



## Super capacitors

- What are supercapacitors, and how do they differ from traditional capacitors and batteries?
- How do supercapacitors store energy, and what makes them more efficient for certain applications compared to conventional energy storage systems?
- What are the key advantages and limitations of using supercapacitors in modern technology?
- In what industries or applications are supercapacitors most commonly used, and why?
- How can super capacitors contribute to advancements in renewable energy, electric vehicles, and other future technologies?

A capacitor is pair of two conductors of any shape, which are separated through a small distance or in close proximity and have equal and opposite charge. In other words, a capacitor is a device that stores electric energy. A super capacitor is also a capacitor but its capacitance value is much higher than other capacitors.

Super capacitor is an electrochemical capacitor that has high energy density and better performance efficiency as compared to the common capacitor. The reason why it has the prefix 'super' attached to it. It stores and releases energy by reversible desorption and adsorption of ions at the electrode-electrolyte interface.

Super capacitors are made up of two electrodes, an electrolyte and a porous membrane separator. Nanomaterial-based super capacitors are used to increase the electrode surface area so as to achieve high performance and enhanced capacitance.



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### **Properties of Super capacitors**

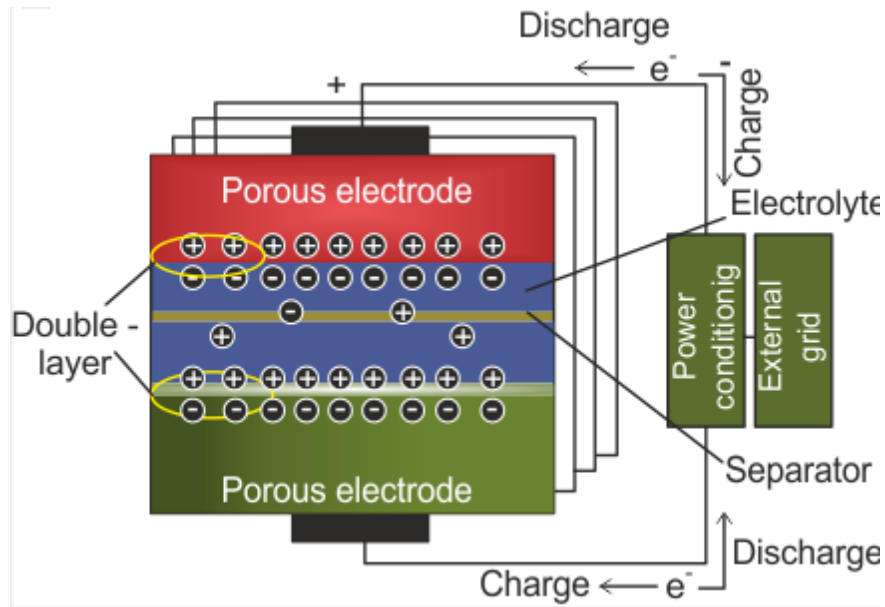
Some properties of super capacitors are listed in the points below:

- Super capacitors have a long cycling time, with high cycle efficiency (84-97%)
- Super capacitors have capacitance ranging from 1mF to >10kF
- Super capacitors have a high energy density of up to 10 Wh/kg
- There is less potential for pollution in super capacitors as no heavy metals are used in their development.
- The charge/discharge time of super capacitors ranges from milliseconds to a few seconds.
- Super capacitors have longer service life of about 10-15 years
- As supercapacitors have higher capacitance with lower voltage limits,

### **Working Principle of Super capacitors**

A super capacitor operates by storing electrical energy between two electrostatic double layers created by the formation of thin charge layers on the electrolyte-electrode interface.

The porous materials or nanomaterial used to cover the metal plates of a super capacitor are typically carbon in the form of activated charcoal. Static electricity, also known as electrostatics, is used to store energy in capacitors. Both positively and negatively charged ions are produced in the electrolyte solution between the two plates of the supercapacitor.



When a voltage is supplied across the super capacitor's plates, one of the plates develops a positive charge, while the other plate develops a negative charge. This attracts the negatively charged ions in the electrolyte to the positively charged plate and the positively charged ions to the negatively charged plate. On the inner surface of both plates, a thin coating of ions is deposited. This results in the production of an electrostatic double layer, which is similar to connecting two capacitors in series. Each charge possesses high capacitance as the distance between both the resultant capacitors is very thin and the area of electrodes is high.

### Advantages of Super capacitors

- High efficiency
- High energy and power density
- High-performance reliability with higher charging rates
- Super capacitors can easily be connected in series like batteries to provide bigger voltages used in power-demanding equipment
- Super capacitors have a high specific power, low resistance which enables them to produce high load currents
- Super capacitors are developed in small sizes and lightweight which makes them easily installed in small areas.



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- Super capacitors have a longer cycling time as compared to the battery and higher service life.

### **Disadvantages of Super capacitors**

- Super capacitors have high self-discharge rates.
- Super capacitors have low voltage limits which demand serial connections to produce high voltage.
- Super capacitors have the highest dielectric absorption of any type of capacitor.
- Full energy spectrum can't be used due to the linear discharge of voltage.

### **Uses of Super capacitors**

Unique storage capability of super capacitors makes them a choice in different fields. Super capacitors are used in hybrid buses in the field of transportation as they combine with the battery to increase battery life and decrease the size.

- Memory devices in laptops, smart phones, tablets etc., are developed using super capacitors. These are also used in LED Flash units.
- Super capacitors are even used in the field of renewable energy such as in wind energy to supply power to the pitch control of blades.
- Super capacitors are consistently being used in other fields such as industry, military, medical, transpiration, music etc.