

Schering Bridge

The Schering bridge use for measuring the **capacitance** of the capacitor, dissipation factor, properties of an insulator, capacitor bushing, insulating oil and other insulating materials. It is one of the most commonly used **AC bridge**. The Schering bridge works on the principle of balancing the load on its arm.

Let, C_1 – capacitor whose capacitance is to be determined,

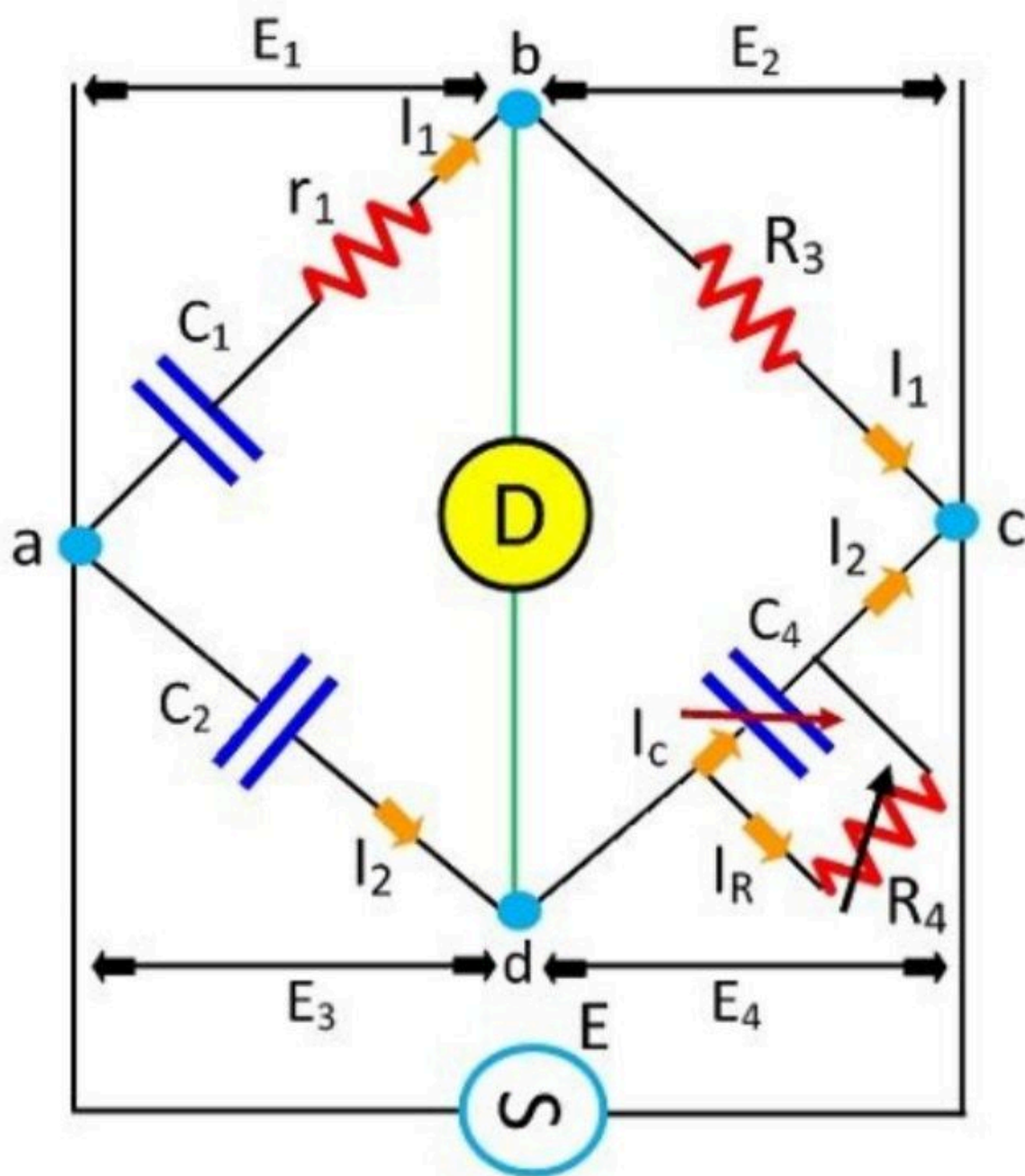
r_1 – a series resistance, representing the loss of the capacitor C_1 .

C_2 – a standard capacitor (The term standard capacitor means the capacitor is free from loss)

R_3 – a non-inductive resistance

C_4 – a variable capacitor.

R_4 – a variable non-inductive resistance parallel with variable capacitor C_4 .



Low Voltage Schering Bridge

Circuit Globe

When the bridge is in the balanced condition, zero current passes through the detector, which shows that the potential across the detector is zero. At balance condition

$$Z_1/Z_2 = Z_3/Z_4$$

$$Z_1Z_4 = Z_2Z_3$$

So,

$$\left(r_1 + \frac{1}{j\omega C_1}\right) \left(\frac{R_4}{1 + j\omega C_4 R_4}\right) = \frac{1}{j\omega C_2} \cdot R_3$$

$$\left(r_1 + \frac{1}{j\omega C_1}\right) R_4 = \frac{R_3}{j\omega C_2} (1 + j\omega C_4 R_4)$$

$$r_1 R_4 - \frac{j R_4}{\omega C_1} = -j \frac{R_3}{\omega C_2} + \frac{R_3 R_4 C_4}{C_2}$$

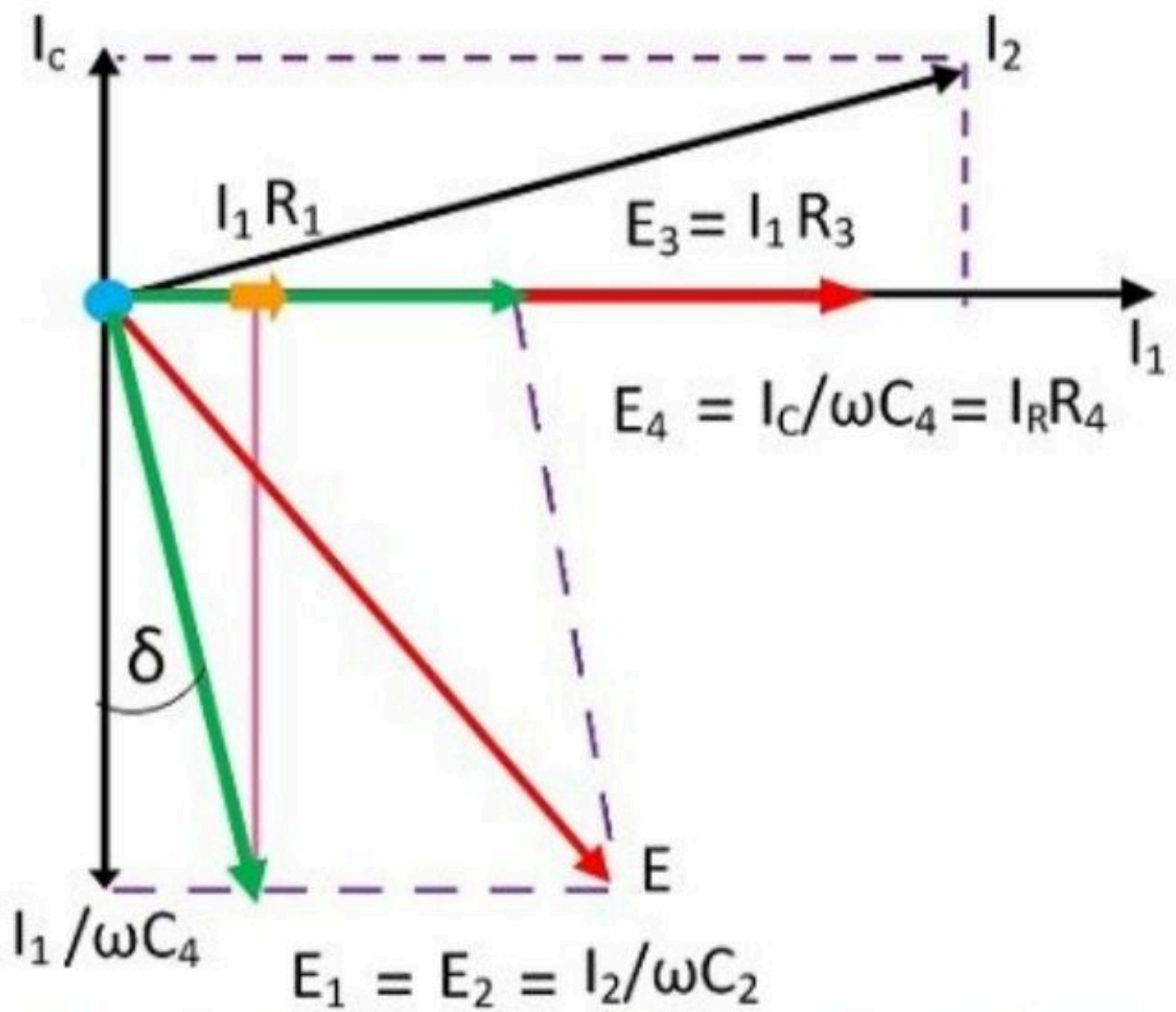
Equating the real and imaginary equations, we get

$$r_1 = \frac{R_3 C_4}{C_2} \dots \dots \dots equ(1)$$

$$C_1 = C_2 \left(R_4 / R_3 \right) \dots \dots \dots equ(2)$$

The equation (1) and (2) are the balanced equation, and it is free from the frequency.

The dissipation factor obtains with the help of the phasor diagram. The dissipation factor determines the rate of loss of energy that occurs because of the oscillations of the electrical and mechanical instrument.



Phasor Diagram of Low Voltage Schering Bridge

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$$D_1 = \tan \delta = \omega C_1 r_1 = \omega (C_1 r_1) = \omega (C_2 R_4 / R_3) \times (R_3 C_4 / C_2)$$

$$D_1 = \omega C_4 R_4$$

By the help of the above equation, we can calculate the value of $\tan \delta$ which is the dissipation factor of the Schering bridge.

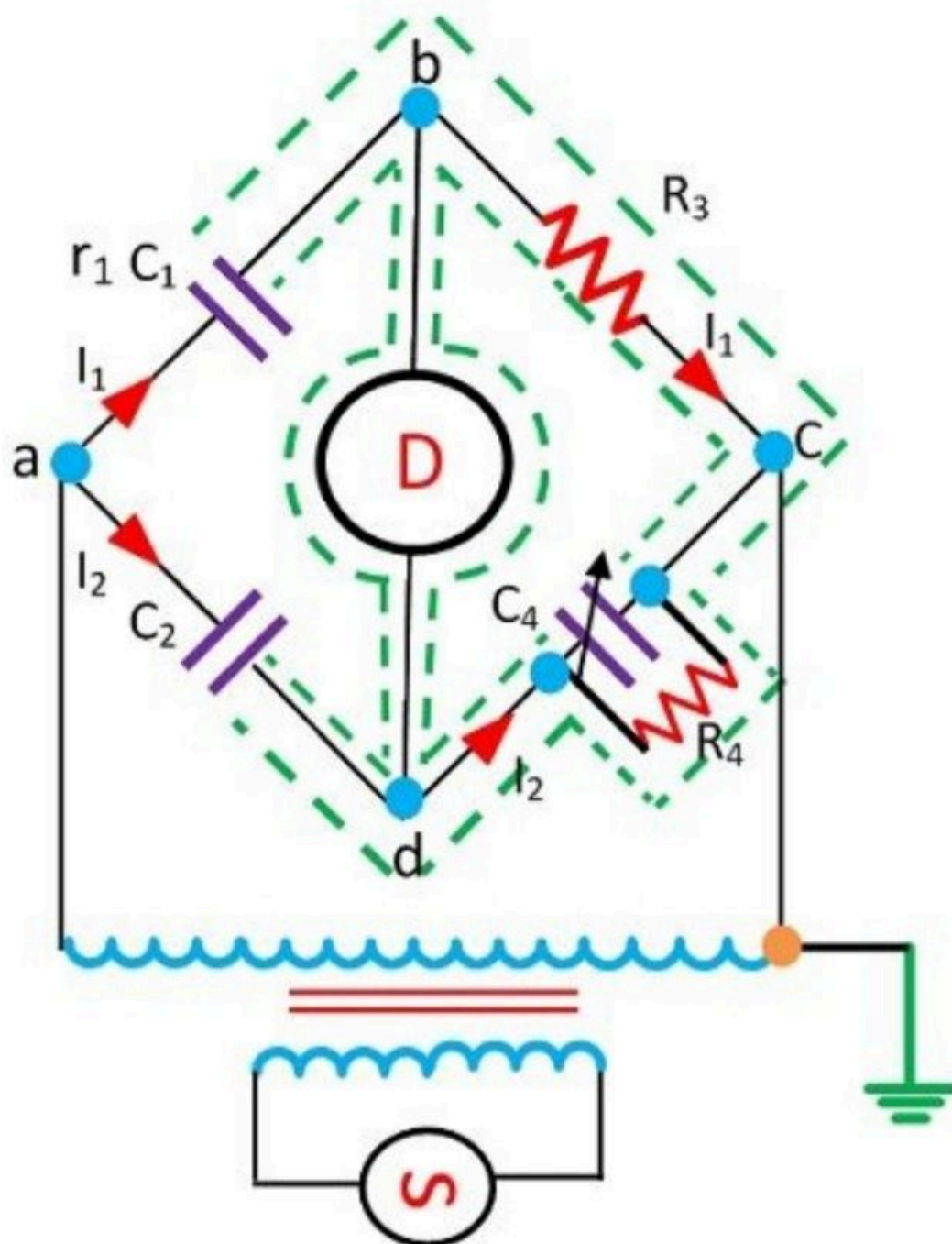
Advantages of Schering Bridge

The following are the advantages of the Schering bridge.

1. Balance equations are free from frequency.
2. The arrangement of the bridge is less costly as compared to the other bridges.

High Voltage Schering Voltage

The low voltage Schering bridge has several disadvantages, and because of this reason, the high voltage and high frequency are required for measuring the small capacitance. The circuit diagram of the Schering bridge is shown in the figure below.



The following are the features of the Schering Bridge.

1. The high voltage supply obtains from the operational amplifier. The **vibration galvanometer** use as a detector for the bridge.
2. The high voltage working capacitors are placed in the arms **ab and ad**. The impedance of the arm **ab and ad** are very high as compared to the arm **bc and cd**. The term impedance means the opposition offered by the circuit in the flow of current. The point c is earthed.
3. The impedance of the arm **ab and ad** is kept high so that the high supply will not affect the potential across the arm **bc and cd**. The potential across the detector is also kept low.

4. The spark gap sets places on each arm for preventing the dangerous high voltage which appears across the arm **bc and dc** because of the breakdown of the high voltage capacitors.
5. The power loss is very small in the arms **ab and ad** because of the high impedance of arms **ab and ad**.

Measurement of Relative Permeability with Schering Bridge

The Schering bridge use for measuring the low permeability of the dielectric material. The relative permeability shows the ability of the material for the formation of the magnetic field. It is calculated with the help of the capacitance and dimension of the electrodes.

The relative permeability of the parallel plate arrangement is expressed as

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

C_s – the measured value of capacitance by considering the specimen as a dielectric.

d – Spacing between electrodes

A – Effective area of electrodes.

ϵ_0 – permittivity of free space

The other method for calculating the relative permittivity of the specimen is explained below.

The relative permittivity of the specimen depends on the thickness of the specimen and the spacing between them and the electrode.

Let, C – capacitance between the electrode and specimen

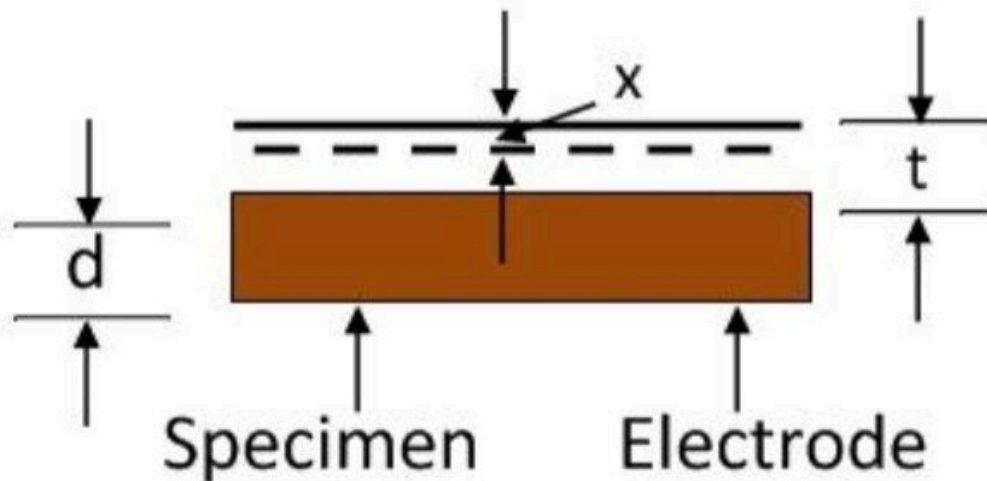
A – area of electrodes

d – the thickness of the specimen

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t – the gap between specimen and electrode.

x – reduction in separation between the specimen and electrode.



Measurement of Relative Permeability

Circuit Globe

C_s – capacitance of specimen.

C_0 – Capacitance between the space because of specimen and electrode.

C – effective capacitance of C_s and C_0 .

The capacitance between the specimen and the electrode is expressed as

$$C = \frac{C_s C_0}{C_s + C_0} = \frac{\left(\frac{\epsilon_r \epsilon_0 A}{d}\right) \cdot \left(\frac{\epsilon_0 A}{t}\right)}{\left(\frac{\epsilon_r \epsilon_0 A}{d}\right) + \left(\frac{\epsilon_0 A}{t}\right)} = \frac{\epsilon_r \epsilon_0 A}{\epsilon_r t + d}$$

When we reduce the specimen and the spacing is again adjusted for obtaining the same value of capacitance, the expression for reducing specimen is.

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

$$\frac{\epsilon_0 A v}{1 + d - x} = \frac{\epsilon_r \epsilon_0 A}{\epsilon_r t + d}$$

$$\epsilon_r = \frac{d}{d - x}$$

The insulating properties of electrical cables and equipment can also be measured through the Schering bridge.