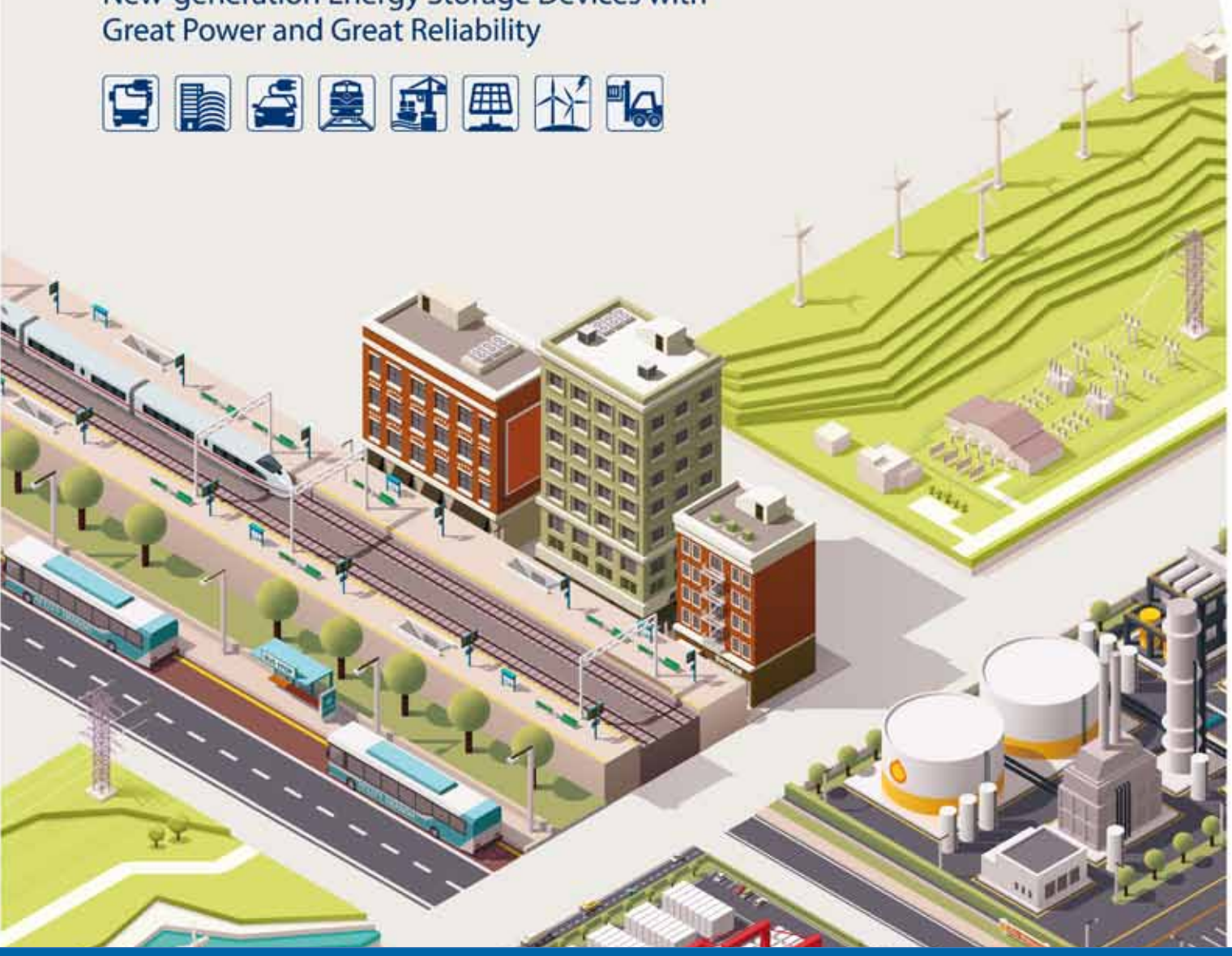
# LS Ultracapacitor

New-generation Energy Storage Devices with
Great Power and Great Reliability

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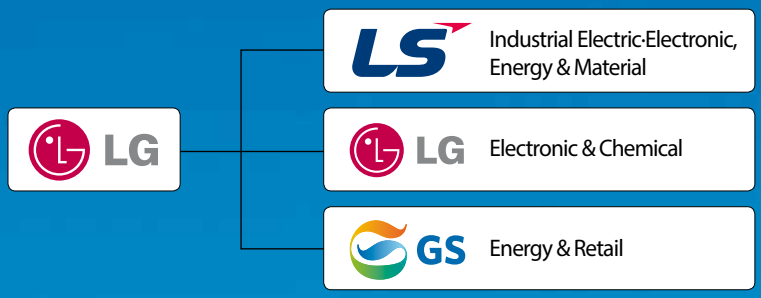
# *Leading Solution*

***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 devloping 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 challanges 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

**Circuit Material**
Copper Foils / FCCL

**Vehicle Parts**
Automotive Rubber Hose

### Machinery

**Tractor**

**Injection Molding Machine**

**Track Shoes**

# 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)

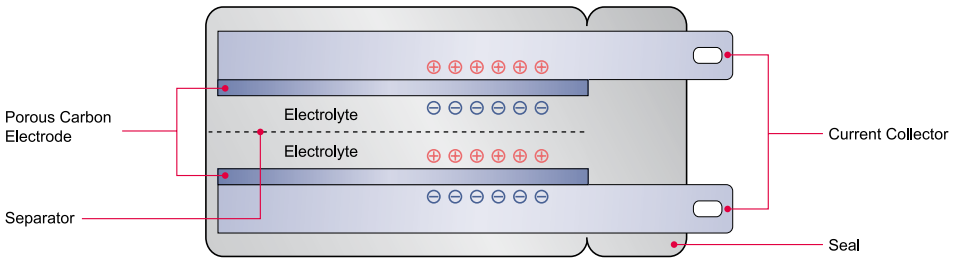
LS ULTRACAPACITOR

LSUC

# Introduction to LS Ultracapacitor Technology

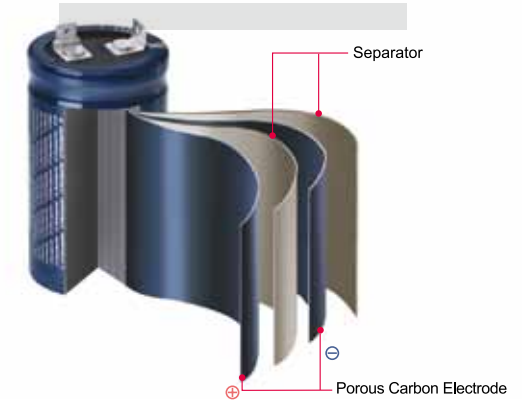
## Structure

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.

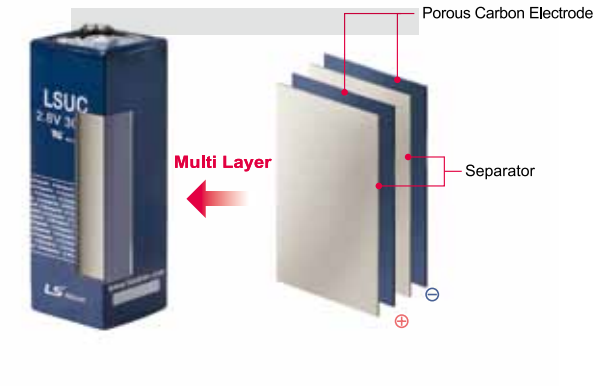



LS Mtron provides optimal package design to provide the best in performance and reliability.

**LS Ultracapacitor Cylindrical Type**

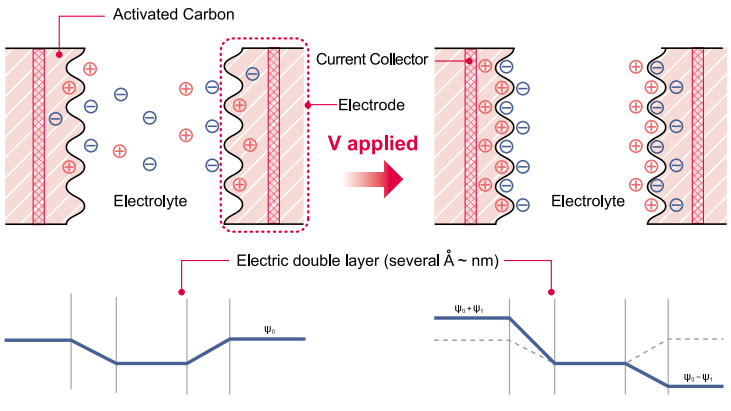



**LS Ultracapacitor Prismatic Type**




## 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.

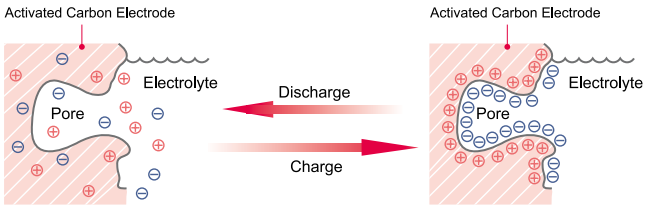



**Potential before charging** **Potential after charging**

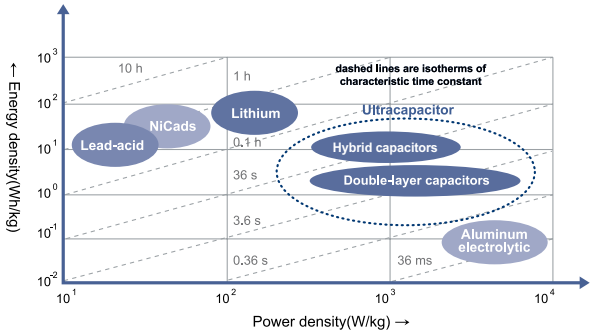
# Differences Between LS Ultracapacitor & Other Energy Storage Devices

## *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.

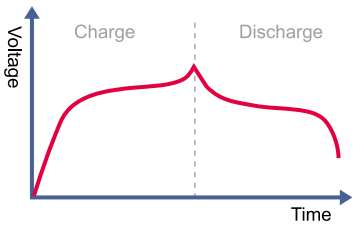



High power, long shelf and cycle life performance of Ultracapacitors originate in the energy storage mechanism differing from batteries. With batteries, energy is stored and released via chemical reaction inside electrode material that causes degradation of the entire system. On the other hand, Ultracapacitors 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.

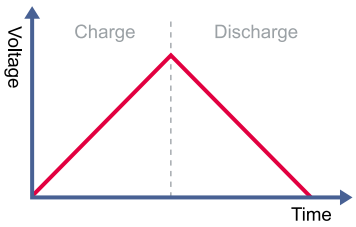



## *Charge & Discharge*

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.




**Battery**




**Ultracapacitor**

## *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.

Energy (Joule) = 1/2 x Capacitance (Farad) x Voltage$^2$ (Volt)

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

Energy (Watt hour) = Energy (Joule) / 3600 (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.

# LS Ultracapacitor Cells

## Specifications

| Series | Part No. | Capaci-tance | Rated Voltage | Max. ESR (DC) | Max. Current Non-repeated (Calculated value) | Leakage Current | Max. Stored Energy | Weight | Operating Temperature Range | Type | Dimension |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Radial Type | LSUC 002R7R 0003F EA | 3F | 2.7V | 80mΩ | 3A | <0.007mA | 0.003Wh | 0.0014kg | -40~65°C | Radial | Φ08 X L20mm |
| | LSUC 002R7R 0005F EA | 5F | 2.7V | 60mΩ | 5A | <0.010mA | 0.005Wh | 0.0021kg | -40~65°C | Radial | Φ10 X L20mm |
| | LSUC 002R7R 0010F EA | 10F | 2.7V | 45mΩ | 9A | <0.023mA | 0.010Wh | 0.0033kg | -40~65°C | Radial | Φ10 X L30mm |
| | LSUC 002R7R 0025F EA | 25F | 2.7V | 25mΩ | 20A | <0.045mA | 0.025Wh | 0.0073kg | -40~65°C | Radial | Φ16 X L25mm |
| | LSUC 002R7R 0033F EA | 33F | 2.7V | 20mΩ | 26A | <0.060mA | 0.033Wh | 0.010kg | -40~65°C | Radial | Φ18 X L31mm |
| | LSUC 002R7R 0050F EA | 50F | 2.7V | 15mΩ | 38A | <0.075mA | 0.051Wh | 0.013kg | -40~65°C | Radial | Φ18 X L40mm |

- Endurance time (65°C, $V_R$) : 1000 hours (ΔC≤30% decrease of initial value and ΔESR≤100% increase of initial specified value)
- Projected life time (25°C, $V_R$) : 10 years (ΔC≤30% decrease of initial value and ΔESR≤100% increase of initial specified value)
- Projected cycle life time [1] (25°C, $V_R$) : 500,000 cycles (ΔC≤30% decrease of initial value and ΔESR≤100% increase of initial specified value)
- [1] Actual cycle life time and value can be subject to various application conditions.

## Specifications

| Series | Part No. | Capaci-tance | Rated Voltage | Max. ESR (DC) | Max. Current Non-repeated (Calculated value) | Leakage Current | Max. Stored Energy | Weight | Operating Temperature Range | Type | Dimension |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Snap-in & Lug Type | LSUC 002R8S 0100F EA | 100F | 2.8V | 9mΩ | 74A | <0.3mA | 0.10Wh | 0.023kg | -40~65°C | Snap-in | Φ22 X L46mm |
| | LSUC 002R8S 0120F EA | 120F | 2.8V | 9mΩ | 81A | <0.4mA | 0.13Wh | 0.023kg | -40~65°C | Snap-in | Φ22 X L46mm |
| | LSUC 002R8L 0320F EA | 320F | 2.8V | 2mΩ | 273A | <1mA | 0.34Wh | 0.078kg | -40~65°C | Lug | Φ35 X L61mm |
| | LSUC 002R8L 0350F EA | 350F | 2.8V | 3.2mΩ | 231A | <1mA | 0.38Wh | 0.072kg | -40~65°C | Lug/Snap-in | Φ35 X L61mm |
| | LSUC 002R8L 0400F EA | 400F | 2.8V | 3mΩ | 255A | <1mA | 0.43Wh | 0.080kg | -40~65°C | Lug/Snap-in | Φ35 X L66mm |
| | LSUC 002R8L 0450F EA | 450F | 2.8V | 3mΩ | 268A | <1mA | 0.49Wh | 0.088kg | -40~65°C | Lug/Snap-in | Φ35 X L71mm |
| | LSUC 003R0S 0100F EA | 100F | 3.0V | 9mΩ | 79A | <0.3mA | 0.12Wh | 0.023kg | -40~65°C | Snap-in | Φ22 X L46mm |
| | LSUC 003R0L 0380F EA | 380F | 3.0V | 3.2mΩ | 257A | <1mA | 0.47Wh | 0.072kg | -40~65°C | Lug/Snap-in | Φ35 X L61mm |
| | LSUC 003R0L 0430F EA | 430F | 3.0V | 3mΩ | 282A | <1mA | 0.53Wh | 0.080kg | -40~65°C | Lug/Snap-in | Φ35 X L66mm |
| | LSUC 003R0L 0480F EA | 480F | 3.0V | 3mΩ | 295A | <1.2mA | 0.60Wh | 0.088kg | -40~65°C | Lug/Snap-in | Φ35 X L71mm |

- Endurance time (65°C, $V_R$) : 1500 hours (ΔC≤20% decrease, ΔESR≤100% increase of initial specified value)
- Projected life time (25°C, $V_R$) : 10 years (ΔC≤20% decrease, ΔESR≤100% increase of initial specified value)
- Projected cycle life time [1] (25°C, $V_R$) : 500,000 cycles (ΔC≤20% decrease, ΔESR≤100% increase of initial specified value)
- [1] Actual cycle life time and value can be subject to various application conditions.

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Snap-in & Lug Type | LSUC 002R8L 0600F EA | 600F | 2.8V | 3.2mΩ | 288A | <1.3mA | 0.65Wh | 0.090kg | -40~65°C | Lug/Snap-in | Φ35 X L71mm |

- Endurance time (65°C, $V_R$) : 1500 hours (ΔC≤30% decrease, ΔESR≤150% increase of initial specified value)
- Projected life time (25°C, $V_R$) : 10 years (ΔC≤30% decrease, ΔESR≤150% increase of initial specified value)
- Projected cycle life time [1] (25°C, $V_R$) : 500,000 cycles (ΔC≤30% decrease, ΔESR≤150% increase of initial specified value)
- [1] Actual cycle life time and value can be subject to various application conditions.

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Prismatic Type | LSUC 002R8P 3000F EA | 3000F | 2.8V | 0.36mΩ | 2019A | <5mA | 3.26Wh | 0.650kg | -40~65°C | Prismatic | W55 X D55 X L155mm |

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

## Specifications

| Series | Part No. | Capaci-tance | Rated Voltage | Max. ESR (DC) | Max. Current Non-repeated (Calculated value) | Leakage Current | Max. Stored Energy | Weight | Operating Temperature Range | Type | Dimension |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Cylindrical Type | LSUC 002R7C 0650F EA | 650F | 2.7V | 0.57mΩ | 640A | <1.5mA | 0.65Wh | 0.200kg | -40~65°C | Cylindrical | Φ60 X L51.5mm |
| | LSUC 002R7C 1200F EA | 1200F | 2.7V | 0.33mΩ | 1160A | <2.7mA | 1.21Wh | 0.280kg | -40~65°C | Cylindrical | Φ60 X L74mm |
| | LSUC 002R7C 1500F EA | 1500F | 2.7V | 0.28mΩ | 1426A | <3.0mA | 1.51Wh | 0.320kg | -40~65°C | Cylindrical | Φ60 X L85mm |
| | LSUC 002R7C 2000F EA | 2000F | 2.7V | 0.27mΩ | 1753A | <4.0mA | 2.02Wh | 0.380kg | -40~65°C | Cylindrical | Φ60 X L102mm |
| | LSUC 002R7C 3000F EA | 3000F | 2.7V | 0.23mΩ | 2396A | <5.0mA | 3.03Wh | 0.515kg | -40~65°C | Cylindrical | Φ60 X L138mm |
| | LSUC 02R85C 3400F EA | 3400F | 2.85V | 0.23mΩ | 2719A | <8.0mA | 3.83Wh | 0.515kg | -40~65°C | Cylindrical | Φ60 X L138mm |
| | LSUC 003R0C 3000F EA | 3000F | 3.0V | 0.23mΩ | 2663A | <5.0mA | 3.75Wh | 0.515kg | -40~65°C | Cylindrical | Φ60 X L138mm |

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

## Products

• 2.8/3.0V Lug & Snap-in Type Cell

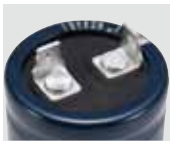
• Cylindrical Type Cell

*Radial Terminal Type*

• Radial (3F ~ 50F)

*Lug & Snap-in Terminal Type*

• Snap-in (100F/ 120F)



• Lug (320F ~ 600F)

• Snap-in (4pin, 350F ~ 600F)

*Cylindrical Terminal Type*

• Short Screw (ST01)

• Weldable (WT01)

• Long Screw (LT01)
※M16 Terminal

• Long Screw (LT02)
※M12 Terminal

## Cell/Module Part No. Rule

**LS □□ □□□R□□ □□□□F □□ (□□□□)**

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

# 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*

| Part No. | Capaci-tance | Rated Voltage | ESR (DC) | Max. Continuous Current ($\Delta T = 40^{\circ}C$) | Leakage Current(1) | Energy Density | Weight | Balancing | Monitoring | Operating Temperature Range | Dimension |
|---|---|---|---|---|---|---|---|---|---|---|---|
| LSUM 016R8L 0058F EA | 58F | 16.8V | 22mΩ | 20A | <11mA | 3.2Wh/kg | 0.7kg | Active or Passive | - | -40 ~ 65°C | L245 x W47 x H76.6mm |
| LSUM 162R4L 0015F EA | 15.5F | 162.4V | 110mΩ | 12A | <32mA | 3.0Wh/kg | 18.5kg | Passive | Temperature (PTC) / Over Voltage | -40 ~ 65°C | L684 x W202 x H183.5mm |
| LSUM 168R0L 0005F EA | 5.8F | 168V | 240mΩ | 12A | <25mA | 3.5Wh/kg | 6.5kg | Passive | Temperature (NTC) / Half Voltage Terminal | -40 ~ 65°C | L235 x W367 x H79mm |
| LSUM 0380R8L 0002F EA | 2.5F | 380.8V | 650mΩ | 12A | <12mA | 2.7Wh/kg | 18.4kg | Passive | Temperature (PTC) / Over Voltage | -40 ~ 65°C | L750 x W191 x H163mm |
| LSUM 016R2C 0250F EA AG | 250F | 16.2V | 2mΩ | 150A | <3mA | 2.3Wh/kg | 3.9kg | Active or Passive | Temperature (NTC) | -40 ~ 65°C | L311 x W166 x H70mm |
| LSUM 016R2C 0500F EA | 500F | 16.2V | 1.7mΩ | 200A | <5mA | 3.3Wh/kg | 5.6kg | Active or Passive | Temperature (NTC) | -40 ~ 65°C | L67.2 x W416.2 x H175.9mm |
| LSUM 016R2C 0500F EA AG | 500F | 16.2V | 1.7mΩ | 200A | <5mA | 3.1Wh/kg | 5.9kg | Active or Passive | Temperature (NTC) | -40 ~ 65°C | L470 x W166 x H70mm |
| LSUM 032R4C 0250F EA | 250F | 32.4V | 3.3mΩ | 150A | <11mA | 3.6Wh/kg | 10kg | Passive | - | -40 ~ 65°C | L137.1 x W426.6 x H184mm |
| LSUM 048R6C 0166F EA DC | 166F | 48.6V | 5mΩ | 130A | <5mA | 3.9Wh/kg | 14kg | Active or Passive | Temperature (NTC) / Over Voltage | -40 ~ 65°C | L194.5 x W419.5 x H177mm |
| LSUM 048R6C 0166F EA YJ | 166F | 48.6V | 5mΩ | 200A | <5mA | 3.2Wh/kg | 17.2kg | Active or Passive | Temperature (NTC) | -40 ~ 65°C | L471 x W418 x H71mm |
| LSUM 051R3C 0166F EA | 166F | 51.3V | 5mΩ | 100A | <28.5mA | 5.1Wh/kg | 12kg | Active & Passive | Temperature (PTC) / Over Voltage | -40 ~ 65°C | L590.4 x W136 x H171mm |
| LSUM 086R4C 0093F EA | 93F | 86.4V | 11.3mΩ | 80A | <120mA | 3.6Wh/kg | 27kg | Passive | Temperature (PT100) | -40 ~ 65°C | L517 x W265 x H210.5mm |
| LSUM 129R6C 0062F EA | 62F | 129.6V | 13.2mΩ | 260A | <5mA | 2.6Wh/kg | 55kg | Active or Passive | Temperature & Voltage (CAN2.0B) | -40 ~ 65°C | L720 x W405 x H226mm |

- 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

## LS Ultracapacitor

New-generation Energy Storage Devices with Great Power and Great Reliability

• LSUM 016R2C 0500F EA AG

• LSUM 048R6C 0166F EA YJ

*Size Scalable (Up or Down)*

• LSUM 016R8L 0058F EA

• LSUM 168R0L 0005F EA

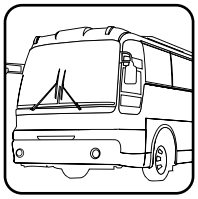
• LSUM 016R2C 0500F EA

• LSUM 048R6C 0166F EA DC

• LSUM 086R4C 0093F EA

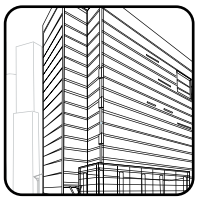
• LSUM 129R6C 0062F EA

# Markets for LS Ultracapacitors



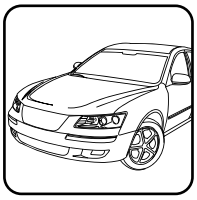
## *HEV (Hybrid Electric Vehicle)*

- 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



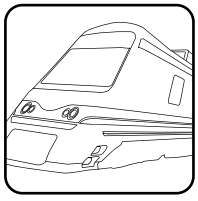
## *Power Quality Solution (UPS)*

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



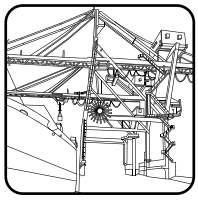
## *FCEV (Fuel Cell Electric Vehicle)*

- Output load compensation for fuel cell
  Provide peak power compensation
  (Fuel cell has constant power performance)



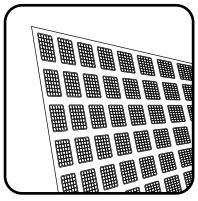
## *Locomotives*

- Auxiliary power
  Regenerate energy while braking
  Provide peak power compensation
  Installed in vehicle or station
  Increase energy efficiency



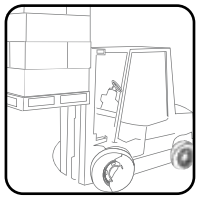
## *Hybrid Harbor Crane*

- Auxiliary power
  Regenerate the energy while lowing the container Provide output load compensation during lifting container Reduce size of ICE Increase energy efficiency of crane



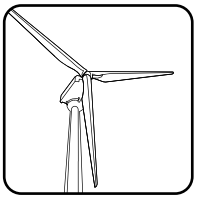
## *Photovoltaic & Solar light*

- 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


Certificate of Registration
nqa
This is to certify that the Quality Management System of
LS MTRON LTD.
applicable to
Design and manufacturing of energy-storage devices
has been assessed and registered by
NQA, Warwick House, Houghton Hall Park, Houghton Regis, Dunstable LU5 5ZX, Bedfordshire, England
against the provisions of
ISO/TS 16949 : 2009
This registration is subject to the company maintaining a quality management system, to the above standard, which will be monitored by NQA.
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ISSUED: 25 February 2008
IAF Code: 19
REVISED: 20 May 2013
EXPIRES: 20 May 2018
Authorized By:
Hwandeog Yu - Chairman
dba TRA Certification International Company Ltd.


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BBBG2.H046367
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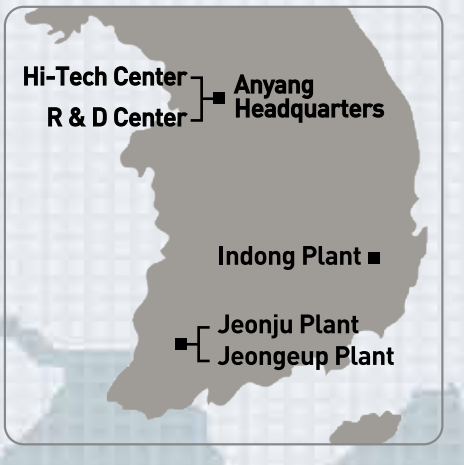


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