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

<table>
<thead>
<tr>
<th>Component</th>
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<tbody>
<tr>
<td>Ultracapacitor</td>
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<tr>
<td>Electronic Parts</td>
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<tr>
<td>Connectors / Antenna’s</td>
</tr>
<tr>
<td>Circuit Material</td>
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<td>Copper Foils / FCCL</td>
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<tr>
<td>Vehicle Parts</td>
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<tr>
<td>Automotive Rubber Hose</td>
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<tr>
<td>Machinery</td>
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<tr>
<td>Tractor</td>
</tr>
<tr>
<td>Injection Molding Machine</td>
</tr>
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<td>Track Shoes</td>
</tr>
</tbody>
</table>
LS Ultracapacitor
New-generation Energy Storage Devices with Great Power and Great Reliability

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.
**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 following equation.

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

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

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

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

<table>
<thead>
<tr>
<th>Series</th>
<th>Part No.</th>
<th>Capacity</th>
<th>Rated Voltage</th>
<th>Max. ESR (DC)</th>
<th>Max. Current</th>
<th>Max. Leakage Current</th>
<th>Max. Stored Energy</th>
<th>Weight</th>
<th>Operating Temperature Range</th>
<th>Type</th>
<th>Dimension</th>
</tr>
</thead>
<tbody>
<tr>
<td>Snap-in &amp; Lug Type</td>
<td>LSUC 002R8S 0100F EA</td>
<td>100F</td>
<td>2.8V</td>
<td>9mΩ</td>
<td>74A</td>
<td>&lt;0.3mA</td>
<td>0.10Wh</td>
<td>0.023kg</td>
<td>-40~65°C</td>
<td>Snap-in</td>
<td>ø22 X L46mm</td>
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<tr>
<td></td>
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<td>120F</td>
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<td>81A</td>
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<td>ø22 X L46mm</td>
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<tr>
<td></td>
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<td>Lug</td>
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<tr>
<td></td>
<td>LSUC 002R8L 030F EA</td>
<td>350F</td>
<td>2.8V</td>
<td>3.2mΩ</td>
<td>231A</td>
<td>&lt;1mA</td>
<td>0.38Wh</td>
<td>0.072kg</td>
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<td>Lug/Snap-in</td>
<td>ø35 X L61mm</td>
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<tr>
<td></td>
<td>LSUC 002R8L 040F EA</td>
<td>400F</td>
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<td>3mΩ</td>
<td>255A</td>
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<td>0.43Wh</td>
<td>0.080kg</td>
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<tr>
<td></td>
<td>LSUC 002R8L 045F EA</td>
<td>450F</td>
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<td>3mΩ</td>
<td>268A</td>
<td>&lt;1mA</td>
<td>0.49Wh</td>
<td>0.088kg</td>
<td>-40~65°C</td>
<td>Lug/Snap-in</td>
<td>ø35 X L71mm</td>
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<tr>
<td></td>
<td>LSUC 003R8S 0100F EA</td>
<td>100F</td>
<td>3.0V</td>
<td>9mΩ</td>
<td>79A</td>
<td>&lt;0.3mA</td>
<td>0.12Wh</td>
<td>0.023kg</td>
<td>-40~65°C</td>
<td>Snap-in</td>
<td>ø22 X L46mm</td>
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<tr>
<td></td>
<td>LSUC 003R8L 030F EA</td>
<td>380F</td>
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<td>0.072kg</td>
<td>-40~65°C</td>
<td>Lug/Snap-in</td>
<td>ø35 X L61mm</td>
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<tr>
<td></td>
<td>LSUC 003R8L 040F EA</td>
<td>430F</td>
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<td>3mΩ</td>
<td>282A</td>
<td>&lt;1mA</td>
<td>0.53Wh</td>
<td>0.080kg</td>
<td>-40~65°C</td>
<td>Lug/Snap-in</td>
<td>ø35 X L66mm</td>
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<tr>
<td></td>
<td>LSUC 003R8L 045F EA</td>
<td>480F</td>
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<td>295A</td>
<td>&lt;1.2mA</td>
<td>0.60Wh</td>
<td>0.088kg</td>
<td>-40~65°C</td>
<td>Lug/Snap-in</td>
<td>ø35 X L71mm</td>
</tr>
</tbody>
</table>

- Endurance time (65°C, V): 1500 hours (ΔC<20% decrease, ΔESR<100% increase of initial specified value)
- Projected life time (25°C, V): 10 years (ΔC<20% decrease, ΔESR<100% increase of initial specified value)
- Projected cycle life time (25°C, V): 500,000 cycles (ΔC<20% decrease, ΔESR<100% increase of initial specified value)
- Actual cycle life time and value can be subject to various application conditions.

### Snap-in & Lug Type

- Endurance time (65°C, V): 1500 hours (ΔC<30% decrease, ΔESR<150% increase of initial specified value)
- Projected life time (25°C, V): 10 years (ΔC<30% decrease, ΔESR<150% increase of initial specified value)
- Projected cycle life time (25°C, V): 500,000 cycles (ΔC<30% decrease, ΔESR<150% increase of initial specified value)
- Actual cycle life time and value can be subject to various application conditions.

### Prismatic Type

- Endurance time (65°C, V): 1500 hours (ΔC<30% decrease, ΔESR<150% increase of initial specified value)
- Projected life time (25°C, V): 10 years (ΔC<30% decrease, ΔESR<150% increase of initial specified value)
- Projected cycle life time (25°C, V): 1,000,000 cycles (ΔC<30% decrease, ΔESR<150% increase of initial specified value)
- Actual cycle life time and value can be subject to various application conditions.

## Products

### Terminal Type

#### Snap-in & Lug

- Snap-in (100F — 120F)
- Lug (320F — 600F)
- Snap-in (4pin, 350F — 600F)

![Snap-in & Lug Type LSUC 002R8L 030F EA](image)

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

![2.8/3.0V Lug & Snap-in Type Cell](image)

- Prismatic Type Cell

![Prismatic Type Cell](image)
Specifications

<table>
<thead>
<tr>
<th>Series</th>
<th>Part No.</th>
<th>Capacity</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>
</tr>
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<tbody>
<tr>
<td>Cylindrical Type</td>
<td>LSUC 002R7C 0650F EA</td>
<td>650F</td>
<td>2.7V</td>
<td>0.57mΩ</td>
<td>640A</td>
<td>&lt;1.5mA</td>
<td>0.03Wh</td>
<td>0.20kg</td>
<td>-60~65°C</td>
<td>Cylindrical</td>
<td>Φ60 X L51.5mm</td>
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<tr>
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<td>LSUC 002R7C 1200F EA</td>
<td>1200F</td>
<td>2.7V</td>
<td>0.33mΩ</td>
<td>1160A</td>
<td>&lt;2.7mA</td>
<td>0.21Wh</td>
<td>0.28kg</td>
<td>-60~65°C</td>
<td>Cylindrical</td>
<td>Φ60 X L74.8mm</td>
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<tr>
<td></td>
<td>LSUC 002R7C 1500F EA</td>
<td>1500F</td>
<td>2.7V</td>
<td>0.23mA</td>
<td>1425A</td>
<td>&lt;3.0mA</td>
<td>0.22Wh</td>
<td>0.32kg</td>
<td>-60~65°C</td>
<td>Cylindrical</td>
<td>Φ60 X L85.8mm</td>
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<tr>
<td></td>
<td>LSUC 002R7C 2000F EA</td>
<td>2000F</td>
<td>2.7V</td>
<td>0.24mA</td>
<td>1753A</td>
<td>&lt;4.0mA</td>
<td>0.22Wh</td>
<td>0.38kg</td>
<td>-60~65°C</td>
<td>Cylindrical</td>
<td>Φ60 X L102mm</td>
</tr>
<tr>
<td></td>
<td>LSUC 002R7C 3000F EA</td>
<td>3000F</td>
<td>2.7V</td>
<td>0.23mA</td>
<td>2396A</td>
<td>&lt;5.0mA</td>
<td>3.0Wh</td>
<td>0.51kg</td>
<td>-60~65°C</td>
<td>Cylindrical</td>
<td>Φ60 X L138mm</td>
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<td>LSUC 002R8SC 3400F EA</td>
<td>3400F</td>
<td>2.85V</td>
<td>0.23mA</td>
<td>2719A</td>
<td>&lt;8.0mA</td>
<td>3.8Wh</td>
<td>0.51kg</td>
<td>-60~65°C</td>
<td>Cylindrical</td>
<td>Φ60 X L138mm</td>
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<td>LSUC 003RDC 3000F EA</td>
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<td>3.0V</td>
<td>0.23mA</td>
<td>2663A</td>
<td>&lt;5.0mA</td>
<td>3.75Wh</td>
<td>0.51kg</td>
<td>-40~65°C</td>
<td>Cylindrical</td>
<td>Φ60 X L138mm</td>
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</table>

- Endurance time (65°C, Vn) : 1500 hours (ΔC<20% decrease, ΔESR<100% increase of initial specified value)
- Projected life time (25°C, Vn) : 10 years (ΔC<20% decrease, ΔESR<100% increase of initial specified value)
- Projected cycle life time (25°C, Vn) : 1,000,000 cycles (ΔC<20% decrease, ΔESR<100% increase of initial specified value)
- **Actual cycle life time and value can be subject to various application conditions.**

Products

Cell/Module Part No. Rule

LS [ ] [ ] [ ] R [ ] [ ] F [ ] [ ] ( [ ] [ ] )

- **Voltage**
- **Capacitance**
- **Internally Control Code**
- **Cell Type**
  - Prismatic: Code P
  - Radial: Code R
  - Snap-in: Code S
  - Lug: Code L
  - Cylindrical: Code C
- **Electrolyte**
  - AN: Code EA
  - PC: Code EP
- **Series**
  - (AN Series, PC Series): Code U
  - (Hybrid Series): Code H
- **Product**
  - (Cell): Code C
  - (Module): Code M
LS Ultracapacitor Modules

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

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>LSUM 016R8L 0058F EA</td>
<td>58F</td>
<td>16.8V</td>
<td>22mΩ</td>
<td>20A</td>
<td>&lt;11mA</td>
<td>3.2Wh/kg</td>
<td>0.7kg</td>
<td>Active</td>
<td></td>
<td>-40 ~ 65°C</td>
<td>L245 x W416 x H176.6mm</td>
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<tr>
<td>LSUM 162R4L 0015F EA</td>
<td>15.5F</td>
<td>16.2V</td>
<td>110mΩ</td>
<td>12A</td>
<td>&lt;25mA</td>
<td>3.0Wh/kg</td>
<td>18.5kg</td>
<td>Passive</td>
<td>Temperature (PTC) / Over Voltage</td>
<td>-40 ~ 65°C</td>
<td>L202 x W684 x H183.5mm</td>
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<tr>
<td>LSUM 168R8L 0005F EA</td>
<td>5.8F</td>
<td>16.8V</td>
<td>240mΩ</td>
<td>12A</td>
<td>&lt;25mA</td>
<td>3.5Wh/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 H197mm</td>
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<td>LSUM 038R8L 0002F EA</td>
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<td>380.8V</td>
<td>650mΩ</td>
<td>12A</td>
<td>&lt;25mA</td>
<td>2.7Wh/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 H163mm</td>
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<tr>
<td>LSUM 016R2C 0250F EA AG</td>
<td>250F</td>
<td>16.2V</td>
<td>2mΩ</td>
<td>150A</td>
<td>&lt;1mA</td>
<td>2.3Wh/kg</td>
<td>3.9kg</td>
<td>Active/Passive</td>
<td></td>
<td>-40 ~ 65°C</td>
<td>L311 x W166 x H170mm</td>
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<tr>
<td>LSUM 016R2C 0500F EA AG</td>
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<td>1.7mΩ</td>
<td>200A</td>
<td>&lt;5mA</td>
<td>3.3Wh/kg</td>
<td>5.8kg</td>
<td>Active/Passive</td>
<td>Temperature (NTC)</td>
<td>-40 ~ 65°C</td>
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<tr>
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<td>500F</td>
<td>16.2V</td>
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<td>200A</td>
<td>&lt;5mA</td>
<td>3.1Wh/kg</td>
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<td>32.4V</td>
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<td>3.6Wh/kg</td>
<td>10kg</td>
<td>Passive</td>
<td></td>
<td>-40 ~ 65°C</td>
<td>L137.1 x W426.6 x H184mm</td>
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<td>LSUM 048R6C 0166F EA DC</td>
<td>166F</td>
<td>48.6V</td>
<td>5mΩ</td>
<td>130A</td>
<td>&lt;5mA</td>
<td>3.9Wh/kg</td>
<td>14kg</td>
<td>Active/Passive</td>
<td>Temperature (NTC) / Over Voltage</td>
<td>-40 ~ 65°C</td>
<td>L194.5 x W418.5 x H175.4mm</td>
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<td>200A</td>
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<td>17.2kg</td>
<td>Active/Passive</td>
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<td>-40 ~ 65°C</td>
<td>L671 x W418 x H171mm</td>
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<td>51.3V</td>
<td>5mΩ</td>
<td>100A</td>
<td>&lt;28.5mA</td>
<td>5.1Wh/kg</td>
<td>12kg</td>
<td>Active &amp; Passive</td>
<td>Temperature (PTC) / Over Voltage</td>
<td>-40 ~ 65°C</td>
<td>L590.4 x W136 x H181mm</td>
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<td>LSUM 086R4C 0039F EA</td>
<td>93F</td>
<td>86.4V</td>
<td>11.3mΩ</td>
<td>80A</td>
<td>&lt;120mA</td>
<td>3.6Wh/kg</td>
<td>27kg</td>
<td>Passive</td>
<td></td>
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<td>LSUM 129R6C 0062F EA</td>
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<td>129.6V</td>
<td>13.2mΩ</td>
<td>260A</td>
<td>&lt;5mA</td>
<td>2.6Wh/kg</td>
<td>55kg</td>
<td>Active/Passive</td>
<td>Temperature &amp; Voltage (CAN2.0B)</td>
<td>-40 ~ 65°C</td>
<td>L720 x W435 x H226mm</td>
</tr>
</tbody>
</table>

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

LS Ultracapacitor
New-generation Energy Storage Devices with Great Power and Great Reliability
Size Scalable (Up or Down)
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

**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
  Provide peak power compensation
  Installed in vehicle or station
  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

**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

**Wind Turbine**
- Emergency backup power
  Provide emergency power for pitch system
  Increase reliability of pitch 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
ISO 14001:2004

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

LS Miron Ltd. Anyang Hi-Tech Center
30, 15-wo 1-dong, Anyang-gu, Anyang-si, Gyeonggi-do, Korea

OHSAS 18001:2007

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

LS Miron Ltd. Anyang Hi-Tech Center
30, 15-wo 1-dong, Anyang-gu, Anyang-si, Gyeonggi-do, Korea
Global Network

Subsidiaries

LS HQ
Yu-Huang Industrial Area, Xiaohuang, Chengyang District, Qingdao, China
Tel: +86-532-8094-2200 Fax: +86-532-8094-2288

LS MoE
LS Industrial Park, Xin Mei Rd, National High-tech Industrial Development Zone, Wuxi, Jiangsu Province, China
Tel: +84-510-8299-3888 Fax: +84-510-8299-3889

YTLS
No.79 Changjiang Road, Development Zone of Yantai, Shandong Province, China
Tel: +86-535-670-5701 Fax: +86-535-650-5726

LS MoG
Yu-Huang Industrial Area, Xiaohuang, Chengyang District, Qingdao, China 266109
Tel: +86-532-8094-5479 Fax: +86-532-8094-5476

LS TA
PO Box 79, 6900 Corporation Parkway, Battleboro, NC 27810, USA
Tel: +1-252-984-0700 Fax: +1-252-984-0701

LS MB
Rua Vereador Klaus Lennertz, 2013, Palmiral, Guarujá/SP Brazil
Tel: +55-47-3422-4563

LSEV
No. 01, Street 11, VGP Bac Ninh, Tu son Town, Bac Ninh Province, Vietnam
Tel: +84(0)24-3765-430/431

LSMI
Tel: +62-21-8326-7740

Invested Company
(Daesung Electric Co., Ltd)

Qingdao
No.775, 308 State Road, Li Cang Qu, Qingdao, China
Tel: +86-532-8764-4221 Fax: +86-532-8769-0776

Wuxi
Tuznêa Road, Xishan Economic Development Zone, Wuxi City, Jiangsu Province 214101
Tel: +86-510-8768-4221 Fax: +86-510-8769-0776

India
No. 118, Ramancherry Madura, Pudur Village, Tiruvallur Taran, Tiruvallur District, Tamil Nadu State, India
Tel: +91-44-2769-3333

Japan
Tokyo Club Bldg, 3 Chome-2-6, Chiyoda-ku, Tōkyō-to, 100-0013, JAPAN
Tel: +81-3-6205-7192 Fax: +81-3-6205-7192

Branches

Japan Office
TOKYO CLUB Bldg 13F, 3-2-4 Kasumigaseki, Chiyoda-ku, Tokyo, 100-0013, Japan
Tel: +81-3-6268-8212 Fax: +81-3-6268-8678

Russia Office
ul. Legnicka 1777, 53-671 Wrocław Poland
Tel: +48-71-349-77-58

Atlanta Office
375 International Park, Suite 400 Newman, GA 30065
Tel: +1-770-259-3645 Fax: +1-770-259-3640

[Map with locations and symbols indicating LS Mtron’s overseas corporations, LS Mtron’s overseas branches (offices), and LS Mtron’s subsidiaries (overseas corporations)]
Korea Operations

ANYANG Hi-Tech CENTER
39, 116beon-gil, LS-ro, Dongan-gu, Anyang-si, Gyeonggi-do, 14118, Korea
Tel.: +82-31-8045-9579 Fax.: +82-31-8045-9564

INDONG PLANT
643, Jinyeong-dong, Gumi-si, Gyeongbuk, Korea
Tel.: +82-54-710-5702 Fax.: +82-54-710-5890

JEONJU PLANT
Industrial complex #3, 778, Yongam-ro, Bongdong-eup, Wando-gun, Jeonbuk, Korea
Tel.: +82-63-279-5114 Fax.: +82-63-279-5051

JEONGEUP PLANT
93R, Industrial complex #3, Jeong-eup, Taegok-ri, Buk-myeon, Jeonbuk-si, Jeonbuk, Korea
Tel.: +82-63-530-4114 Fax.: +82-63-530-4118

R&D CENTER
LS Mtron Lab, 555, Hogye-dong, Dongan-gu, Anyang-si, Gyeonggi-do, Korea
Tel.: +82-31-688-5305 Fax.: +82-31-688-5497

HEAD OFFICE
11th floor, LS Tower, 1028-4, Hogye-dong, Dongan-gu, Anyang-si, Gyeonggi-do, Korea
Tel.: +82-31-689-8288 Fax.: +82-31-689-8279

Korea

Daesung Electric Co., Ltd
WTL5 = Qingdao Daesung Electronic Co., Ltd
LSGQ, LSMQ = Daesung Wuxi Electronic Co., Ltd
LSMW =

Japan Branch Office
Daesung Electronic Japan LTD

Daesung Electronic India Private, Ltd

LSEV

LSMI

Poland Office