



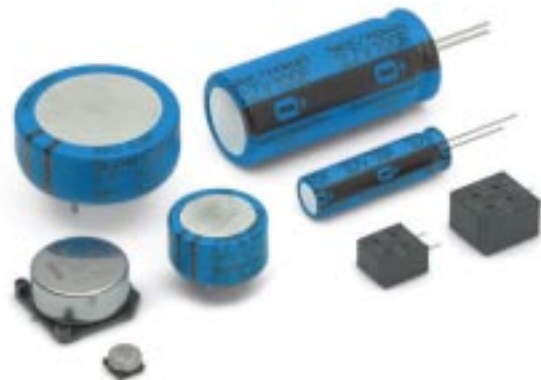
Super capacitor (High capacity, low ESR type)
Outline 1
Outline 2
Features
Application 1
Application 2

Whether by inserting a plug into an electric outlet or by using batteries, a power source is necessary for operating electrical or electronic products.

That is stating a rather obvious fact, now isn't it? However, the fact that a single product has a variety of power sources with different characteristics that are skillfully used in combination is something that is not widely known. Switching power supplies that convert the electricity from an electric outlet to voltages or frequencies appropriate for the various parts, batteries that are light but have large capacities, and capacitors that provide electricity rapidly to chips that operate at ultra-high speeds are examples of the various energy devices that are incorporated in equipment and that perform the functions that are appropriate to the devices. Among these, NEC TOKIN's electric double-layer capacitor, "Super capacitor" supplements the function of batteries, and as a product that maximizes these functions, is used in a wide range of applications from ocean vessels and automobiles to mobile products. The attention-drawing " Super capacitor" is an energy device that is being widely adopted by a variety of fields.



HP series  
Thin type (IT equipment peak assist)



F series / HV series  
(Back-up power supply)



FB series (Basic type)  
Large Capacitance type (Instantaneous  
Large Current Supply) 24V type

An "electric double-layer capacitor" is a capacitor that utilizes the phenomenon called electric double layer whereby electricity is stored where a solid and a liquid come into contact. Concretely, the structure of an electric double-layer capacitor involves two electrodes made by forming active carbon into thin sheets that are separated by a semi-permeable membrane called a separator and placed in an electrolyte solution such as diluted sulfuric acid. The electrodes are subjected to a low voltage (about 0.8 volts) that does not cause electrolysis of electrolyte, this therefore results in ions rapidly being stored on the surface of the active carbon.

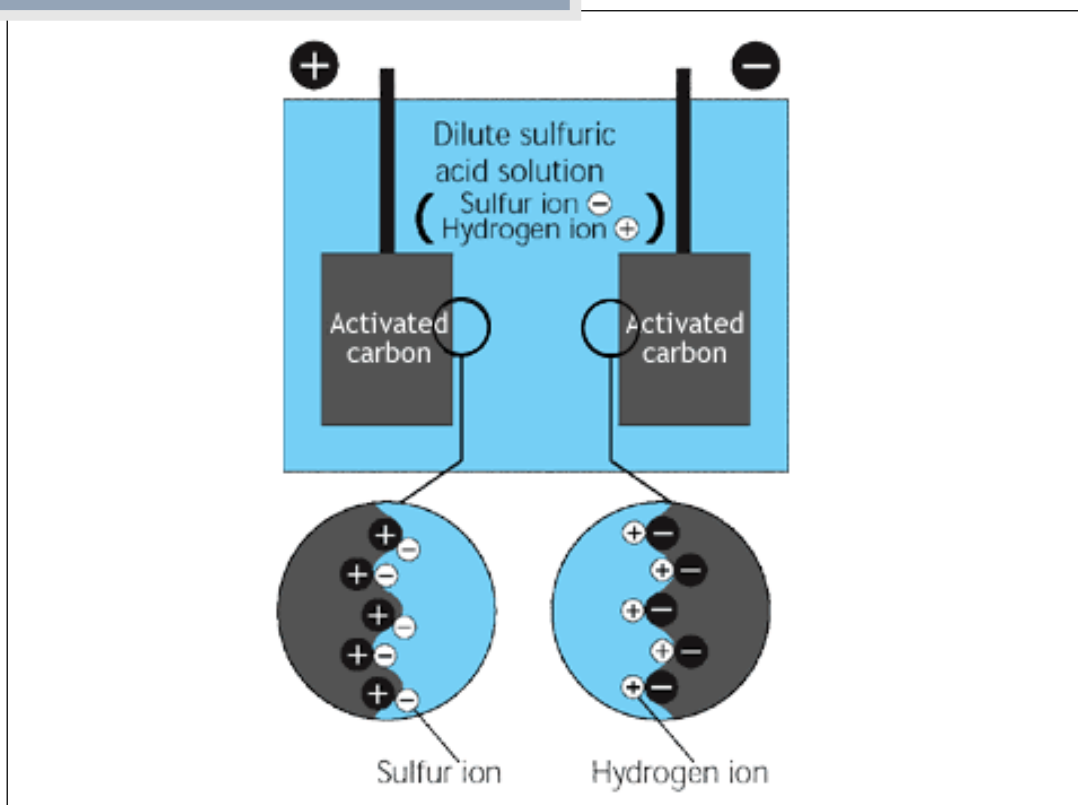
The active carbon has an extremely large surface area of between 1,000 and 2,000 square meters per gram, which allows the absorption of a large number of ions. In fact, the capacity reaches 1 farad, that is, 100 thousand times the capacity of normal capacitors.

Utilizing this principle, "Super capacitor" was developed by NEC more than 20 years ago and is currently used as the backup electric power source for clocks in VCRs and other appliances.

While on the one hand "Super capacitor" has a very large internal resistance and is only capable of allowing currents of between several tens of micro-amperes to 1 milli-ampere to flow, on the other, it exhibits superior characteristics in continued storage of electricity (self-discharge characteristics) and is appropriate for applications in which a discharge time of 100 hours or more is required. As the capacitor recharges when the equipment is plugged into an electric outlet, there is no need for replacement such as in the case of batteries, and for this reason, "Super capacitor" was ideal as a backup electric power source.

However, there had been the great hope that the electric double-layer capacitor, capable of storing a large amount of electricity, would fulfill the more significant and fundamental function of a capacitor, that is, to support instantaneous peak electric current occurrence on equipment. NEC TOKIN have been consistently working on developing "Super capacitor" with reduced internal resistance in order to address such potential capability.

### Reaction Principle of Super Capacitor

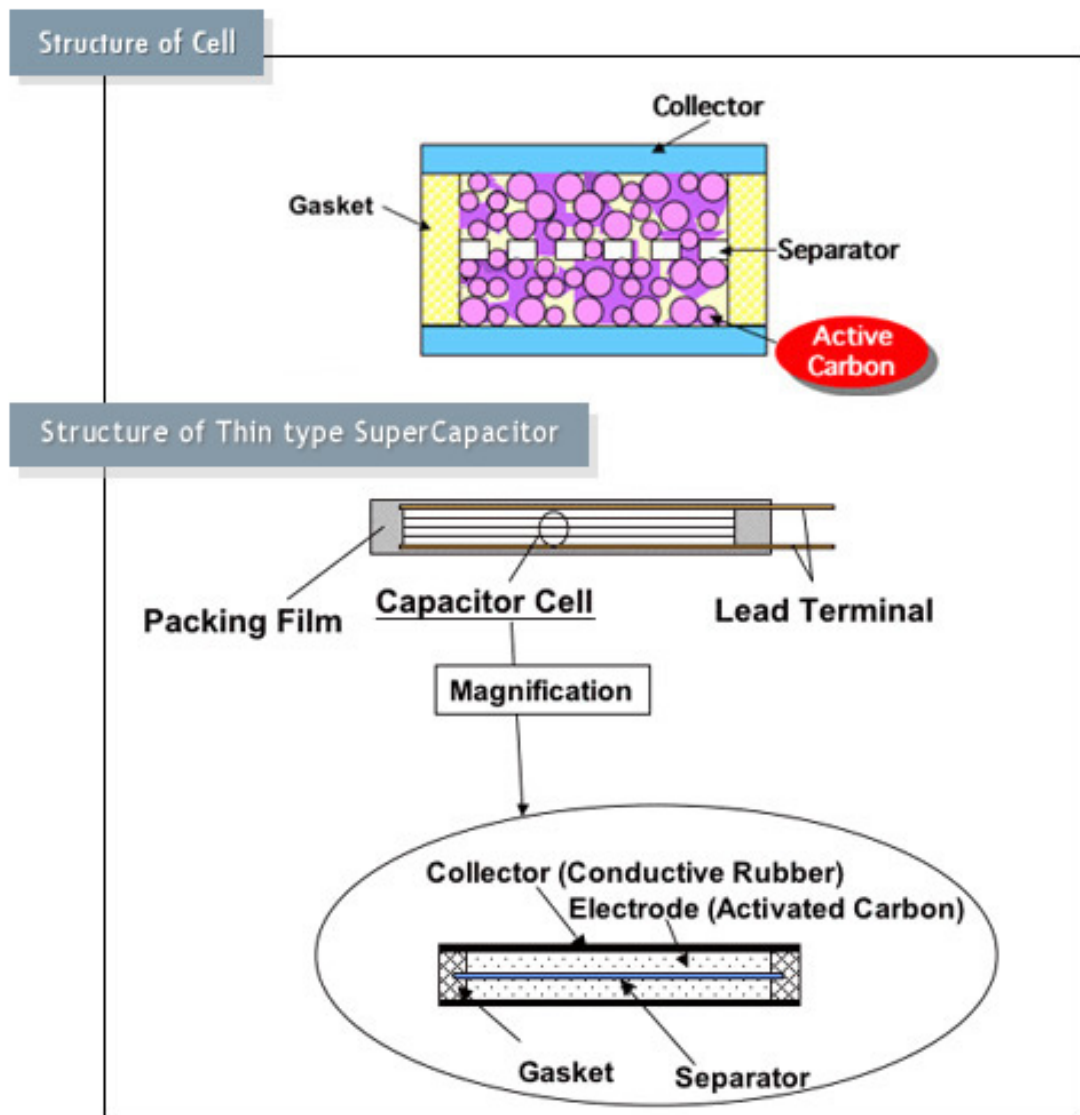


The problem with "Super capacitor" was that the internal resistance was too high. In other words, if this internal resistance could be reduced, the amount of electric current would increase and the scope of applications would also significantly grow.

Through consequent research, it was found that the reason the internal resistance of "Super capacitor" was high had to do with the fact that the active carbon electrode was manufactured in a crimping process. This method was simple and advantageous as a manufacturing process, but detailed analysis revealed that there were numerous gaps between the active carbon particles and that this was the main cause of the resistance.

For this reason, technology to minimize these gaps by the optimum composition of the active carbon particles was developed. Fabricated using this method, "Super capacitor" is capable of storing an even larger capacity of electricity than previous devices. At the same time, "Super capacitor" has reduced internal resistance so that it is capable of exchanging electricity at high speeds in the order of milli-seconds and has been reborn as a completely new energy device.

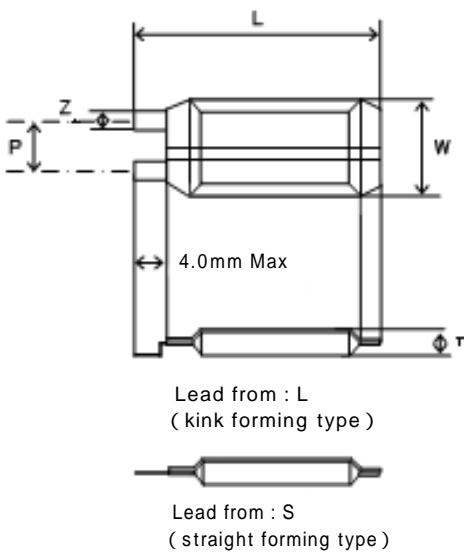
"Super capacitor" differs from batteries that produce electricity through chemical alterations. It is a box for storing electricity, in other words, a capacitor. Accordingly, "Super capacitor" will show very little degradation regardless of the number of times it is charged and discharged, and is capable of being operated in harsh environments without affecting performance. This has brought about great expectation that "Super capacitor" will be used in a variety of applications as a device that supplements situations in which batteries do not adapt well.



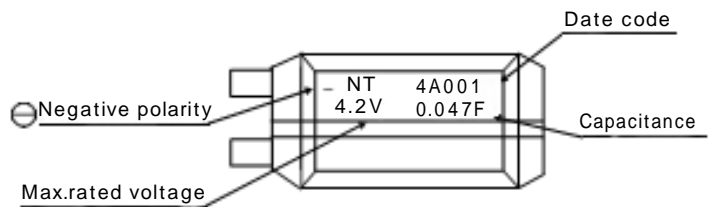
Recently, more progress in application is being made in the area of mobile electronic equipment such as digital cameras. As digital cameras have become more advanced in recent years, the use of rechargeable batteries, such as lithium ion, has increased. However, with rechargeable batteries there is always the worry that they will run out, making them inconvenient for longer trips, as the charger needs to be taken. It would be far more convenient to use dry cell batteries that can be purchased anywhere and "Thin type Super capacitor" enables this. Normally, high performance digital cameras would be able to take a very limited number of photographs using dry cell batteries. This is not because the capacity of the dry cell battery is insufficient but rather that a large electric current instantaneously flows when the liquid crystal display is lit or the zoom or flash functions used, thus leading to a drop in the voltage. The camera's battery warning display judges residual power based on the voltage and if the voltage drops temporarily, it judges that the batteries have run out and forcibly switches the equipment off.

By using the battery and Super capacitor simultaneously, Super capacitor assists the battery in applying enough current when the device requires high current, prevents battery voltage drops, and would allow use of its full capacity. Moreover, the number of cells needed for a camera requiring four, size AA dry cells may be reduced to two. Similarly, as an application that cuts the peak electric current of a battery, in addition to digital cameras, application of "Thin type Super capacitor" is possible in a variety of areas including PDAs, wireless LAN data communications cards, and external hard disk, CD or DVD drives to which electric power can be supplied directly from the USB connectors for personal computers and other such equipment. Moreover, the capabilities of "Thin type Super capacitor" can be exhibited in pet robots or radio-controlled hobby products that require numerous motors.

Dimensions



Markings



Part Number	Max. Rated voltage (Vdc)	Nominal Capacitance (F)	ESR ( at 1kHz ) ( m )	L MAX. (mm)	W MAX. (mm)	T MAX. (mm)	Z (mm)	P (mm)
HPSL0G223ZL	4.2	0.022	300	34	14	2.3	2.5	7.5 ± 0.5
HPSN0G473ZL	4.2	0.047	200	42.5	17	2.3	3.0	10 ± 0.5

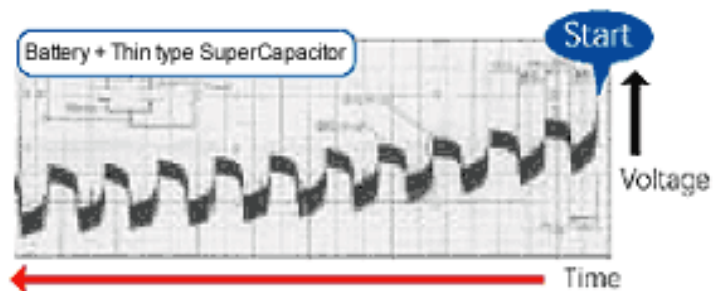
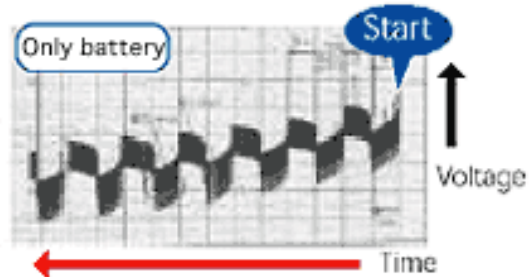
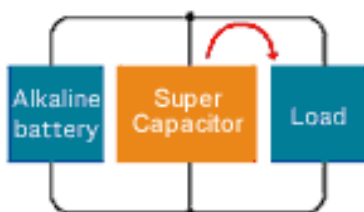


HP series  
Thin type (IT equipment peak assist)

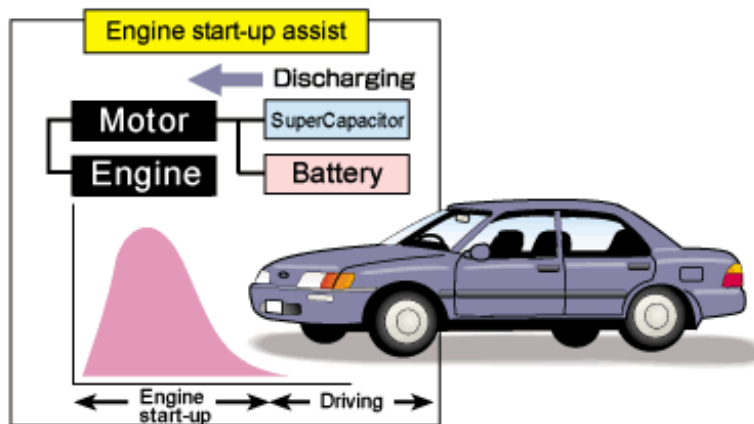
--- An ideal energy solution based on batteries and capacitors. ---

Combining the best capacitor with the battery enhances the efficiency of electric energy, the battery life substantially extending. For example, in systems on which a pulsating load is imposed, such as digital cameras and mobile telephones, a thin-type electric double-layer capacitor, the SuperCapacitor HP series, should be used in combination with the battery because the SuperCapacitor HP series supplies instantaneous energy in large quantities. In this way, systems can work much longer on batteries.

A 1.6 times longer battery working time can be achieved by supplying a current from the Thin type SuperCapacitor instantaneously in a digital still camera when the peak current is necessary (during auto focus or flash operation).

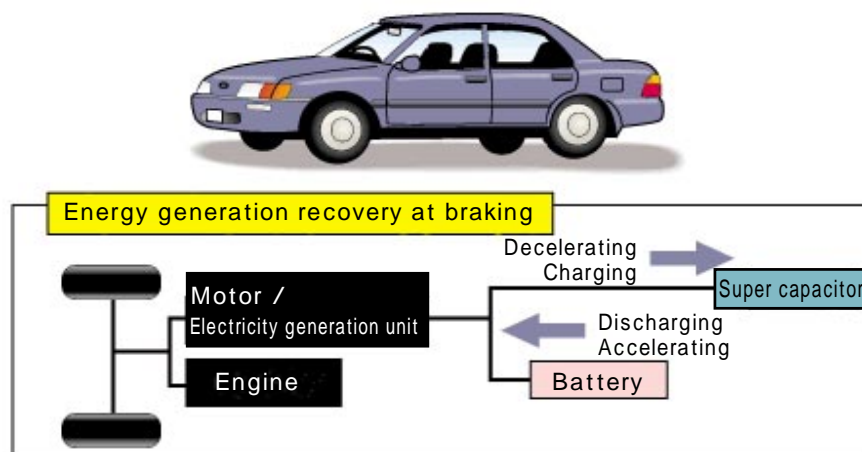


### Automobile Engine Start-up Assist



Supports hard engine start-ups thanks to unlimited charging and discharging  
 In terms of both environmental and energy issues, " idling stop " to stop automobile engines at red lights is attracting worldwide attention. Idling stop forces an automobile engine to stop and start-up approximately 1 million times during the life of the vehicle. To solve this, electricity is accumulated in the Super capacitor from the battery is used to start up the engine.

### Automobile Energy Recovery at Deceleration



Efficient energy accumulation thanks to quick charging in seconds  
 Electric vehicles and hybrid cars, which will become mainstream in the 21st century, are designed to use energy efficiently, and reuse the energy generated and accumulated during automobile deceleration. The time period for this energy generation is very short, meaning that batteries can recover only 30% of the energy, yet Super capacitor can recover approximately 80% of this energy.

## High Power Electric Double-Layer Capacitors      Super capacitor FB series

This is a capacitor with capacitance in F (farad) units. As this capacitor uses the principles of electric double-layer, no chemical reactions and almost no degrading of the electrodes occur. This means that there is no theoretical limit to charging and discharging, and quick charging and discharging can be performed in seconds.



24V type

### Features

- 24V type without balance circuit realized
- Rapid charging and discharging
- Unlimited charging-discharging
- Environment-friendly product
- Wide range of the operating temperature
- Long life
- High shock resistance
- High weatherability

### Applications

- Anti-lock brake system of freight car
- Automotive ECU systems

### Performance (Standard)

Part Number	Max.Rated Voltage (DC)	Nominal Capacitance	Max.ESR (at 1kHz)	Operating Temperature	Dimension (mm)
FB1E505Z	24V	5F	1.0	- 40 to + 85	148(W) x 72(D) x 84(H)