LS Ultracapacitor
New-generation Energy Storage Devices with Great Power and Great Reliability
Leading Solution

LS Mtron, LS Cable & System, LSIS,
LS-Nikko Copper, Gaon Cable, E1 and Yesco
Vision Statement
In order to become a leader in the competitive global market LG has been divided into three business groups based upon their core competencies, Industrial Electric-Electronic Energy & Materials (LS), Electronic & Chemical (LG), and Energy & Retail (GS).

INNOVATIVE TECHNOLOGY PARTNER - LS Mtron
LS Mtron’s mission is to grow into a company that provides market leading solutions while developing a workplace where its employee can achieve their dreams. All employees of LS Mtron stand behind the vision of becoming an Innovative Technology Partner and work tirelessly to make LS Mtron a world-class company.

LS Mtron will secure world-class core technologies to find and implement the most efficient solutions based on a market knowledge that can meet the challenges of our today’s markets. We will work hand-in-hand with our customers in order to grow into a global leader.

Business of LS Mtron
- Component
- Ultracapacitor
- Electronic Parts
  - Connectors / Antenna’s
- Machinery
  - Tractor
  - Injection Molding Machine
  - Track Shoes
Overview

LS Ultracapacitor energy storage devices are positioned between conventional electrolytic capacitors and rechargeable batteries. LS Ultra capacitors feature high power, high energy, reliability and long life which enables use in a variety of applications such as back-up power, auxiliary power, instantaneous power compensation and peak power compensation.

- Rated voltage: up to 3.0V
- High power performance (vs. Battery)
- High energy performance (vs. Conventional electrolytic capacitor)
- Environmentally friendly
- Maintenance-free
- Wide operating temperature range (-40°C ~ +65°C)
Introduction to LS Ultracapacitor Technology

**Operating Principle**
Ultracapacitors store energy based on electrostatic charges on opposite electrode surface of the electric double layer which is formed between the electrodes and the electrolyte. Randomly distributed ions in the electrolyte move toward the electrode surface of opposite polarity under electric field when charged. It is a purely physical phenomenon rather than a chemical reaction and is a highly reversible process. This results in a high power, high cycle life, long shelf life and maintenance-free product.

**Structure**
An Ultracapacitor consists of two electrodes immersed in an electrolyte and a separator which prevents the charge from moving between two electrodes of opposite polarity.

LS Mtron provides optimal package design to provide the best in performance and reliability.
**High Energy & High Power**

Ultracapacitors are unique energy storage devices offering high power and high energy simultaneously, compared with conventional electrolytic capacitors and batteries. The high energy stored by Ultracapacitors in comparison to conventional electrolytic capacitors is derived from activated carbon electrode material having the extremely high surface area and the short distance of charge separation created by the opposite charges in the interface between electrode and electrolyte.

High power, long shelf and cycle life performance of Ultracapacitors originate in the energy storage mechanism differing from batteries. With batteries, energy is stored and released via chemical reaction inside electrode material that causes degradation of the entire system. On the other hand, Ultracapacitors use physical charge separation phenomena between the charge on an electrode and ions in electrolyte at the interface. Since the charge and discharge processes are purely physical and highly reversible, Ultracapacitors can release energy much faster and with more power compared to batteries which rely on slow chemical reactions and can be cycled hundreds of thousands of times without significant effect on performance.

**Charge & Discharge**

Ultracapacitors possess different charge and discharge characteristics compared with rechargeable batteries. Batteries have a voltage plateau region but Ultracapacitors have a linear relationship with voltage during charge and discharge. This linear relationship with voltage can change to constant voltage by simply utilizing a DC-DC converter. The amount of energy stored in an Ultracapacitor can be easily calculated by measuring voltage.

**Formulas for calculating energy in a capacitor**

The different units used between Ultracapacitors (Farad) and batteries (Ampere hour) can be confusing to users when adopting Ultracapacitors in their system. The amount of energy stored in an Ultracapacitor can be easily calculated by using the following equation.

\[
\text{Energy (Joule)} = \frac{1}{2} \times \text{Capacitance (Farad)} \times \text{Voltage}^2 \quad \text{(Volt)}
\]

This can be converted from Farad for Ultracapacitors to Watt hour unit which is normally used for conventional rechargeable batteries.

\[
\text{Energy (Watt hour)} = \frac{\text{Energy (Joule)}}{3600} \quad \text{(sec)}
\]

LS Mtron recommends discharging Ultracapacitors from 100% of their rated voltage to 50% of their rated voltage in order to deliver 75% of their total energy.
### Specifications_2.7V

<table>
<thead>
<tr>
<th>Series</th>
<th>Part No.</th>
<th>Capacitance</th>
<th>Rated Voltage</th>
<th>Max. ESR (DC)</th>
<th>Max. Current (Non-repeated)</th>
<th>Leakage Current</th>
<th>Max. Stored Energy</th>
<th>Weight</th>
<th>Operating Temperature Range</th>
<th>Type</th>
<th>Dimension</th>
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<tr>
<td>Radial Type</td>
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<td>3F</td>
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> Projected life time or cycle life time are varied based on cell type. Data sheet for each product can be downloaded on [www.ultracapacitor.co.kr](http://www.ultracapacitor.co.kr)

### Specifications_2.8V

<table>
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<th>Series</th>
<th>Part No.</th>
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<th>Max. Current (Non-repeated)</th>
<th>Leakage Current</th>
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<th>Operating Temperature Range</th>
<th>Type</th>
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### Specifications_3.0V

<table>
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<tr>
<th>Series</th>
<th>Part No.</th>
<th>Capacitance</th>
<th>Rated Voltage</th>
<th>Max. ESR (DC)</th>
<th>Max. Current (Non-repeated)</th>
<th>Leakage Current</th>
<th>Max. Stored Energy</th>
<th>Weight</th>
<th>Operating Temperature Range</th>
<th>Type</th>
<th>Dimension</th>
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### Specifications_Cylindrical

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<th>Rated Voltage</th>
<th>Max. ESR (DC)</th>
<th>Max. Current Non-repeated (Calculated)</th>
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<th>Max. Stored Energy</th>
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<th>Operating Temperature Range</th>
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<td>LSUC 002R7C 0650F EA</td>
<td>650F</td>
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<td>LSUC 002R7C 1200F EA</td>
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<td>LSUC 002R7C 3000F EA</td>
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</table>

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### Products

- **Radial Terminal Type**
  - Radial (9F ~ 50F)
  - Snap-in (100F ~ 120F)
  - Lug (120F ~ 600F)
  - Snap-in (100F, 120F, 350F ~ 600F)

- **Lug & Snap-in Terminal Type**
  - Lug (320F ~ 600F)

- **Cylindrical Terminal Type**
  - Short Screw (ST01)
  - Weldable (WT01)
  - Long Screw (LT01) w/M16 Terminal
  - Long Screw (LT02) w/M12 Terminal

- **2.8/3.0V Lug & Snap-in Type Cell**

- **Cylindrical Type Cell**

### Cell/Module Part No. Rule

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<tr>
<th>LS</th>
<th>C</th>
<th>R</th>
<th>P</th>
<th>F</th>
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<td>Cell Type (Prismatic)</td>
<td>Voltage</td>
<td>Cell Type (Radial)</td>
<td>Capacitance</td>
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<td>Cell Type (Lug)</td>
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</table>
LS Ultracapacitor Modules provide the optimal solution for high voltage and current requirements by connecting Ultracapacitor unit cells in series. Higher voltage and capacitance modules can be built simply by connecting the modules. Low internal resistance and high working voltage features of LS Mtron modules maximize the available energy while keeping maintenance free, high reliability and wide operating temperature features of LS Ultracapacitor unit cell.

Features
- Low Internal Resistance
- Balancing and Overvoltage Protection
- Easy Build-up Design for High Voltage Module
- Efficient Heat Transfer to Outside
- Pressure / Moisture Control

LS Ultracapacitor modules are suitable energy storage systems for a wide variety of applications.

### Specifications – Busbar Type

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<tbody>
<tr>
<td>LSUM 016R8L 008F EA</td>
<td>58F</td>
<td>16.8V</td>
<td>22mΩ</td>
<td>&lt;11mA</td>
<td>3.2W/kg</td>
<td>0.7kg</td>
<td>Active or Passive</td>
<td>-</td>
<td>-40 ~ 65°C</td>
<td>L245 x W47 x H16.6mm</td>
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</table>
| LSUM 016R8L 005F EA | 15.5F       | 162.4V        | 110mΩ    | <32mA                              | 3.0W/kg             | 18.5kg         | Passive          | Temperature (PTC) / Over Voltage | -40 ~ 65°C      | L684 x W202 x H16.35mm 
| LSUM 016R8L 0005F EA | 5.8F        | 166V          | 240mΩ    | <25mA                              | 3.5W/kg             | 6.5kg          | Passive          | Temperature (NTC) / Half Voltage Terminal | -40 ~ 65°C      | L235 x W367 x H79mm     |
| LSUM 038R8L 000F EA | 2.5F        | 380.8V        | 660mΩ    | <12mA                              | 2.7W/kg             | 18.4kg         | Passive          | Temperature (PTC) / Over Voltage | -40 ~ 65°C      | L750 x W191 x H16.3mm     |

- Leakage Current (1) can be changed by Balancing method
- NTC Thermistor & Group voltage monitoring via CAN2.0B
- Customized module can be supplied under the customer’s requirement

### Specifications – PCB Type

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<td>162.4V</td>
<td>110mΩ</td>
<td>&lt;32mA</td>
<td>3.0W/kg</td>
<td>18.5kg</td>
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<td>Temperature (PTC) / Over Voltage</td>
<td>-40 ~ 65°C</td>
<td>L684 x W202 x H16.35mm</td>
<td></td>
</tr>
<tr>
<td>LSUM 016R8C 0005F EA</td>
<td>5.8F</td>
<td>166V</td>
<td>240mΩ</td>
<td>&lt;25mA</td>
<td>3.5W/kg</td>
<td>6.5kg</td>
<td>Passive</td>
<td>Temperature (NTC) / Half Voltage Terminal</td>
<td>-40 ~ 65°C</td>
<td>L235 x W367 x H79mm</td>
<td></td>
</tr>
<tr>
<td>LSUM 016R8C 000F EA</td>
<td>2.5F</td>
<td>380.8V</td>
<td>660mΩ</td>
<td>&lt;12mA</td>
<td>2.7W/kg</td>
<td>18.4kg</td>
<td>Passive</td>
<td>Temperature (PTC) / Over Voltage</td>
<td>-40 ~ 65°C</td>
<td>L750 x W191 x H16.3mm</td>
<td></td>
</tr>
</tbody>
</table>

- Leakage Current (1) can be changed by Balancing method
- NTC Thermistor & Group voltage monitoring via CAN2.0B
- Customized module can be supplied under the customer’s requirement

### Specifications – Busbar Type

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>LSUM 016R8C 0250F EA</td>
<td>2.5F</td>
<td>380.8V</td>
<td>650mΩ</td>
<td>&lt;11mA</td>
<td>2.7W/kg</td>
<td>18.4kg</td>
<td>Passive</td>
<td>-90 ~ 65°C</td>
<td>L750 x W191 x H16.3mm</td>
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<tr>
<td>LSUM 016R8C 0166F EA</td>
<td>15.5F</td>
<td>162.4V</td>
<td>110mΩ</td>
<td>&lt;32mA</td>
<td>3.0W/kg</td>
<td>18.5kg</td>
<td>Passive</td>
<td>Temperature (PTC) / Over Voltage</td>
<td>-40 ~ 65°C</td>
<td>L684 x W202 x H16.35mm</td>
<td></td>
</tr>
<tr>
<td>LSUM 016R8C 0005F EA</td>
<td>5.8F</td>
<td>166V</td>
<td>240mΩ</td>
<td>&lt;25mA</td>
<td>3.5W/kg</td>
<td>6.5kg</td>
<td>Passive</td>
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- Leakage Current (1) can be changed by Balancing method
- NTC Thermistor & Group voltage monitoring via CAN2.0B
- Customized module can be supplied under the customer’s requirement
Markets for LS Ultracapacitors

**HEV (Hybrid Electric Vehicle)**
- Auxiliary power
  - Recapture braking energy and compensate peak power load
  - Increase energy efficiency of vehicle
- Emergency backup power for brake
  - Increase reliability of safety system

**Power Quality Solution (UPS)**
- Instantaneous power compensation
  - Suitable for short time backup (~30 sec)
  - Fast reacting time could prevent voltage sag
- Increase power quality for delicate process

**FCEV (Fuel Cell Electric Vehicle)**
- Output load compensation for fuel cell
  - Provide peak power compensation
  - (Fuel cell has constant power performance)

**Locomotives**
- Auxiliary power
  - Regenerate energy while braking
  - Increase energy efficiency

**Hybrid Harbor Crane**
- Auxiliary power
  - Regenerate the energy while lowering the container
  - Provide output load compensation during lifting container
  - Reduce size of ICE
  - Increase energy efficiency of crane

**Photovoltaic & Solar light**
- Energy storage
  - Photovoltaic
    - Provide energy for motor used in heliostats
  - Solar light
    - Store energy generated from the sun light during daytime
    - Provide energy for light during night time
    - Increase service life of solar light product

**Wind Turbine**
- Emergency backup power
  - Increase emergency power for pitch system

**Hybrid Construction & Distribution Equipment**
- Auxiliary power
  - Recapture the energy from equipment operation
  - Excavator: Boom movement, Upper part rotation etc.
  - Forklift: Lowering goods, braking forklift etc.
  - Provide peak power compensation

- Efficiency of crane compensation during lifting container
- Provide output load compensation
- Regenerate the energy while lowering
  - (Fuel cell has constant power performance)
  - Increase energy efficiency

- Emergency backup power for brake
- Increase reliability of safety system
- Backup power for brake
- Increase reliability of pitch system
- Provide energy for light during night time
- Store energy generated from the sun light during daytime
Certifications

ISO 14001:2004

Design & Development, Manufacturers of Connectors and Antennas for Electronic Equipment, Ultra-Capacitors


OHSAS 18001:2007

Design & Development, Manufacture of Connectors and Antennas for Electronic Equipment, Ultra-Capacitors

Global Network

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Korea Operations

LS TOWER, Hi-Tech Center
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Jeonju Plant, Engine Plant
(Tractors, Injection Molding Systems Track Shoes, Tractor Engine)

[Domestic Business Locations]

Anyang
Jeonju
Nongan, Jeonju
Casco, Jeongeup

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[Sales Offices]
[Subsidiaries]
Outstanding People, Best-in-Class Product, Winning Partnership