



# Displacement Sensors

## Variable Area Capacitors

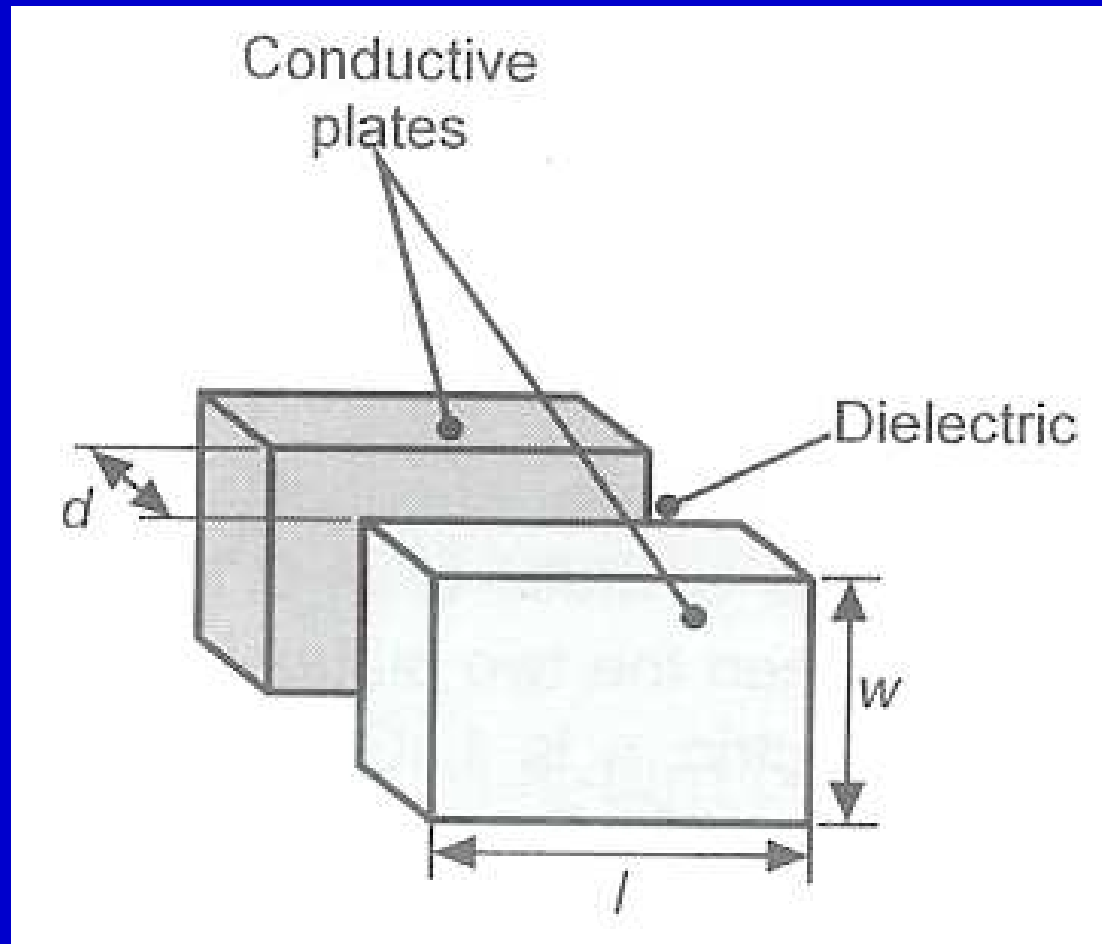
# Variable Area Capacitors



- This method of measuring displacement uses the electrical property of **capacitance**.

**Capacitance** is the property of a system that enables it to store electrical charge. A capacitor is an electrical component having capacitance. Capacitors are formed by conductors separated by a dielectric

# Variable Area Capacitors



- **Conductors of a capacitor**, in the form of parallel plates, with a dielectric material between them. A dielectric material is a substance such as glass or kerosene that can sustain an electric field.

## Variable Area Capacitors



- The capacitance is measured in farads (F) and is given by the expression:

$$C = \frac{A \epsilon_0 \epsilon_r}{d}$$

where:

- . **A** is the area of overlap between two capacitor plates (m<sup>2</sup>)
- .  **$\epsilon_0$**  is the permittivity of free space (8.854 x 10<sup>-12</sup> F.m<sup>-1</sup>)
- .  **$\epsilon_r$**  is the relative permittivity of the dielectric between the capacitor plates (no units)
- . **d** is the distance between the plates (m)

## Variable Area Capacitors – Mode of operation



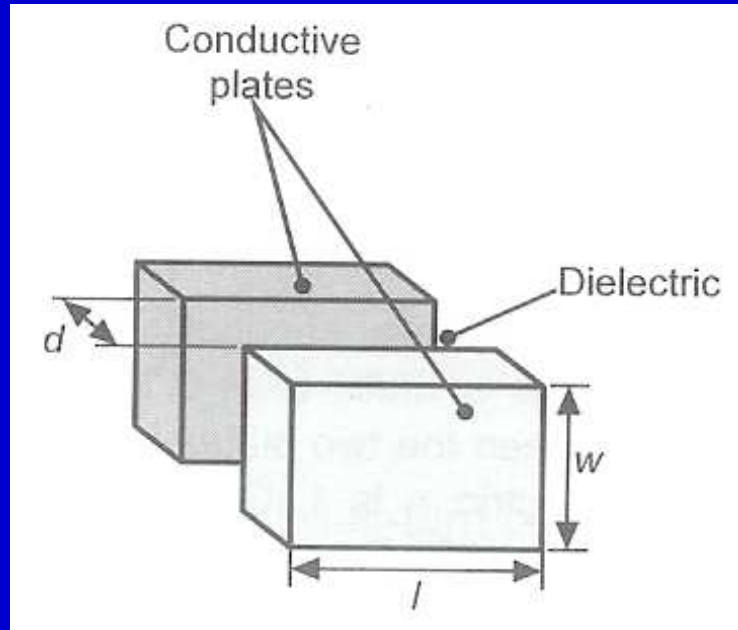
Capacitive displacement transducers produce a **change in capacitance proportional to a change in displacement.**

The capacitance  $C$  can be changed by varying:

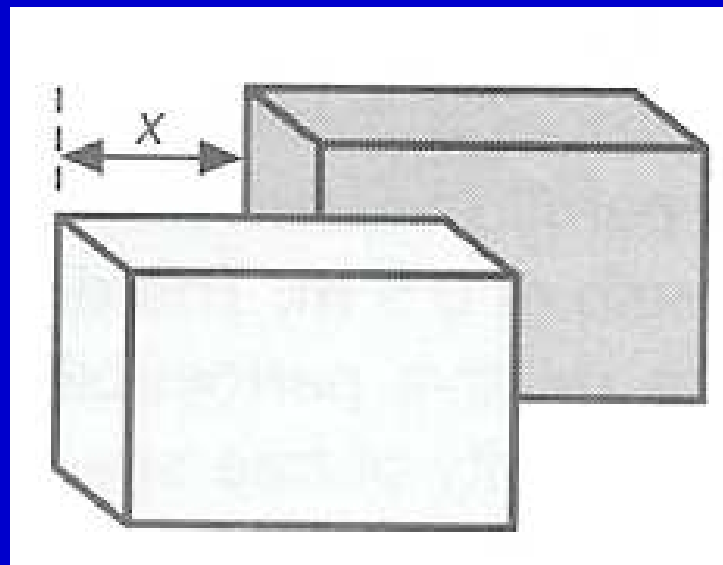
- **the area of overlap  $A$**
- **the relative permittivity of the dielectric  $\epsilon_r$**
- **the distance  $d$  between the plates.**

We shall consider the type where the area of overlap between the two conductive plates is altered, known as the variable area type.

# Variable Area Capacitors – Mode of operation



$$C = \frac{A \epsilon_0 \epsilon_r}{d}$$



$$C = \frac{(A - wx) \epsilon_0 \epsilon_r}{d}$$

## Variable Area Capacitors – **Mode of operation**



### CONCLUSION

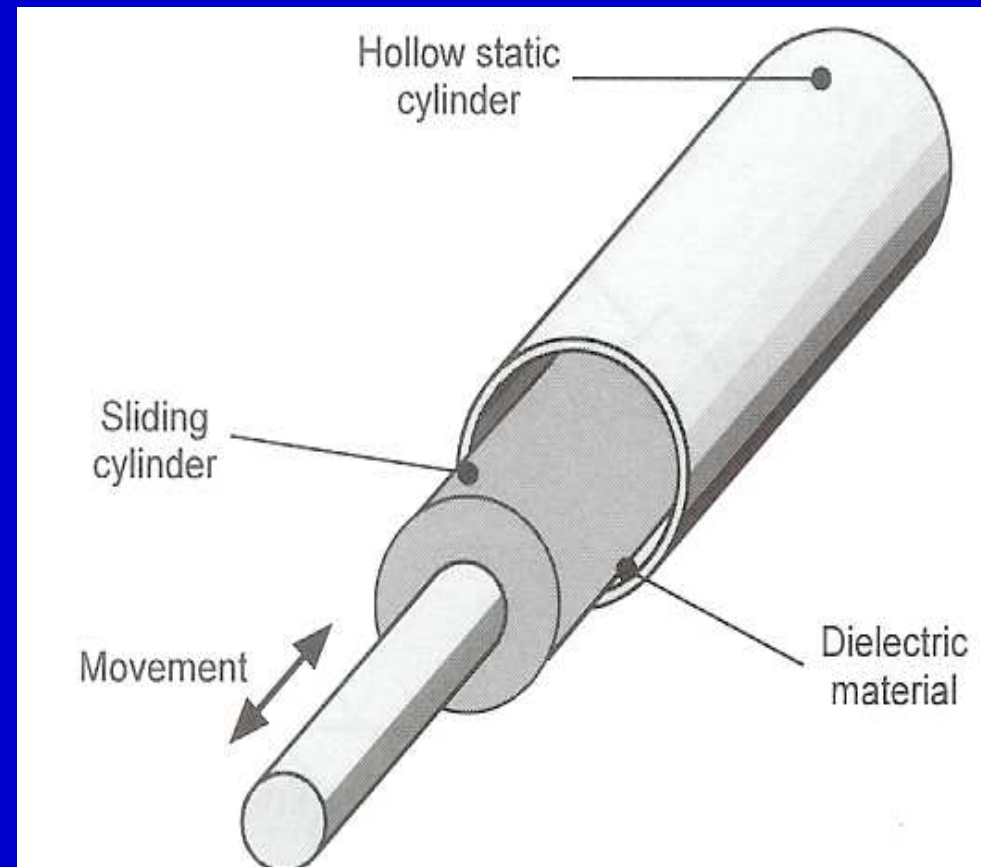
The change in capacitance is proportional to the change in area of overlap of the plates.

Therefore, by using an appropriate capacitor design, mounting arrangement and measurement system, we can use capacitance change to measure displacement.

## Variable Area Capacitors – The cylindrical form



It consists of a static cylinder into which a sliding cylinder is inserted to form the capacitive plates. The inside of the static cylinder is coated with dielectric material. The sliding cylinder attaches to the object whose displacement is to be measured. As the sliding cylinder moves in or out of the fixed cylinder, the area between the plates changes, so the capacitive output changes in proportion to the displacement.



## Variable Area Capacitors – Applications



- **Capacitive displacement transducers are generally only suitable for measuring small displacements.**
- **Specifications of this type of displacement sensor are available for use in high humidity or high temperature zones.**
- **They are very sensitive, have infinite resolution, but they can be expensive and need significant signal conditioning. For these reasons they tend to be used for specialist applications.**
- **Examples of these are surface profile sensing, wear measurement, or crack growth**