SNS COLLEGE OF TECHNOLOGY

Coimbatore-35

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DEPARTMENT OF MECHATRONICS

19MCB303 – SENSORS AND SIGNAL PROCESSING

UNIT 3 – ELECTROMECHANICAL SENSORS

LVDT & RVDT

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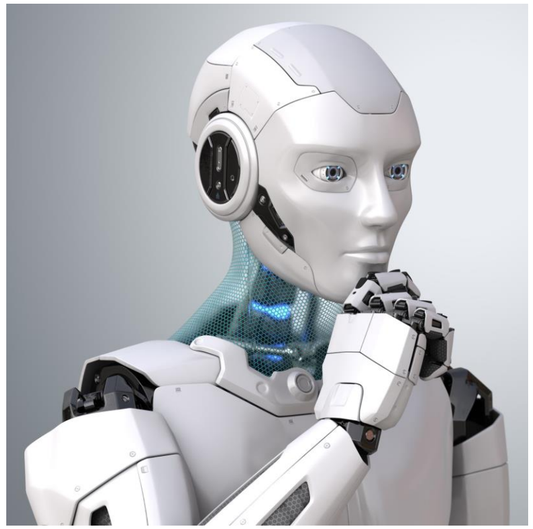
Syllabus

UNIT-III	ELECTRICAL MEASUREMENT	9

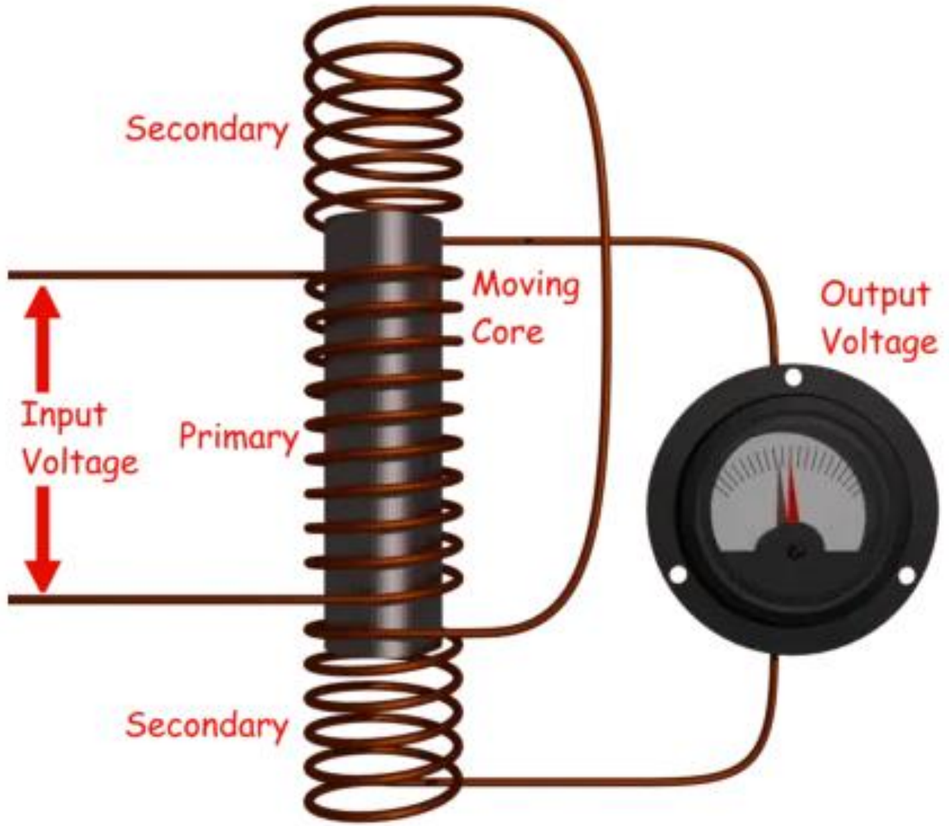
Resistive transducers– Potentiometer–RTD– Thermistor – Thermocouple–Strain gauges–use in displacement, temperature, force measurement–Inductive transducer–LVDT– RVDT–use in displacement– Capacitive transducer – Piezoelectric transducer –Digital displacement transducers.

Applications

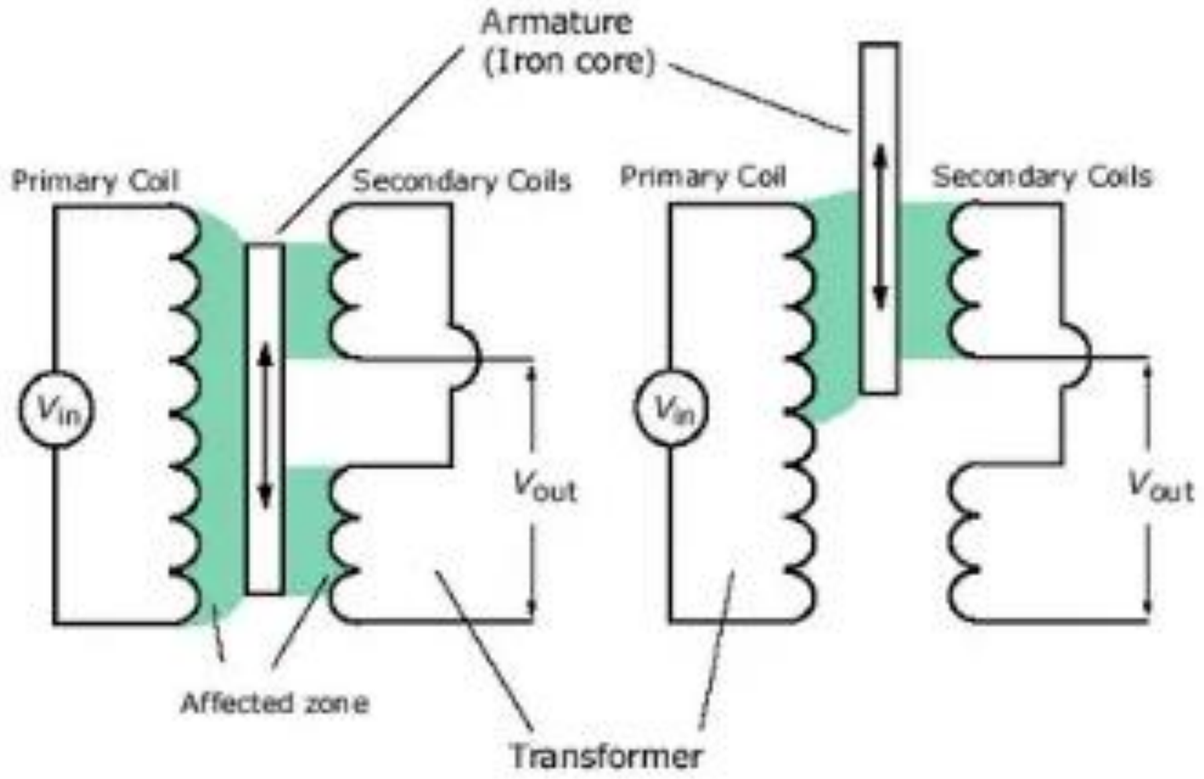


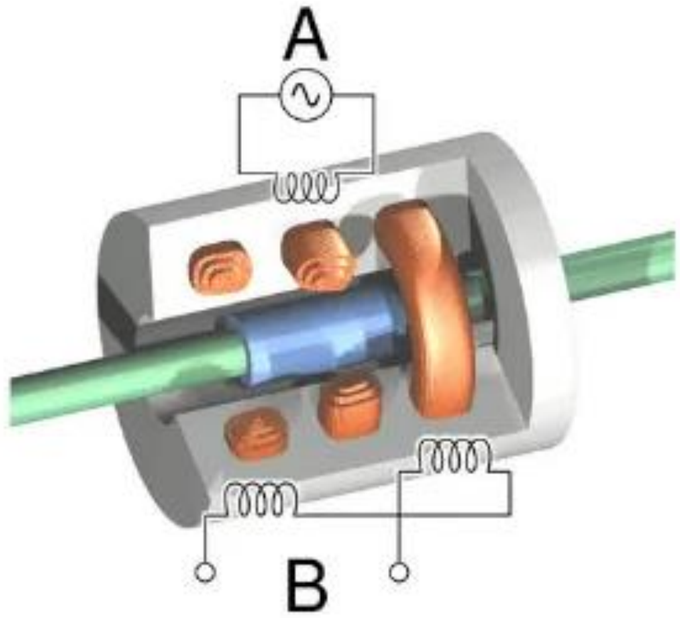
LVDT

- The term LVDT stands for the Linear Variable Differential Transformer. It is the most widely used inductive transducer that converts the linear motion into the electrical signal.
- The output across secondary of this transformer is the differential thus it is called so. It is very accurate inductive transducer as compared to other inductive transducers.



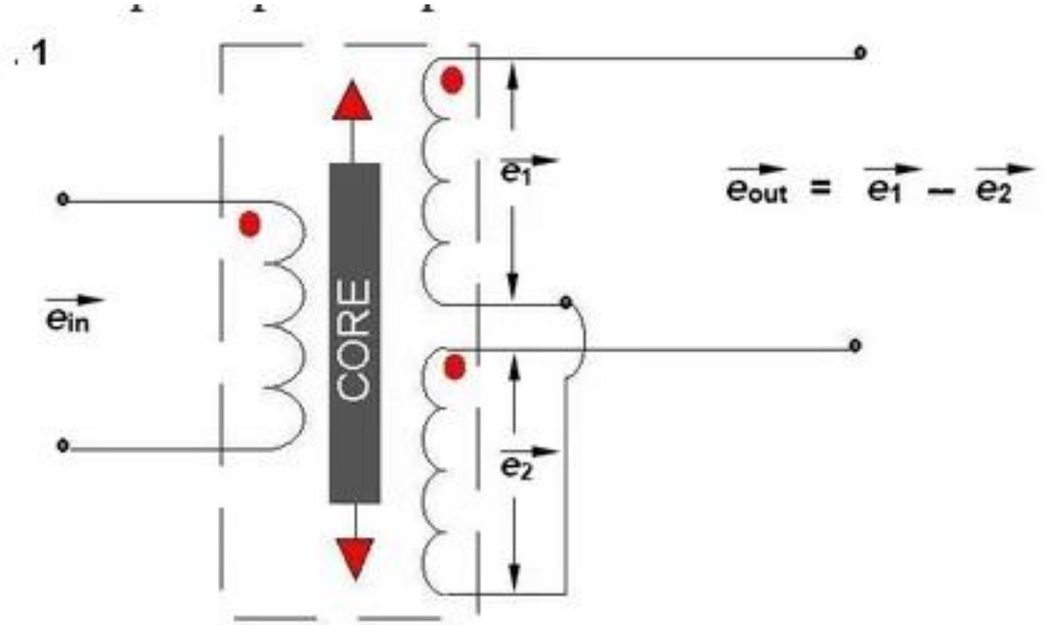
LVDT


Armature
(Iron core)
Primary Coil
Secondary Coils
Primary Coil
Secondary Coils
V_{in}
V_{out}
V_{in}
V_{out}
Affected zone
Transformer


A
B

Construction and Working

- As the primary is connected to an AC source so alternating current and voltages are produced in the secondary of the LVDT. The output in secondary S1 is e1 and in the secondary S2 is e2. So the differential output is,



$$e_{out} = e_1 - e_2$$

Construction and Working

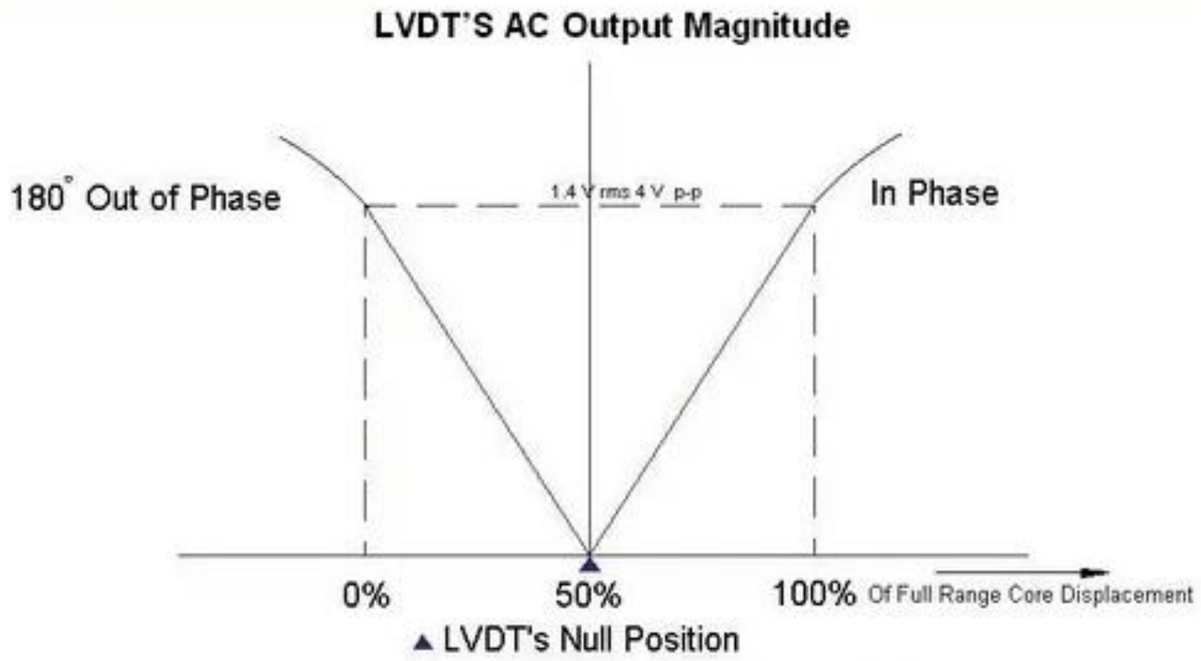
- CASE I When the core is at null position (for no displacement) When the core is at null position then the flux linking with both the secondary windings is equal so the induced emf is equal in both the windings. So for no displacement the value of output eout is zero as e1 and e2 both are equal. So it shows that no displacement took place.

- CASE II When the core is moved to upward of null position (For displacement to the upward of reference point) In the this case the flux linking with secondary winding S1 is more as compared to flux linking with S2. Due to this e1 will be more as that of e2. Due to this output voltage eout is positive.

- CASE III When the core is moved to downward of Null position (for displacement to the downward of the reference point). In this case magnitude of e2 will be more as that of e1. Due to this output eout will be negative and shows the output to downward of the reference point.

Output VS Core Displacement

- A linear curve shows that output voltage varies linearly with displacement of core.



AC Output of Conventional LVDT Versus Core Displacement

Advantages

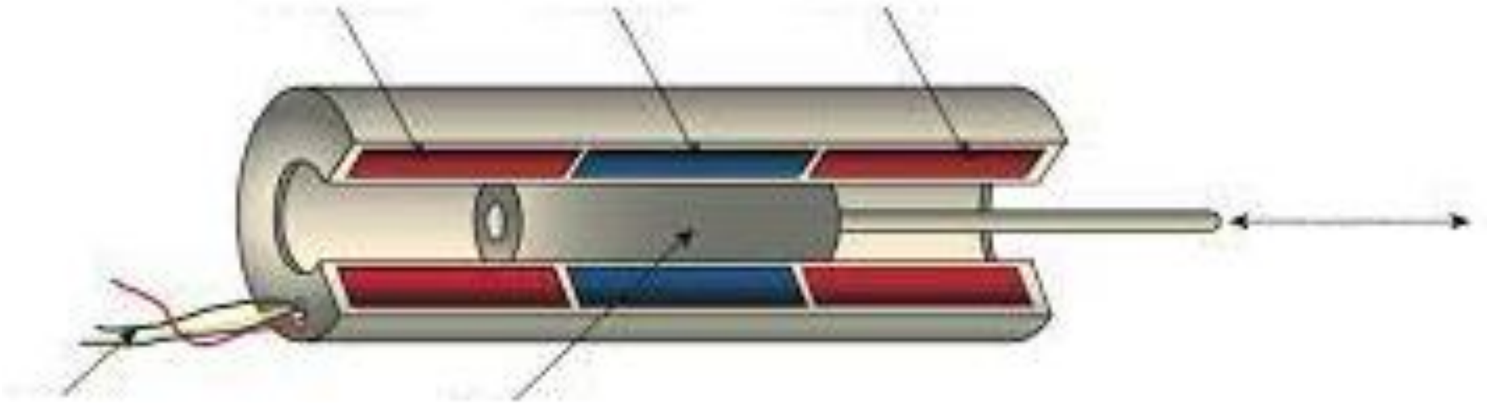
- ❑ Smooth and Wide Range of Operation
- ❑ High Sensitivity
- ❑ Low Hysteresis Losses
- ❑ Low Friction Losses
- ❑ Rugged Operation
- ❑ Low Power consumption
- ❑ Direct conversion to Electrical Signal
- ❑ Fast dynamic Response

Disadvantages

- Since LVDT is Inductive Transducer, so it is sensitive to Stray Magnetic Field. Hence an extra setup is required to protect it from Stray Magnetic Field.
- Since it is an electromagnetic device, so it also gets affected by the vibrations and temperature variation.

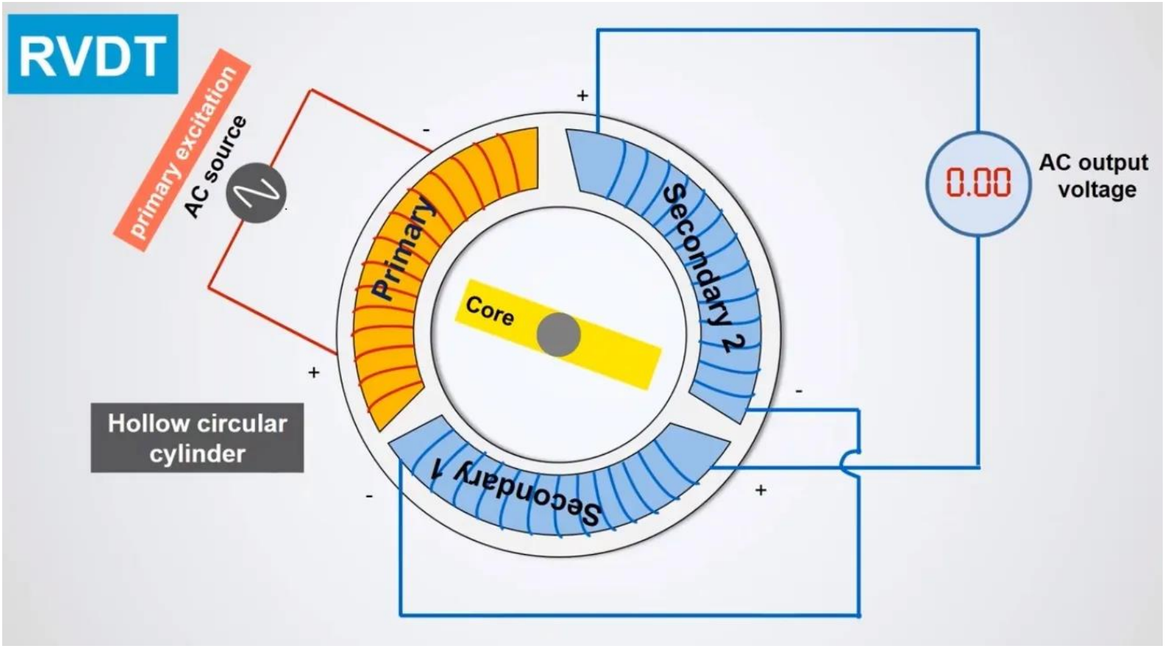
Assessment

Identify the Parts of LVDT

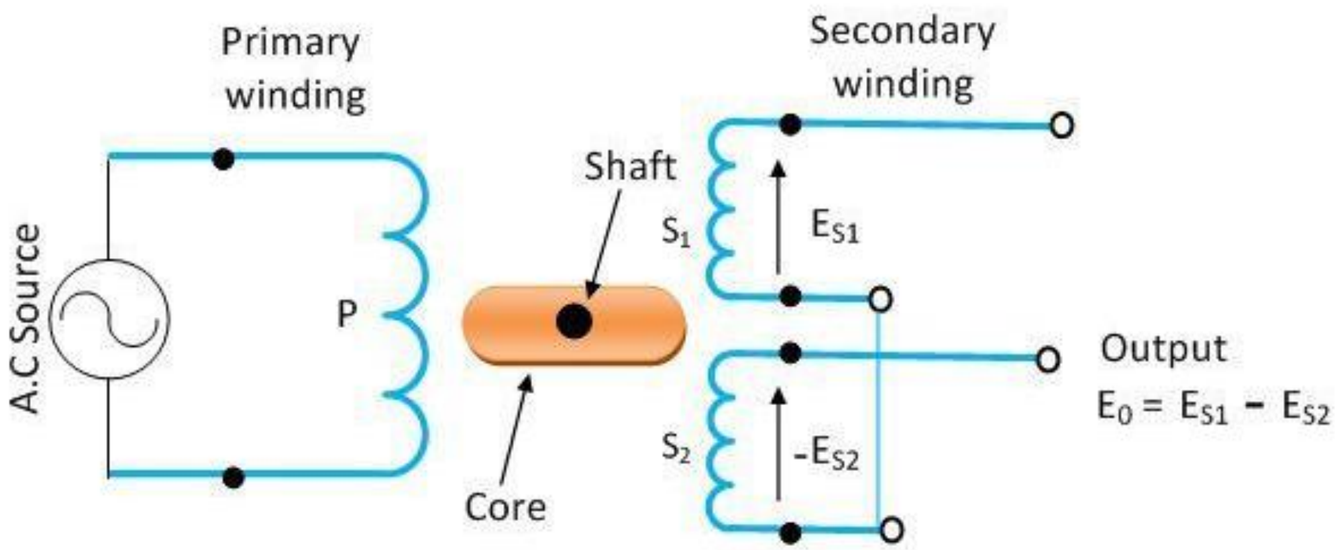


RVDT

- The term RVDT stands for the Rotary Variable Differential Transformer. It is the most widely used inductive transducer that converts the linear motion into the electrical signal.
- The output across secondary of this transformer is the differential thus it is called so. It is very accurate inductive transducer as compared to other inductive transducers.



RVDT


Primary winding
Secondary winding
Shaft
A.C Source
P
S_1
E_{S1}
Output
$E_0 = E_{S1} - E_{S2}$
S_2
$-E_{S2}$
Core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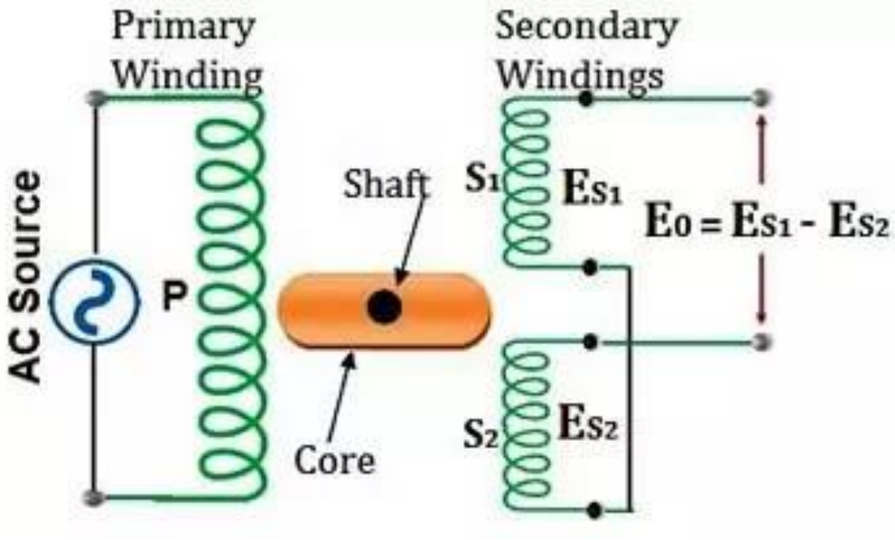
Construction and Working

- The working principle of RVDT and LVDT both are the same and based on the mutual induction principle. When AC excitation of 5-15V at a frequency of 50-400 Hz is applied to the primary windings of RVDT then a magnetic field is produced inside the core. This magnetic field induces a mutual current in secondary windings.
- Then due to transformer action, the induced voltages in secondary windings (S1 and S2) are Es1 and Es2 respectively. Hence the net output voltage will be the difference between both the induced secondary voltages.
- Hence Output will be E0 = Es1 – Es2.



Construction and Working

Case 1: When the core is at the Null position.

When the core is at the null position then the flux linkage with both the secondary windings will be the same. So the induced emf (Es1 and Es2) in both the windings will be the same. Hence the Net differential output voltage E0 = Es1 – Es2 will be zero (E0 = Es1 – Es2 = 0). It shows that no displacement of the core.

Case 2: When the core rotates in the clockwise direction.

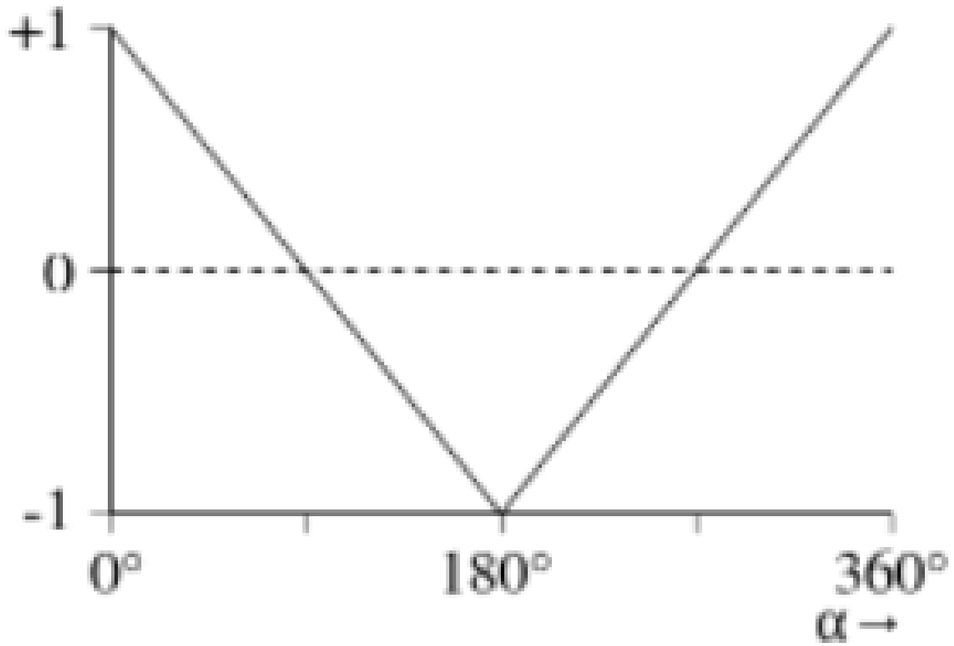
When the core of RVDT rotates in the clockwise direction. Then, in this case, the flux linkage with S1 will be more as compared to S2. This means the emf induced in S1 will be more than the induced emf in S2. Hence Es1 > Es2 and Net differential output voltage E0 = Es1 – Es2 will be positive. This means the output voltage E0 will be in phase with the primary voltage.

Case 3: When the core rotates in the anti-clockwise direction.

When the core of RVDT rotates in the anti-clockwise direction. Then, in this case, the flux linkage with S2 will be more as compared to S1. This means the emf induced in S2 will be more than the induced emf in S1. Hence Es1 < Es2 and Net differential output voltage E0 = Es1 – Es2 will be negative. This means the output voltage E0 will be in phase opposition (180 degrees out of phase) with the primary voltage.

Output VS Core Displacement

- A curve shows that output voltage varies with displacement of core.



Advantages

- ❑ High Accuracy.
- ❑ Compact and strong construction.
- ❑ The consistency of RVDT is high.
- ❑ Long life span.
- ❑ Very high Resolution.
- ❑ Low cost.
- ❑ High durability.
- ❑ Linearity is excellent.
- ❑ The performance is repeatable.
- ❑ Easy to handle.

Disadvantages

- Since the output of RVDT is linear (about +40 degrees or -40 degrees), So it restricts its usability.
- The contact among the measuring exteriors as well as the nozzle is not possible for all time.

Applications

- Actuators for controlling flight as well as engine.
- Fuel valve as well as hydraulics.
- Brake with a cable system.
- Modern machine tools.
- Nose wheel steering systems.
- Weapon and Torpedo system.
- Engine fuel control system.
- Aircraft and avionics.
- Engines bleed air systems.
- Robotics

Reference

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3. https://electricalbaba.com/lvdt-construction-and-working-principle/
4. https://www.electrical4u.com/linear-variable-differential-transformer/

Thank You