



Cautions for Use of LS Ultracapacitor

Caution! Must read the notice below before using LS Ultracapacitor

1. Circuit Design

▪ Concerning Polarity

It is important to distinguish between the cathode and anode when using LS Ultracapacitor.

When a reverse voltage is applied, it may result in a drastic increase in the leakage current at the electrodes, a drop in capacitance, and an increase in internal resistance, or may cause leakage or product damage at times.

While the user may experience anything out of the ordinary, depending on the time of application of a reverse voltage, voltage, and temperature, the following problems are most likely to happen: 1) heating of the product; 2) distortion or a leak on the product exterior due to a rise in the withstanding voltage; 3) an increase in the leakage current and/or increase in the self-discharge; 4) a sharp increase in internal resistance and/or a decline in the capacity; and 5) the operation of a safety valve.

▪ Working Voltage

The product must be used at or below the rated voltage. Overvoltage may cause distortion of the product exterior or the shortening of product life. Unlike batteries, our Ultracapacitor is not subject to the lower voltage limits. According to customer specifications, the working voltage can be applied from 0V to the rated voltage. The applicable voltage for the LSHC ranges from 1.0V to the rated voltage.

Ultracapacitor may experience an IR drop. Take the IR drop described below into account when designing your product.

▪ IR Drop

In general, once charged, energy storage devices experience a voltage drop due to their internal resistance at the time of discharge. Since Ultracapacitor is often applied to high-output devices, they produce a voltage drop at the time of high-current discharge according to Ohm's law. Hence, voltage drop according to the maximum output or current of a desired application must be taken into consideration when applying an Ultracapacitor. For internal resistance per product, see the Product Specifications.

▪ Ripple Current

See the Specifications for the currents at which the LS Ultracapacitor can be continuously charged and discharged.

Depending upon the desired application, higher currents may be required or operating profiles may vary. We can offer a technical argument regarding the impact that the current and charge/discharge profile the user needs to design their product have upon product life. As well, if a ripple current higher than the maximum rated limit is frequently applied, it may result in the heating of the product due to the effect of high-current charge/discharge. Since such event can affect the product life, it is recommended not to use the product if a ripple current higher than the maximum current occurs. Under special circumstances where it is unavoidable to use the product despite a ripple current, please contact us.

▪ Direct Connection

Direct connection may cause a voltage imbalance between devices. When modules in direct connection under unbalanced voltage are charged, one or two of them may experience overvoltage. Since overvoltage can lead to the shortening of the life cycle and product damage, perform voltage balancing according to the characteristics of each type of Ultracapacitor. Voltage balancing can be divided into passive balance in which balancing resistance is connected parallel, considering the leakage current of the product, and active balance, which allows operation at a higher voltage than a certain level. Our LSUC series allow both active and passive balance while for LSHC series, only active balance is available.

LSUC Product Line

With regard to direct connection, it is recommended to connect devices as soon as possible after discharging them completely by, for example, short-circuiting them for a certain time period. For the LSUC series, voltage is supposed to return to 0.4V although the products are completely discharged. Since the time required for such return varies depending on the product, it is recommended to connect the products within a given time period.

LSHC Product Line

LSHC is able to maintain voltage at 1V ± 0.1V after 1V discharge. Voltage slightly varies depending on the discharge current. It is recommended to assemble the product within a certain time period after discharging it under the uniform conditions of current.

Since LS Ultracapacitors are distributed within the specified capacity range according to the Specifications, individual products differ in capacity. For example, if products A, B, and C, whose capacity is 100F, 110F, and 90F, respectively, are directly connected and constant-current charged/discharged, according to the formula $\Delta V(\text{Voltage change}) = \text{Current} * \text{Time} / \text{Capacity}$, they all show different rates of voltage change, which in turn results in voltage deviation. Therefore, it is recommended to use similar devices in capacity for direct connection.

2. Product Mounting

The following must be observed when mounting the product.

- (1) Do not pull at the external terminals (lead, terminal)
- (2) Use the utmost caution not to expose it to a shock or cause scratches on the surface.
- (3) Do not drop the product or expose it to shock.
- (4) Do not let the two ends of the terminal touch any conductive material.



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(5) Avoid repeated rapid charge/discharge. It may cause overheating, a decline in the capacity, an increase in internal resistance, or a bad effect upon the module life cycle.

Do NOT under any circumstances dismantle the product!!

Depending on the terminal shape, the type of connection to cells or devices may vary as follows:

Terminal Shape	Leadwire, Snap-in, Lug
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Do not directly connect the product to other devices; mount it on the PCB before connection.

1. Hand Soldering (Manual Soldering)
 - Temperature of the soldering iron: 350 ± 10 °C
 - Soldering time: within 3 seconds
2. Wave Soldering (Automatic Soldering Using a Conveyor)
 - Temperature of the solder pot: 265 °C
 - Conveyor speed: 3.0 cm/sec
 - Other cautions: Before wave soldering, the LSUC must be completely discharged.
For the LSHC, hand soldering is recommended.

After soldering, use an exclusive cleaning agent for cleaning.

Terminal Shape	Screw
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To minimize contact resistance, which may occur at the clamping area, the following must be observed.

Each cell must be connected using a busbar.

Busbar specifications may differ depending on the product size and the operating conditions. We recommend you to use the busbars and bolts provided by us. If you fail to receive busbars from us, contact us for the busbar specifications.

When clamping a busbar, make sure that it does not cover the safety valve. Use M6 bolts for 3000F(LSUC002R8P3000FEA) and 5400F(LSHC002R5P 5400FEA), and M5 bolts for 1000F, 1700F and 1800F(LSUC002R8P1000FEA, LSUC002R8P1700FEA, LSHC002R5P1800FEA). When tightening bolts, comply with the clamping torque recommended by the bolt supplier, according to the bolt material and shape.

To minimize contact resistance and to prevent accidents, such as fire, due to foreign substances, keep the clamping area clean. To prevent the loosening of screws, it is recommended to apply adhesive (e.g., Threadlocker) to the ridges of the bolts before clamping.



(E.g.) Image of Busbar Clamping

3. Storage and Operating Conditions

LS Ultracapacitor has an element containing organic electrolyte sealed in an aluminum case.

For safe use, avoid storing or using the product under the following conditions:

- (1) Exposure to direct sunlight
 - (2) Areas under the direct influence of water, salty water or oil.
 - (3) Areas near a high-temperature heating element or with high humidity.
 - Recommended storage temperature/humidity: Indoor (temperature range: $5 \sim 30$ °C, humidity: 45~70%RH)
 - There must be no dew condensation due to temperature differences.
 - (4) Areas where the product is susceptible to pollution due to acid or alkaline chemicals.
 - (5) Environment where the product is vulnerable to chemically active gas.
 - (6) Environment where the product is directly exposed to reach of children.
 - (7) Environment where excessive vibration or impact exists.
- ** Keep the product as packaged as possible during storage.

4. Disposal

LS Ultracapacitor is made using active carbon, metals, paper, and organic electrolytes, and do not contain environmentally harmful substances, such as heavy metals. However, the standards for disposal of such devices may vary depending upon the local area. Therefore, please consult the industrial disposal expert in your local area before disposing of this product. All packaging materials are recyclable.

5. In the Event of an Emergency

If any of the following occurs, immediately unplug the product and contact us as detailed below.

- If a spark occurs around the terminal while a high current is applied
- If the product gets swollen or liquid flows from the product
- If the product gets overheated at a higher temperature than the rated limit.
- If gas or strange odor comes out of the product



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- If the contracted packaging material (PET) of the product gets seriously damaged or catches fire.

If necessary, unplug the application first, and separate the product while wearing voltage-/heat-/chemical-resistant gloves. When separating the product, use the utmost caution to prevent a short circuit of the terminal. Under normal conditions, a sudden increase in IR drops or exterior distortion or leak does not occur; in case of any changes in the properties or exterior, please contact us as detailed below.

6. Product Life Cycle

In general, Ultracapacitor has a limited life.

1. The life of Ultracapacitors is greatly affected by operating temperature; the lower the operating temperature, the longer the product life. Therefore, we recommend the user to avoid installing the product around the heating section. Aside from the ambient temperature, the heating of the product due to repeated high-current charge-discharge can also have an impact upon the life cycle. Therefore, it is recommended to check the area for installation and the amount of heat generated according to the operating conditions.

2. If the product is used at higher temperatures than the upper limit indicated in the Specifications, not only does it shorten the life cycle, but it also causes leakage and product damage due to an increase in the vapor pressure of an electrolyte and due to a rise in withstanding voltage following electrical-chemical reactions.

If you have any questions regarding the operating conditions and the product life cycle, please contact us.

7. Quality

LS Ultracapacitors are produced and distributed in accordance with the international standards on quality control. All manufacturing processes are conducted in Korea-based LS Plant, which achieved the certifications listed below, and the company is doing the best it can to provide the best quality and satisfy its customers.

Quality Standard : ISO/TS16949:2009

Product Safety : UL

Environmental Standard : ISO14001:2004

Safety/Health : OHSAS18001:2007

Location of the Plant : Anyang Plant in Republic of Korea



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