

Aim ➡ To study the series and parallel connections of Capacitors.

Equipment Required ➡

Power supply, capacitors, breadboard, connecting wires, multimeter.

Theory ➡

Capacitors are passive electrical components that store electrical energy in the form of an electric field between their plates. They are used in various applications such as filtering, energy storage, and signal coupling. Understanding the behavior of capacitors in different configurations is essential for designing efficient electronic circuits.

In a series connection, capacitors are connected end-to-end, and the total capacitance decreases as more capacitors are added. The formula for total capacitance [C_T] in a series circuit is given by:

$$\frac{1}{C_T} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + \cdots + \frac{1}{C_n}$$

In this case, the charge [Q] stored on each capacitor is the same, but the voltage drop [V] across each capacitor can vary depending on its capacitance value, as described by:

$$V = \frac{Q}{C}$$

The total voltage supplied by the power source is the sum of the voltage drops across each capacitor:

$$V_T = V_1 + V_2 + V_3 + \cdots + V_n$$

In a parallel connection, capacitors are connected across the same voltage source and the total capacitance increases. The formula for total capacitance [C_T] in a parallel circuit is:

$$C_T = C_1 + C_2 + C_3 + \cdots + C_n$$

In this configuration, the voltage [V] across each capacitor is the same, while the total charge [Q_T] stored is the sum of the individual charges on each capacitor:

$$Q_T = Q_1 + Q_2 + Q_3 + \cdots + Q_n$$

The relationship between voltage and charge in each branch is governed by the equation:

$$Q_n = C_n \times V$$

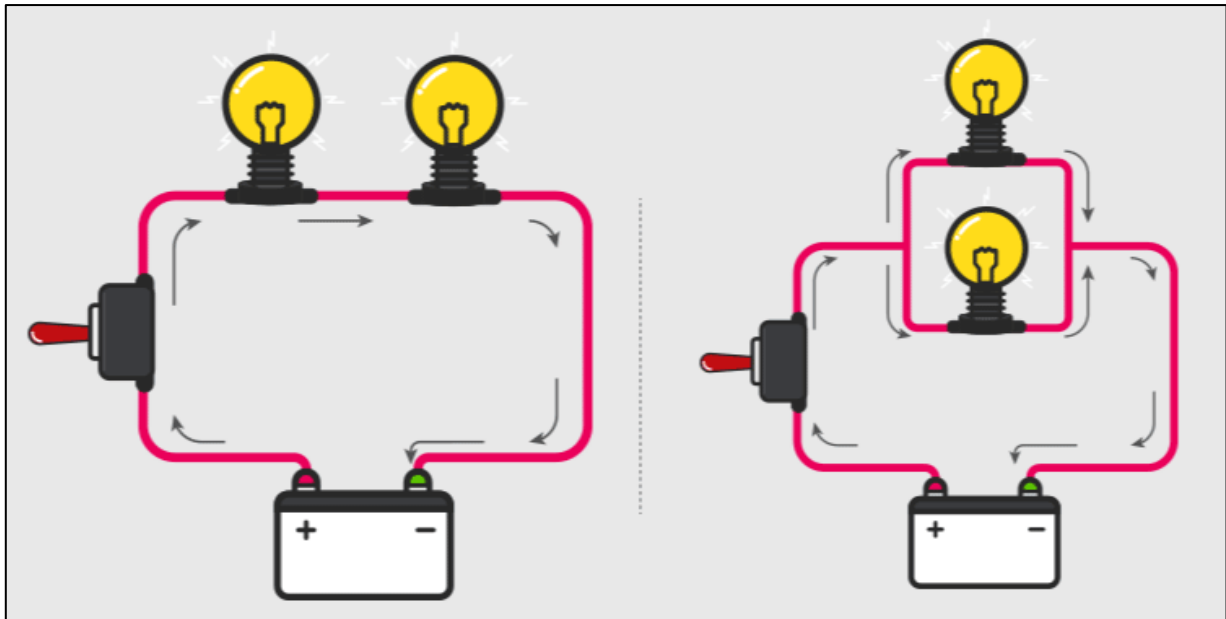


Fig. i) Series Connection of C

Fig. ii) Parallel Connection of C

This distinction between series and parallel connections is important in circuit design. Series capacitors are used when higher voltage handling is required, while parallel capacitors are used to increase the total capacitance and store more charge. Understanding these principles aids in effective design and optimization of electrical circuits.

Procedure ⇄

1. Place the breadboard on a flat surface.
2. For the series connection, connect the capacitors in a line and attach the power supply across the ends.
3. For the parallel connection, connect one terminal of each capacitor to the positive terminal of the power supply and the other to the negative terminal.
4. Ensure secure connections using jumper wires.
5. Measure the total capacitance with a multimeter for both configurations.
6. Turn on the power supply and record the voltage across the circuit.
7. Calculate the charge using the formula:

$$Q = C \times V$$

Output ⇌

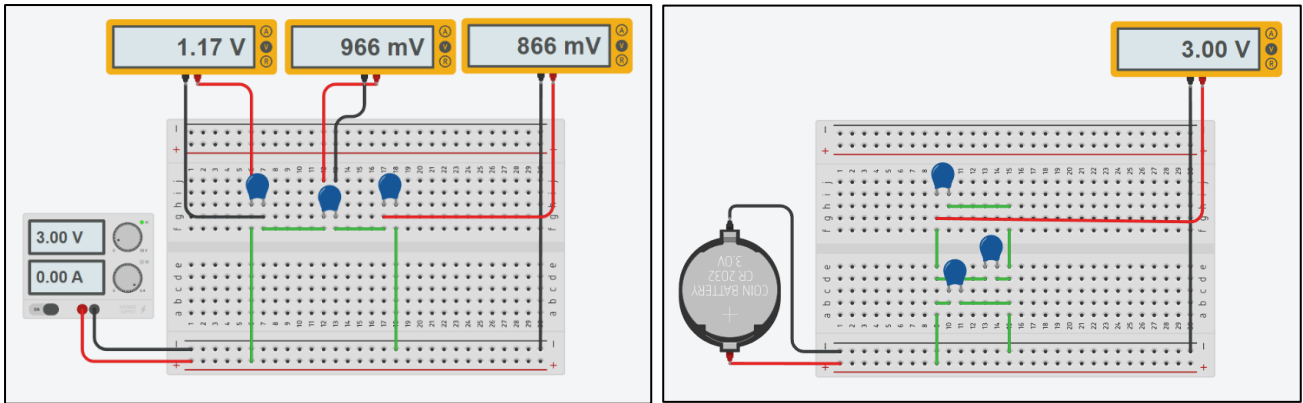


Fig. iii) Series Connection in Tinkercad Fig. iv) Parallel Connection in Tinkercad

Calculation ⇌

Capacitances used – $C_1 = 100nF$, $C_2 = 400nF$, $C_3 = 500nF$

Series Combination ↴

$$\frac{1}{C_S} = \left(\frac{1}{100} + \frac{1}{400} + \frac{1}{500} \right) nF^{-1}$$
$$C_S = 0.69nF$$

Parallel Combination ↴

$$C_P = (100 + 400 + 500)nF$$
$$C_P = 1\mu F$$

Result ⇌

The experiment showed that series connections resulted in a lower total capacitance and equal charge on each capacitor, while parallel connections led to higher total capacitance and equal voltage across each capacitor.

Conclusion ⇌

This experiment successfully demonstrated the principles of series and parallel capacitor connections, illustrating how these configurations affect total capacitance, charge distribution, and voltage drops in a circuit.

Precautions ⇌

- Ensure correct connections to avoid incorrect results or damage to components.

- Do not exceed the voltage rating of the capacitors.
- Use appropriate capacitor values for safe circuit operation.