

# **CHARACTERISTICS OF TRANSDUCERS**

## STATIC CHARACTERISTICS

Application involved measurement of quantity that are either constant or varies slowly with time is known as static.

- ❖ Drift
- ❖ Dead Zone
- ❖ Static Error
- ❖ Reproducibility
- ❖ Static correction
- ❖ Scale range
- ❖ Scale span
- ❖ Noise
- ❖ Dead Time
- ❖ Hysteresis.
- ❖ Linearity

- **ACCURACY:** It is the closeness with an instrument reading approaches the true value of the quantity being measured.
- **TRUE VALUE:** True value of quantity may be defined as the average of an infinite no. of measured value.
- **SENSITIVITY** is defined as the ratio of the magnitude of the output response to that of input response.
- **STATIC ERROR:** It is defined as the difference between the measured value and true value of the quantity.
- **Reproducibility** is specified in terms of scale readings over a given period of time.
- **Drift** is an undesirable quality in industrial instruments because it is rarely apparent and cannot be maintained.
- It is classified as 1. Zero drift      2.Span drift or sensitivity drift  
3.Zonal drift.
- **Noise** A spurious current or voltage extraneous to the current or voltage of interest in an electrical or electronic circuit is called noise.

## DYNAMIC CHARACTERISTICS

**SPEED OF RESPONSE:** It is defined as the rapidity with which a measurement system responds to changes in measured quantity. It is one of the dynamic characteristics of a measurement system.

**FIDELITY:** It is defined as the degree to which a measurement system indicates changes in the measured quantity without any dynamic error.

**DYNAMIC ERROR:** It is the difference between the true value of the quantity changing with time and the value indicated by the measurement system if no static error is assumed.

It is also called measurement error. It is one the dynamic characteristics.

## **MEASURING LAG:**

It is the retardation delay in the response of a measurement system to changes in the measured quantity. It is of 2 types:

Retardation type: The response begins immediately after a change in measured quantity has occurred.

Time delay: The response of the measurement system begins after a dead zone after the application of the input

# ERRORS IN MEASUREMENT

Limiting Errors (Guarantee Errors) Known Error

**INSTRUMENTAL ERROR:** These errors arise due to 3 reasons-

- Due to inherent shortcomings in the instrument
- Due to misuse of the instrument
- Due to loading effects of the instrument

**ENVIRONMENTAL ERROR:** These errors are due to conditions external to the measuring device. These may be effects of temperature, pressure, humidity, dust or of external electrostatic or magnetic field.

**OBSERVATIONAL ERROR:** The error on account of parallax is the observational error.

**RESIDUAL ERROR :** This is also known as residual error. These errors are due to a multitude of small factors which change or fluctuate from one measurement to another. The happenings or disturbances about which we are unaware are lumped together and called "Random" or "Residual". Hence the errors caused by these are called random or residual errors.

# TRANSDUCER

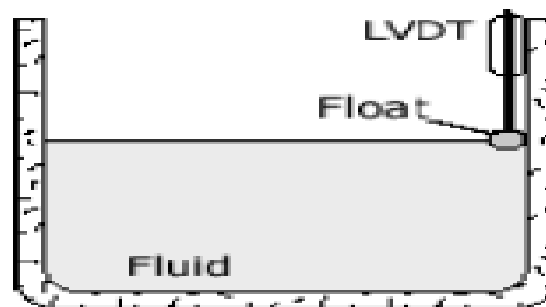
The transducer is defined as the device which convert the one form of energy into another form of the energy

Example:

- ❖ Temperature transducers
- ❖ Thermocouples
- ❖ Resistance-Temperature Detectors (RTD)
- ❖ Thermistor
- ❖ Resistive position transducers
- ❖ Displacement transducers
- ❖ Strain gauge

# ELECTRICAL TRANSDUCERS

- The electrical transducers is one which converts the non-electrical quantity into the equivalent electrical quantity.
- Non-electrical quantity such as force, displacement, stress, temperature.
- Electrical quantity such as current, voltage





# CLASSIFICATION OF TRANSDUCERS

- ❖ On the basis of transduction form used.
- ❖ As primary and secondary transducers.
- ❖ As passive and active transducers.
- ❖ As analog and digital transducers.
- ❖ As transducers and inverse transducers

# SELECTION CRITERIA OF THE TRANSDUCERS

- ❖ Operating principle
- ❖ Sensitivity
- ❖ Operating range
- ❖ Accuracy
- ❖ Errors
- ❖ Environmental capability
- ❖ Insensitive to unwanted Signal
- ❖ Stability

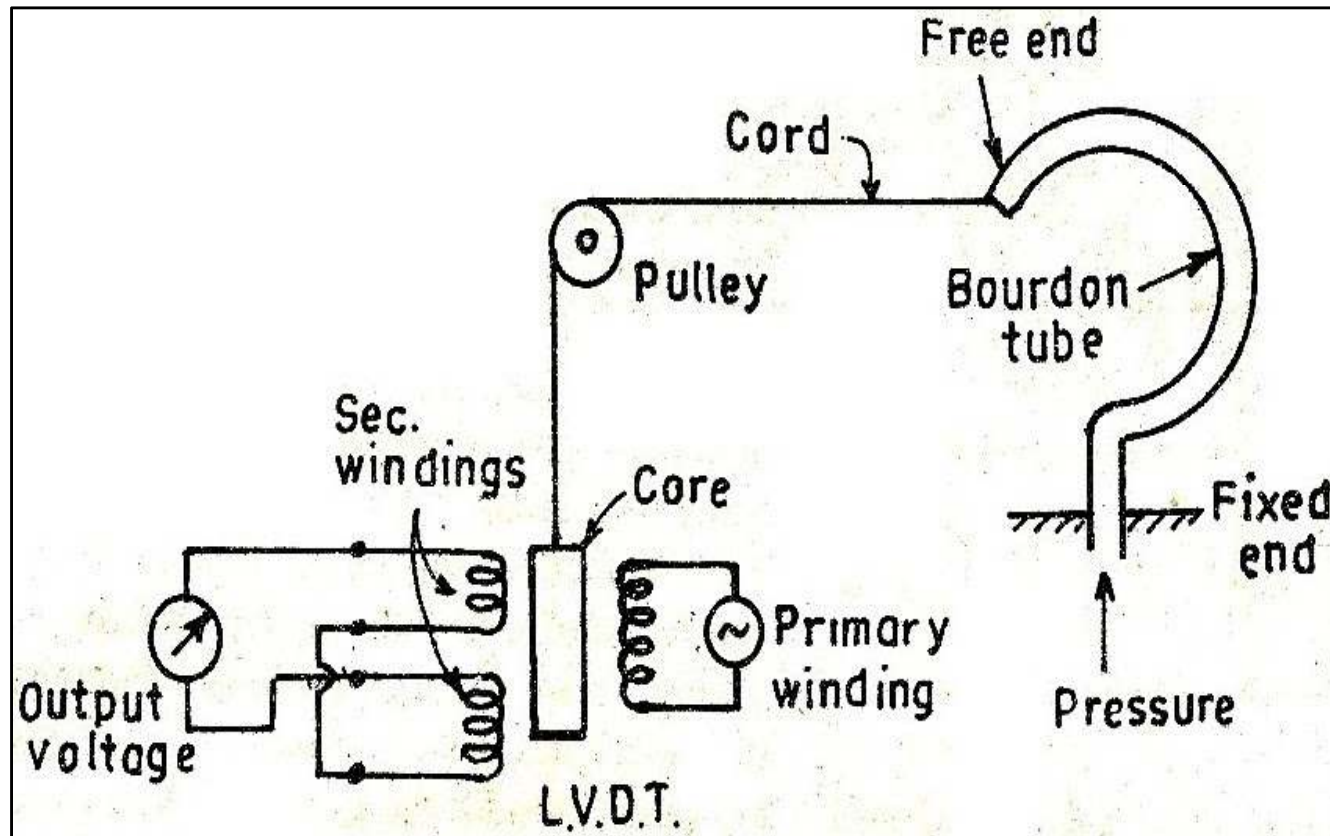
## **On the basis of transduction form used**

- ❖ Resistive Transducers.
- ❖ Capacitive Transducers.
- ❖ Inductive Transducers.
- ❖ Voltage and current Generating Transducers.

# PRIMARY AND SECONDARY TRANSDUCERS

## Example:

LVDT and bourdon tube



# PASSIVE AND ACTIVE TRANSDUCERS

If transducers derive the power require for transduction from an power source, then this kind of transducer are known as passive transducer

## **Example:**

- LVDT
- RVDT

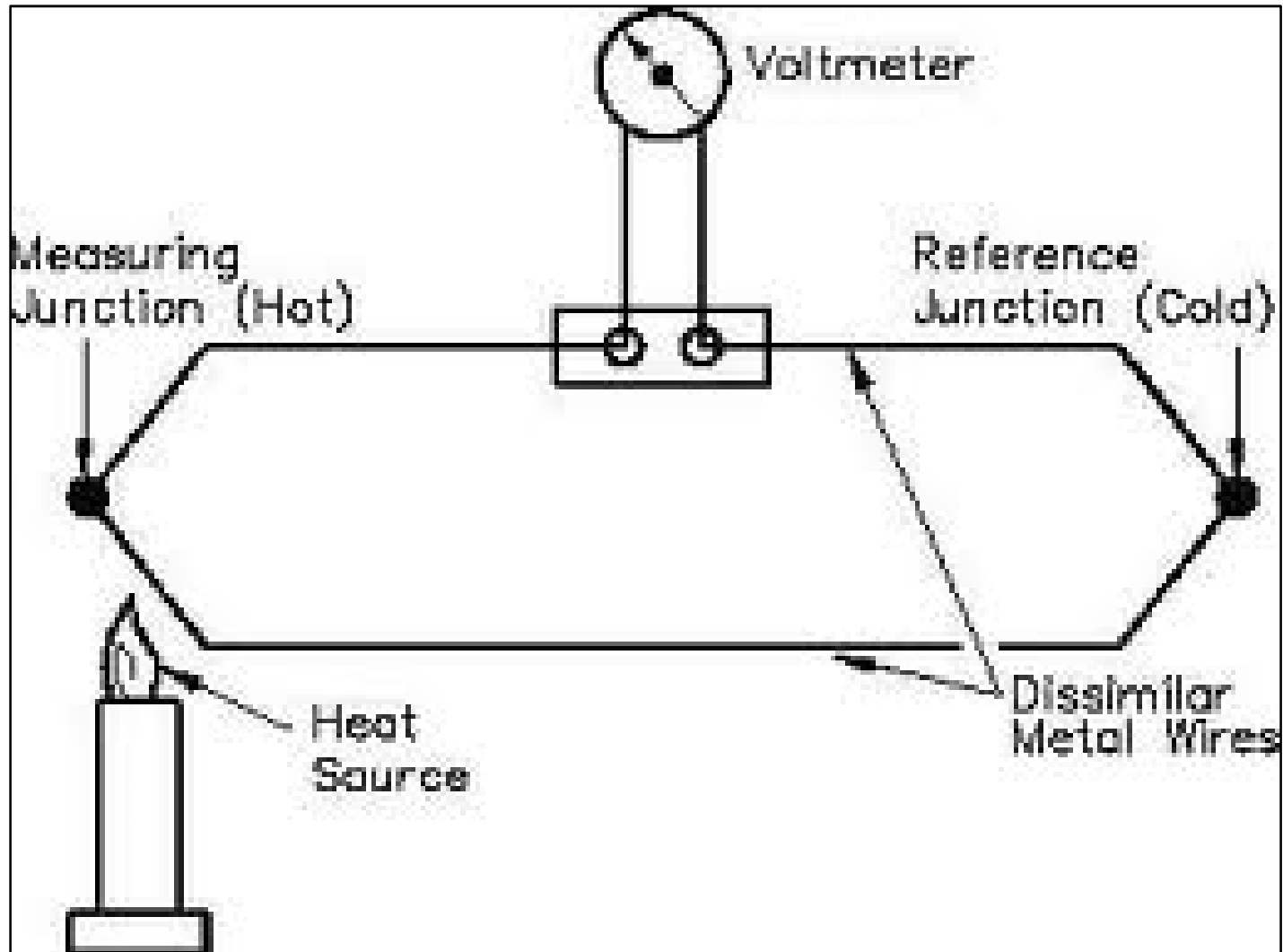
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When there is no need for any source then these type of transducers are Active transducers

### **Example:**

- Thermocouple
- Piezoelectric crystal

# THERMOCOUPLE



## TYPES OF THERMOCOUPLE

TYPE	NAME	RANGE
T	Copper-Constantan	-250 to 400
J	Iron-Constantan	-200 to 850
E	Cromel-Constantan	-200 to 850
K	Chromel-Alumel	-180 to 1100
W	Tungsten-Rhenium	0 to 2600
R	Platinum 13%-Rhodium	0 to 1750
S	Platinum 10%-Rhodium	0 to 1750
B	Platinum 30%-Rhodium 6%	0 to 1800



# DIGITAL TRANSDUCERS – OPTICAL ENCODERS

Signal output – pulses, sequence of 1`s or 0`s,time  
sequence ,sinusoidal waveform

Types – Tachometer, incremental tachometer, absolute  
encoder

Construction – Two types- Contact & Non contact type

Contact type /Brush type – Cylindrical disc with coding patterns  
conducting (black)& Non conducting(white) sections

Circuits with sliding contacts

Encoder pattern determines the displacement

Code pattern of displacement is natural binary pattern

But brushes & segments not perfectly aligned

Solution – Gray to binary converter

# **BASIC CONSTRUCTION OF TRANSDUCERS**

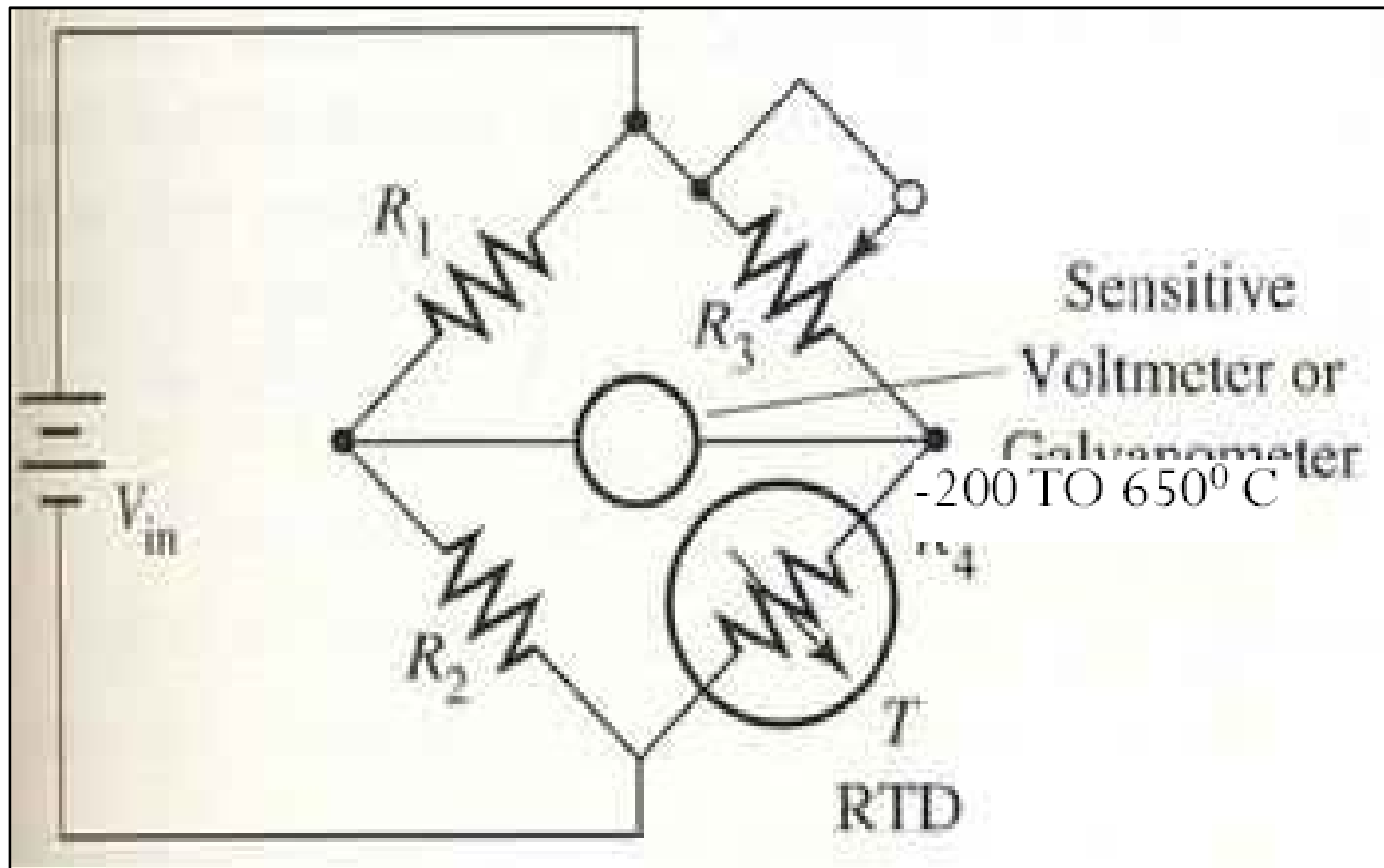
It consist of two important parts

- Sensing element.
- Transduction element.

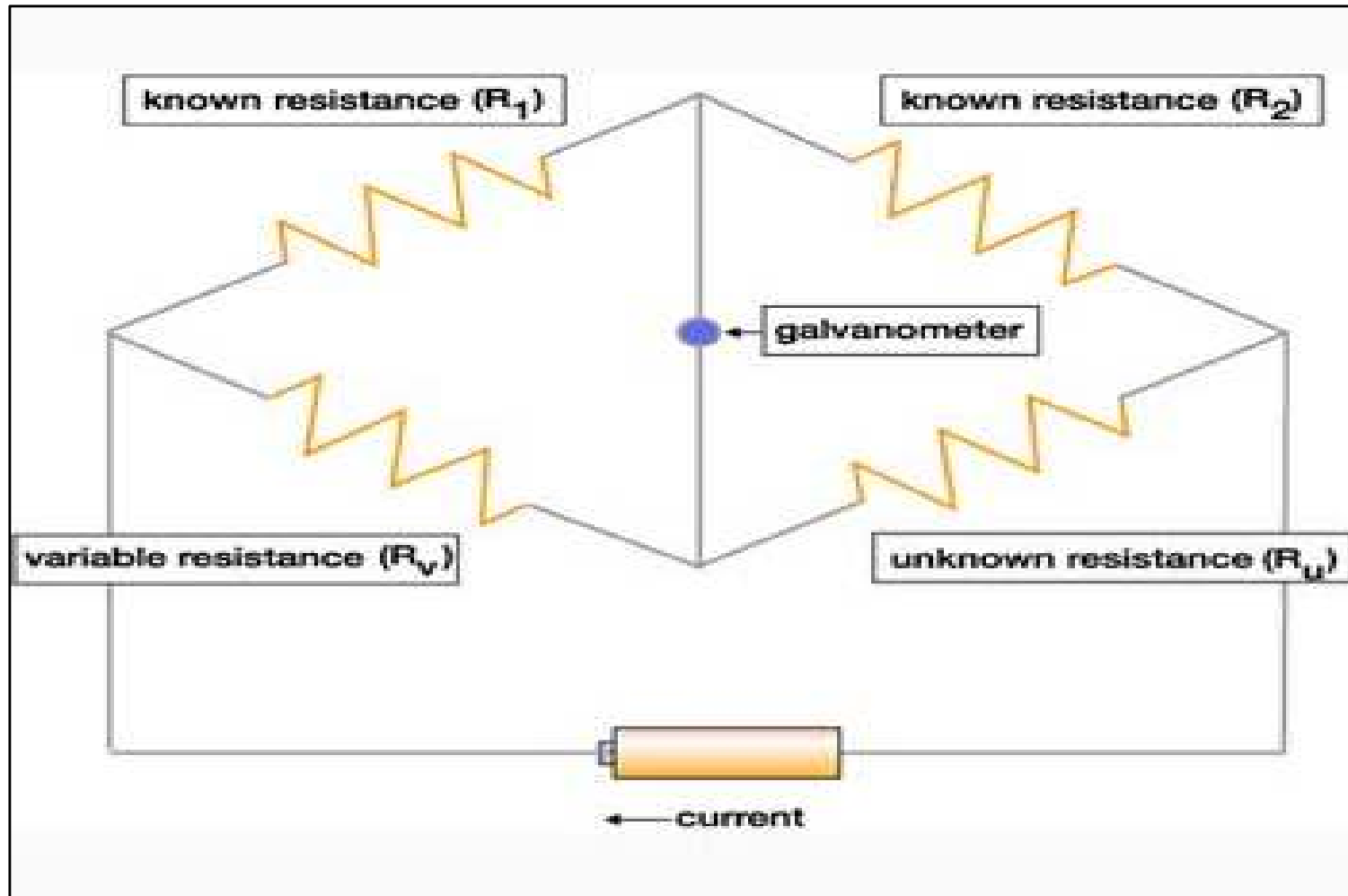
## **VARIABLE RESISTIVE TRANSDUCER: STRAIN GAUGE**

- It works on Piezo-resistive effect.
- These are used for measurement of stress and strain
- If an elastic material is subjected to tension then its resistance changes.

# VARIABLE RESISTIVE TRANSDUCER: RESISTANCE TEMPERATURE DETECTOR



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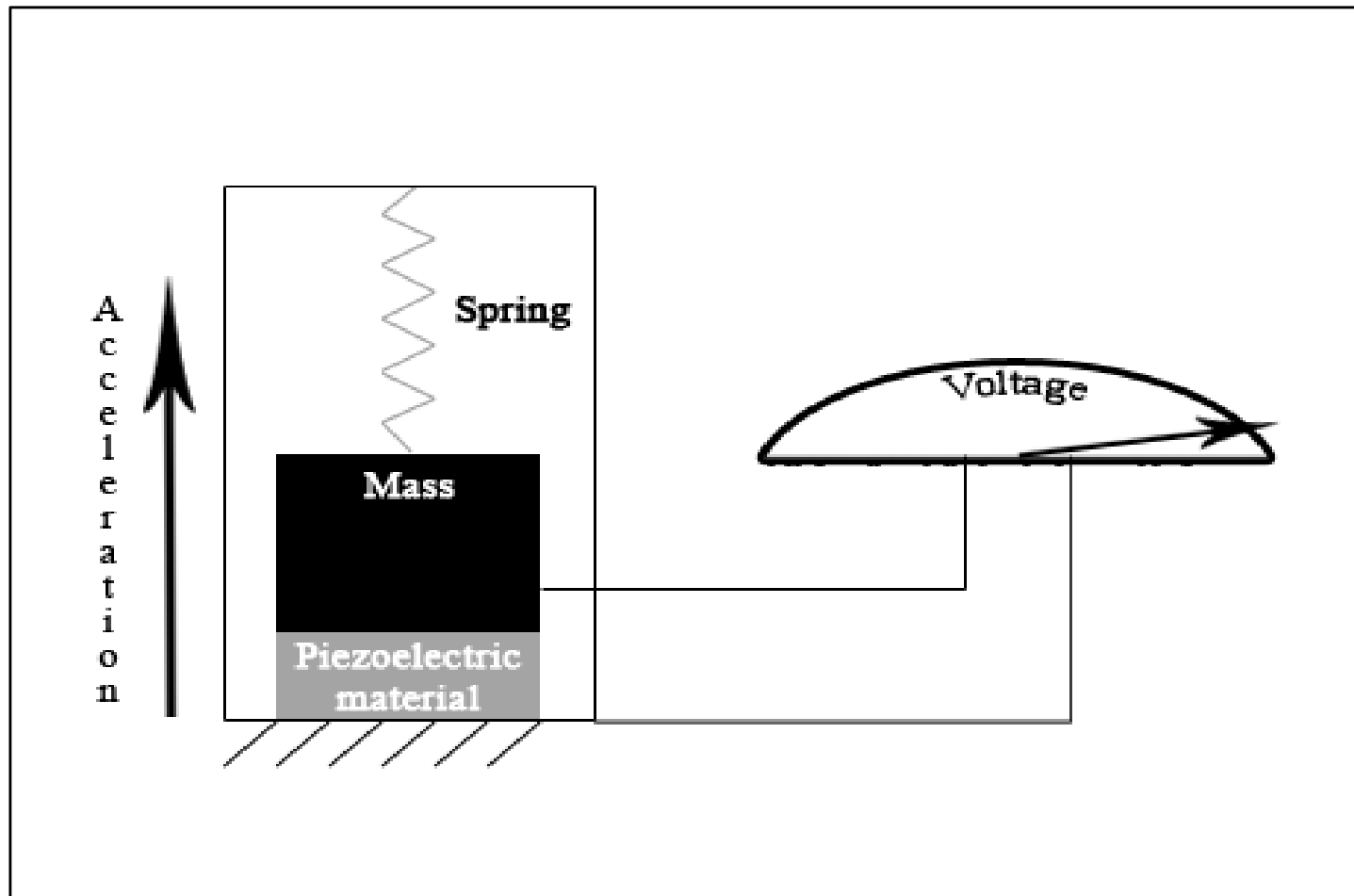
# THERMISTORS



- Thermistors are used for the measurement of precision temperature

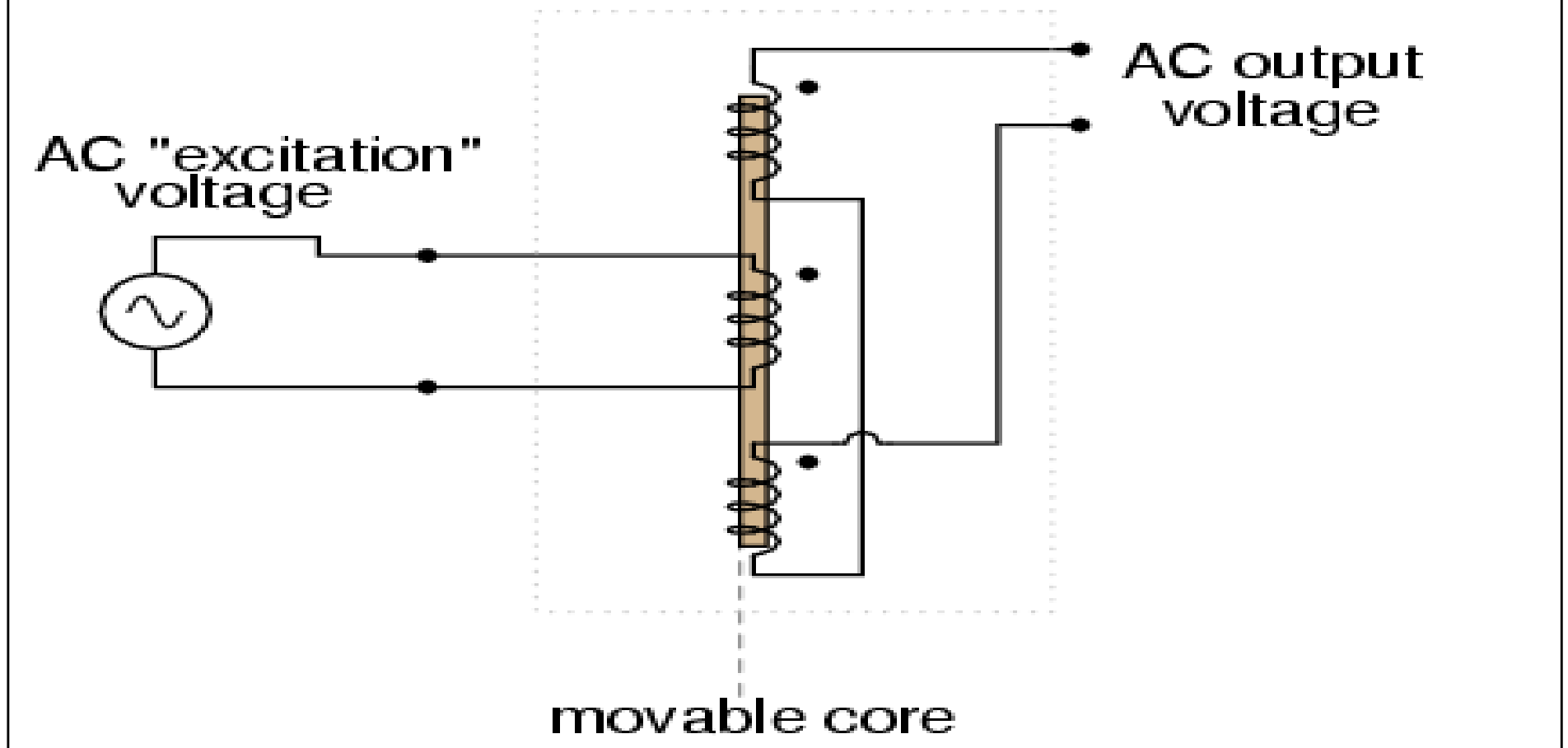
# VARIABLE CAPACITIVE TRANSDUCER PIEZOELECTRIC CRYSTAL

- Quartz ,Rochelle salt, Lithium sulphate or barium titanate.



# VARIABLE INDUCTIVE TRANSDUCER LVDT

*The Linear Variable Differential Transformer  
(LVDT)*





# APPLICATION

- Audio/video equipment
- Pressure indication
- Measurement of displacement
- Alarms