive inductive transducer**.

LVDT

Linear Variable Differential Transformer (LVDT)

INTRODUCTION :

Input **Linear Displacement** → **LVDT** → Output **Electrical Signal**

- Physical quantities such as **Force , weight , pressure,** etc. are first converted into displacement by primary transducer
- LVDT converts this displacement into corresponding electrical signal
- Hence LVDT is used as a **Secondary transducer**

Linear Variable Differential Transformer (LVDT)

Basic Principle

The LVDT works on the principle of **mutual inductance**.

It uses the **change in magnetic coupling** between a primary coil and two secondary coils to measure displacement.

Linear Variable Differential Transformer (LVDT)

CONSTRUCTION

An LVDT mainly consists of:

1) Primary Coil

Located at the center of the transformer.

2) Two Secondary Coils (S1 and S2):

Identically wound on either side of the primary coil, connected in series opposition (differentially).

3) Movable Ferromagnetic Core:

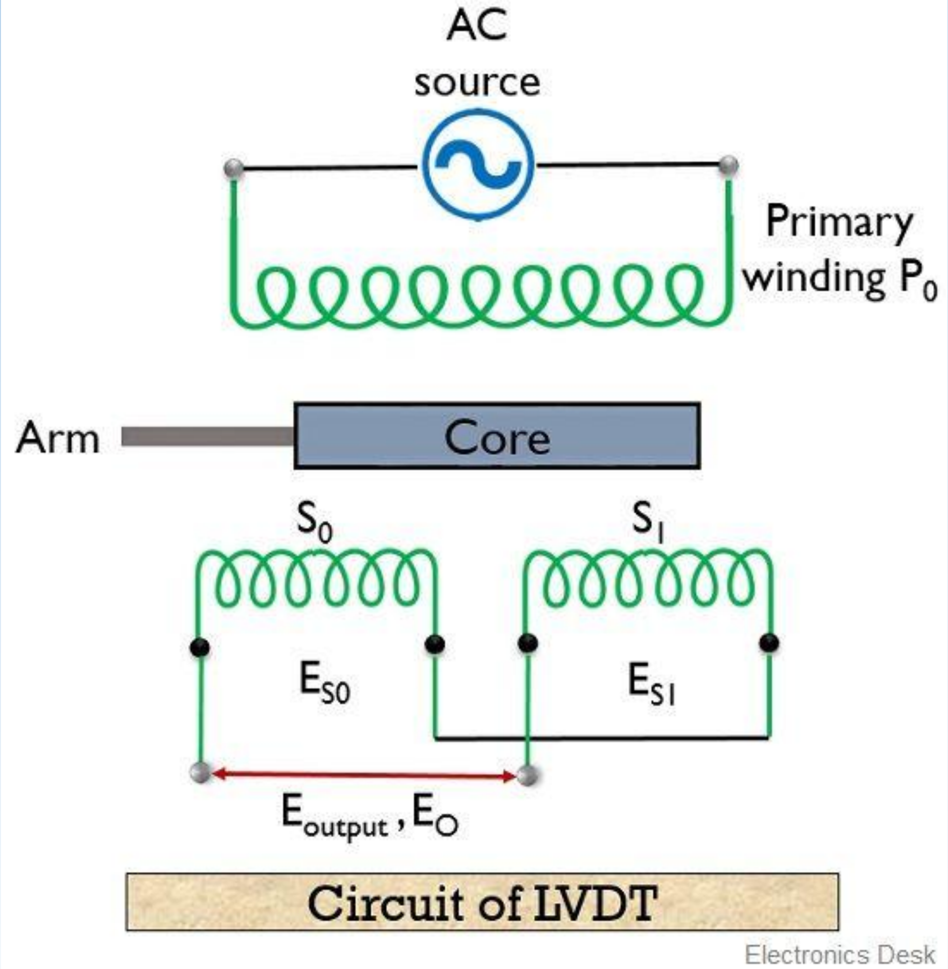
Connected to the object whose position is being measured; it moves inside a hollow cylindrical former.

4) Non-magnetic Housing:

Provides mechanical support and protection.

Linear Variable Differential Transformer (LVDT)

CONSTRUCTION



1) Primary Coil

2) Two Secondary Coils (S1 and S2):

3) Movable Ferromagnetic Core:

4) Non-magnetic Housing:

Linear Variable Differential Transformer (LVDT)

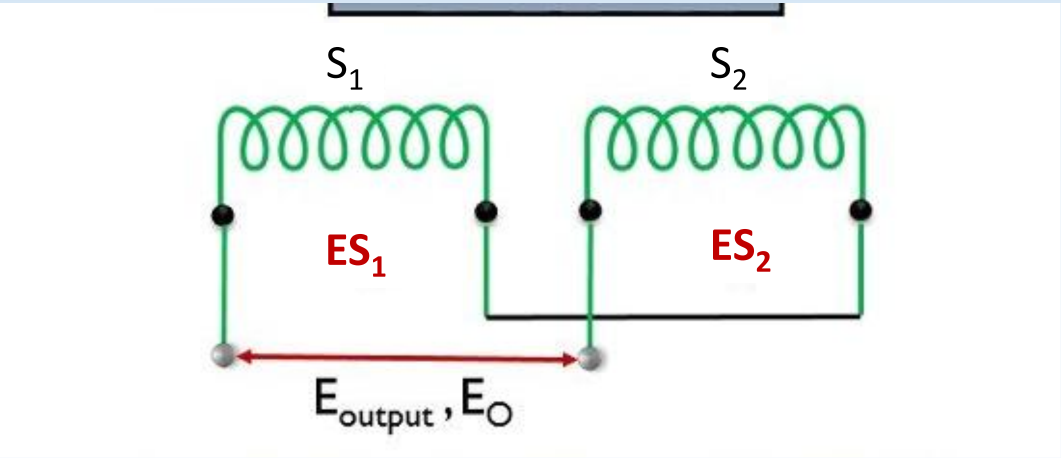
WORKING

1. An **AC excitation voltage** (typically 1–10 kHz) is applied to the **primary coil.**

2. The alternating magnetic field induces voltages in the **secondary coils** via mutual inductance in the presence of core

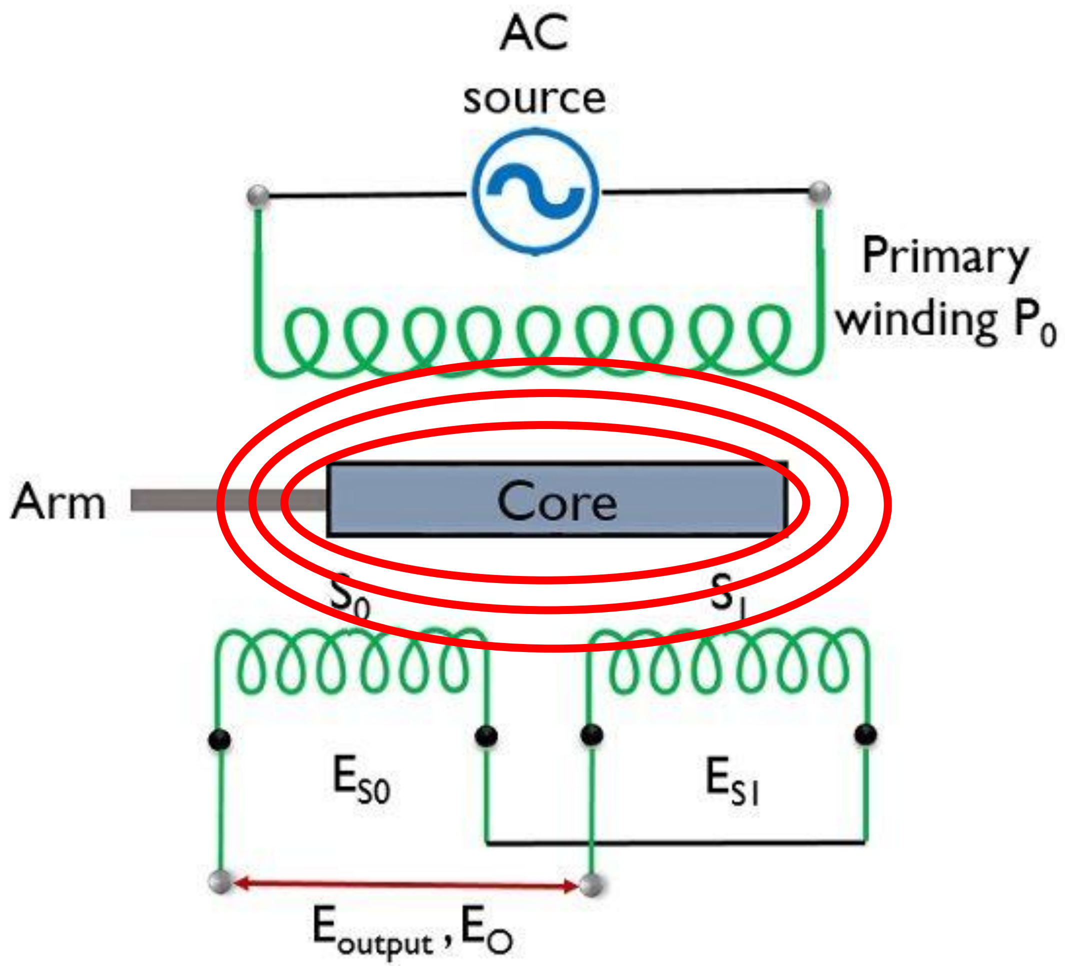
3. The **output voltage (Vout)** is the **difference between the voltages** in the two secondaries:

The secondary windings are connected in such a way that resulted output is the **difference between the voltages**



Linear Variable Differential Transformer (LVDT)

CONSTRUCTION



1. Excitation of the Primary Coil

- An **alternating current (AC)**, typically sinusoidal (e.g., 1–10 kHz), is applied to the **primary coil (P)**.
- This generates an **alternating magnetic field** around the coil.

2. Magnetic Coupling

- The **movable core** (soft ferromagnetic material) inside the hollow coil assembly **guides the magnetic flux**.
- This magnetic flux **couples the primary coil with the two secondary coils** (S1 and S2) placed symmetrically on either side of the primary.

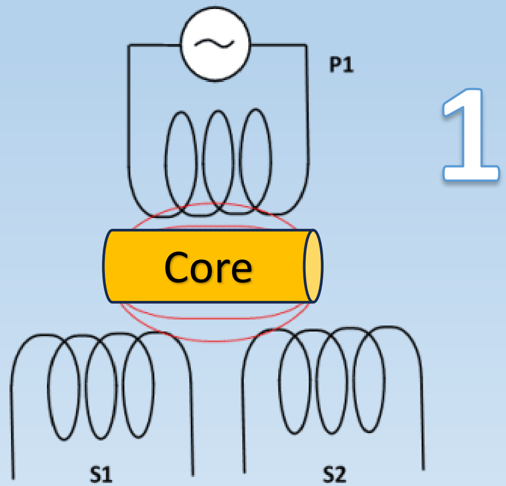
3. Induction in Secondary Coils

- According to **Faraday's Law of Electromagnetic Induction**, a changing magnetic field induces an EMF (voltage) in each secondary coil.
- The **magnitude** of the induced voltage in S1 and S2 depends on how much magnetic flux is coupled through them — which depends on **core position**.

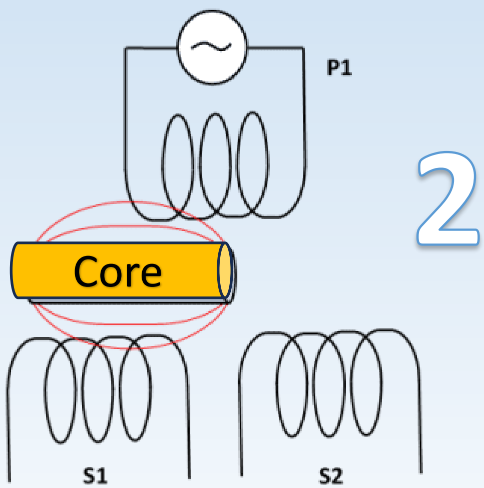
Linear Variable Differential Transformer (LVDT)

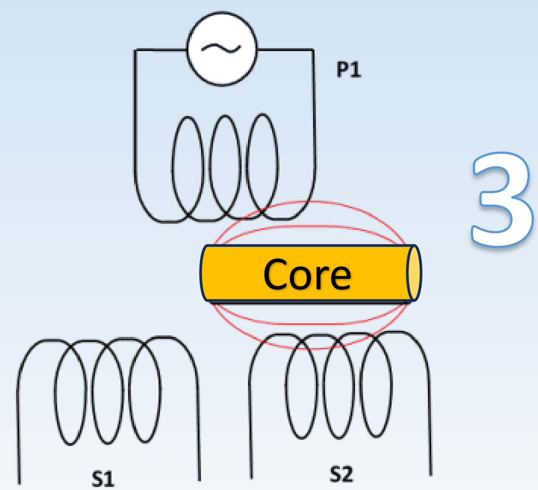
Conditions

Displacement Scenarios:



$$V_o = V_{s1} - V_{s2}$$

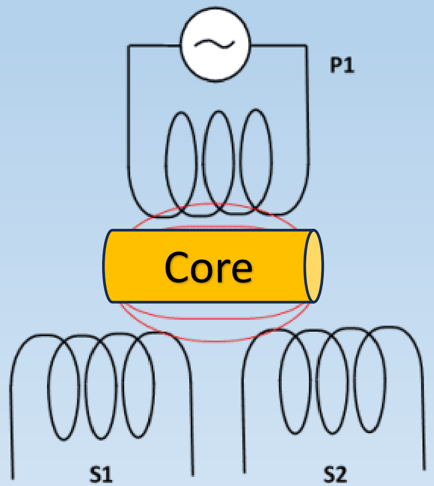




Linear Variable Differential Transformer (LVDT)

Conditions

Displacement Scenarios: 1



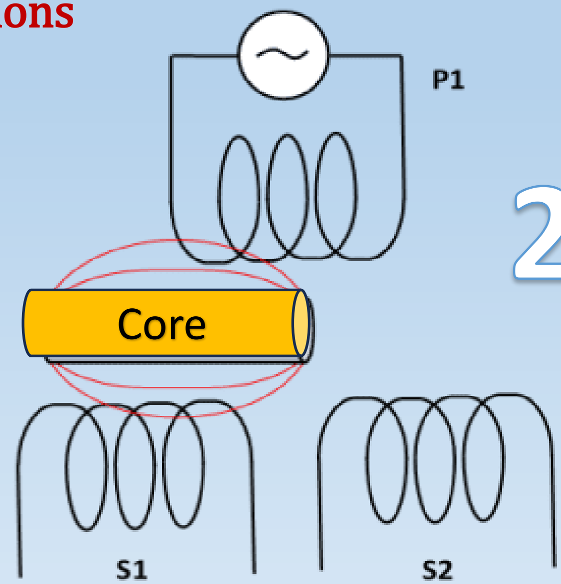
Null Position (Center):

- The core is at the center → **equal mutual inductance** → $V_{S1}=V_{S2}$

- Output voltage $V_{out} = 0$ V

Linear Variable Differential Transformer (LVDT)

Conditions



2

Displacement Scenarios:

Core Moves to the Left:

•Closer to **S1** → mutual inductance with **S1 increases**, and with **S2 decreases**.

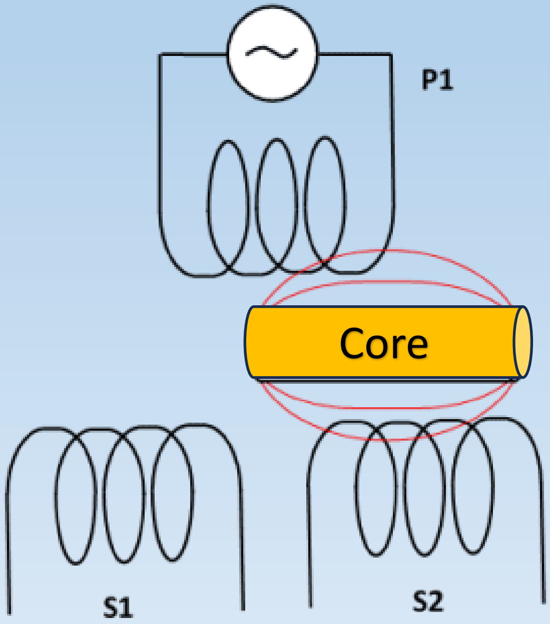
•$V_{S1} > V_{S2}$ ⇒ Vout is **positive**

•Indicates displacement **to the left.**

Linear Variable Differential Transformer (LVDT)

WORKING

Displacement Scenarios: 3



Core Moves to the Right:

- Closer to **S2** → mutual inductance with **S2 increases**, and with **S1 decreases.**
- $V_{S1} < V_{S2} \Rightarrow$ Vout is **negative**
- Indicates displacement **to the Right**

Working

- **Case 1:** When the core is at null position (for no displacement)

  The secondary windings is equal so the induced emf is equal in both the windings.

  $\therefore V_O=0$

- **Case 2:** When the core is moved toward S_1

  The magnitude of E_1 will be more as that of E_2.

  $\therefore$ **V0 = E1 – E2** will be **positive**

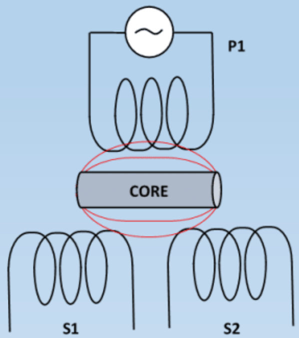
- **Case 3:** When the core is moved toward S_2

  The magnitude of E_2 will be more as that of E_1.

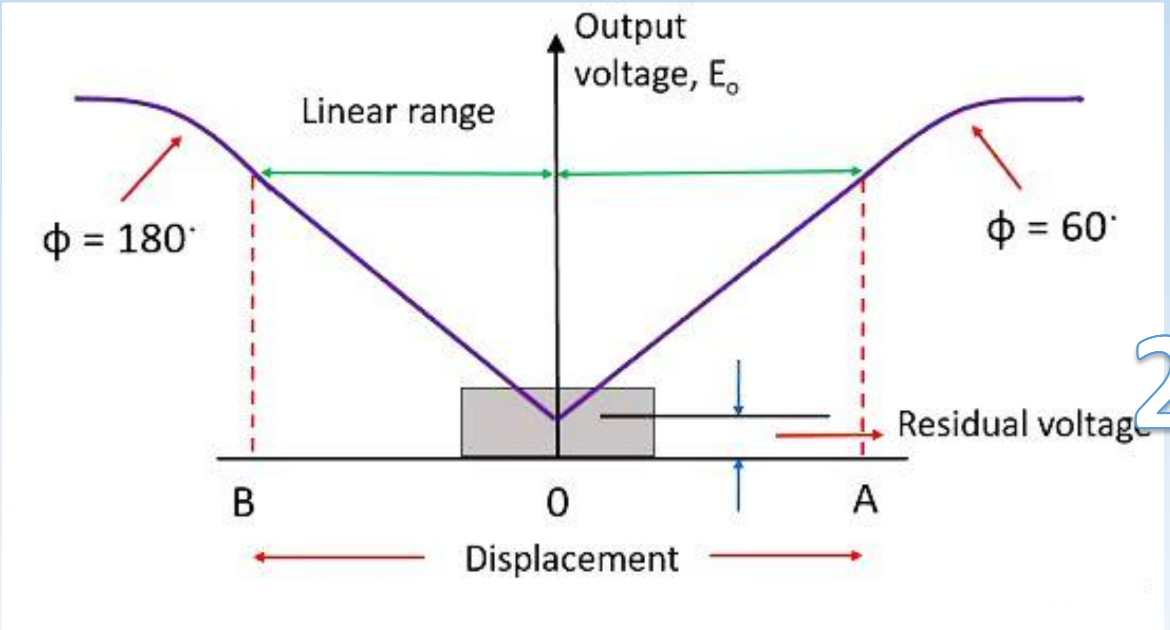
  $\therefore$ **V0 = E1 – E2** will be **negative**.

Linear Variable Differential Transformer (LVDT)

WORKING



1



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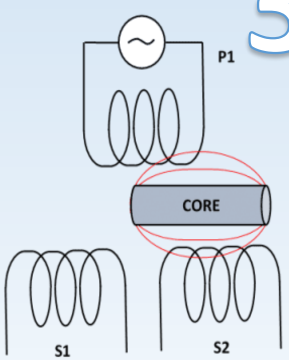

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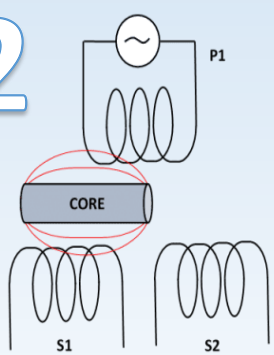
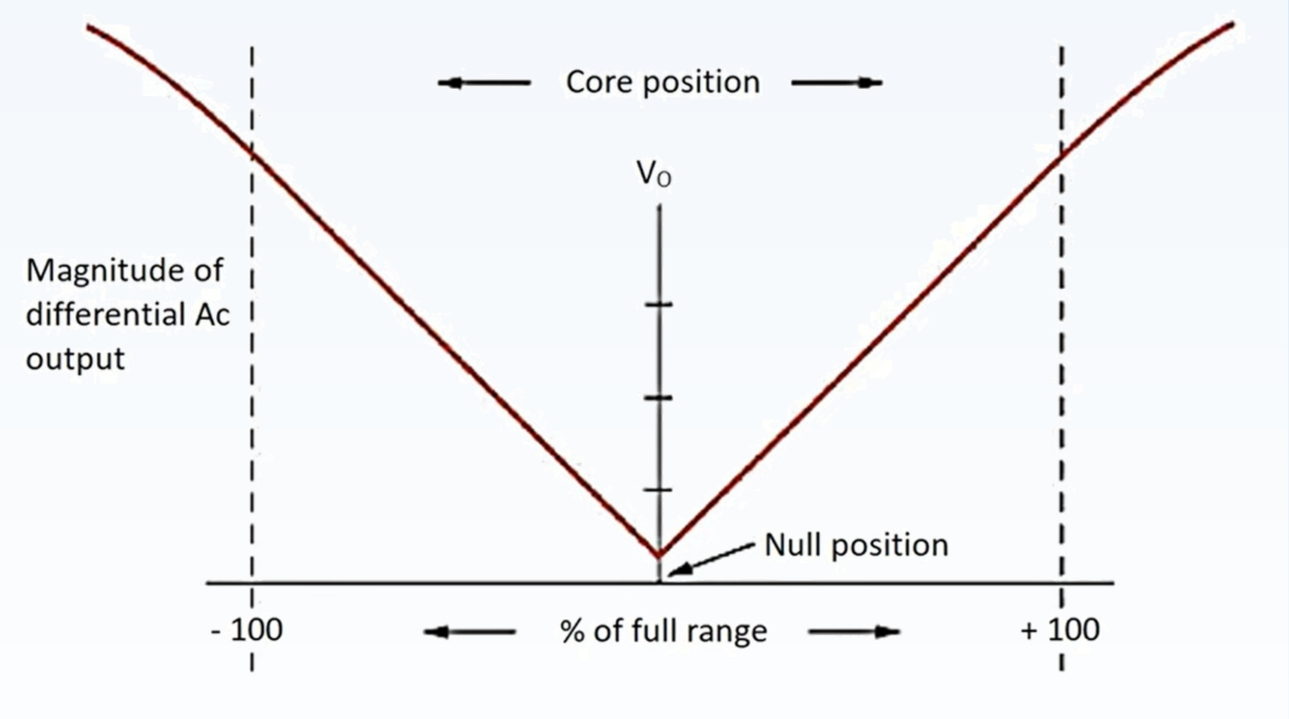


Linear Variable Differential Transformer (LVDT)

Output characteristics

WORKING

- **Case 1:** When the core is at null position $V_O=0$
- **Case 2:** When the core is moved toward S_1 V_O=Positive
- **Case 3:** When the core is moved toward S_2 V_O=Negative



Linear Variable Differential Transformer (LVDT)

ADVANTAGES

1.LVDT gives high output and it possesses high sensitivity.

2.The displacement measurement range of LVDT is very high, it lies in between **1.25 mm to 250 mm**.

3.LVDT has the ability to withstand higher vibrations and shock levels. They are small and lightweight and provides better stability.

4.It shows low hysteresis.

5.Power consumption of LVDT is low.

LIMITATIONS

1.Large displacement is required in order to have considerable output.

2.Sometimes its performance gets affected by vibrations.

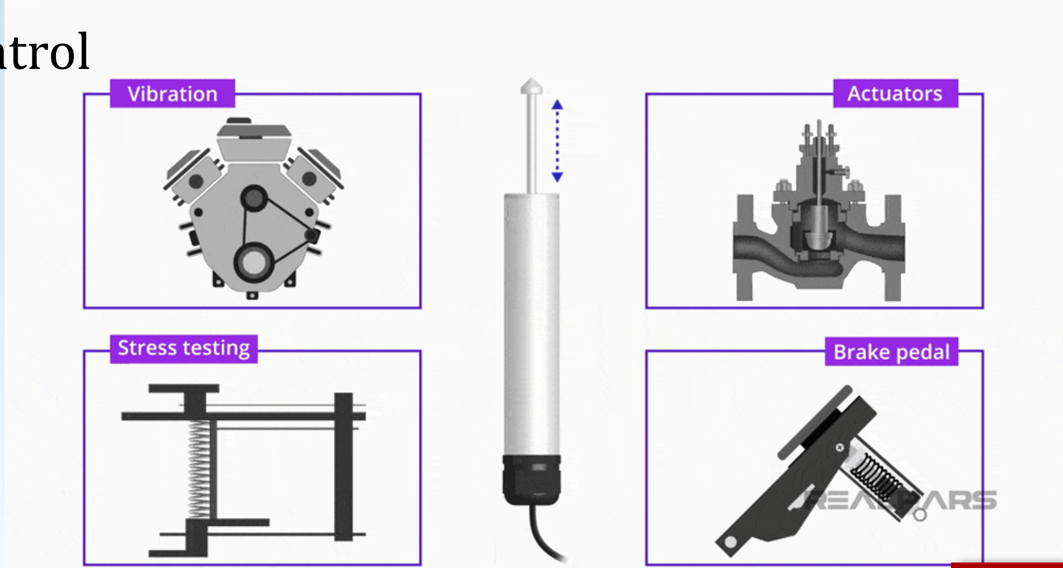
3.These are sensitive to stray magnetic fields.

4.Change in temperature affects the performance of LVDT.

Linear Variable Differential Transformer (LVDT)

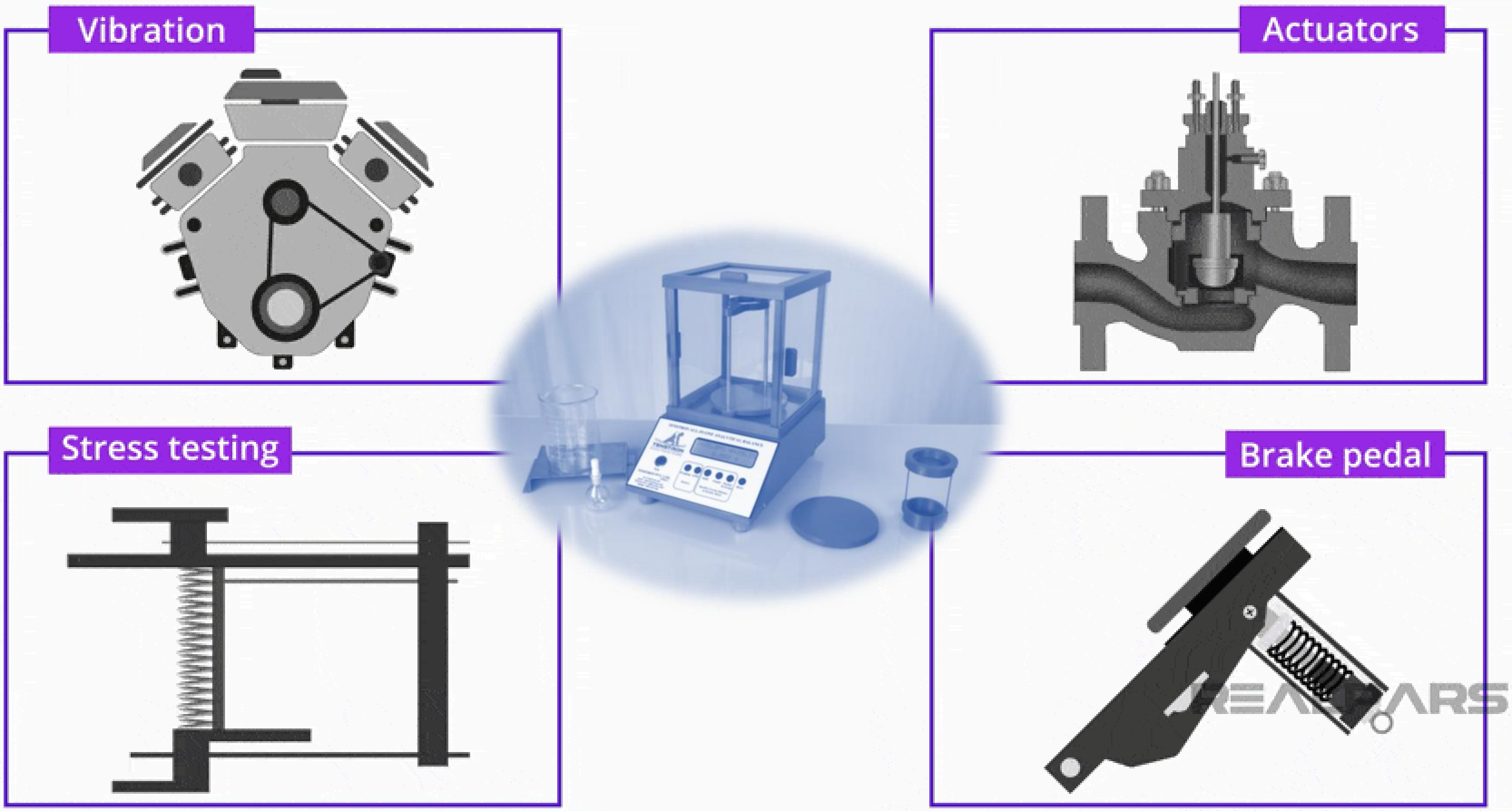
APPLICATIONS

- Aerospace and automotive testing
- Industrial automation
- Valve position feedback
- Structural health monitoring
- Robotic actuators and motion control



Linear Variable Differential Transformer (LVDT)

APPLICATIONS



LVDT

Linear Variable Differential Transformer (LVDT)