ESS Batteries by Samsung SDI

Top Safety & Reliability Solutions

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About Samsung SDI

Sales Revenue
USD $4.5B(est.)

Employees
19,000

Global Network
28 subsidiaries

Asset
USD $12.8B

Creative Energy & Materials Solution Leader

A creative leader in technology on the foundation of continuous improvement and innovation.

Core Value

- Excellence
- Customer
- Innovation

Business Areas

- Small Size Battery
- Automotive Battery
- ESS Battery
- Electronic Materials
ESS Battery Business

As a specialized manufacturer of lithium-ion batteries, Samsung SDI is leading the growth of the ESS market with our customers.

Business History

- 1970: Established Samsung SDI
- 2000: Began Lithium-ion Battery Business
- 2008: Established JV Company in China
- 2010: Began Battery Business for Energy Storage
- 2011: Long-term Supply Contract for Residential Batteries
- 2012: Began Battery Business for Energy Storage
- 2013: Supplied UPS Batteries to Data Centers
- 2014: Global No. 1 Market Share for ESS (B3 research, 2014)
- 2015: No. 1 Market Share for Residential ESS in Japan
- 2017: Total Installation Over 1.3GWh of ESS batteries

Sales & Production Sites

- Germany: Munich
- Korea: Giheung, Cheonan, Ulsan, Suwon
- Japan: Tokyo
- China: Hefei, Xian
- USA: San Jose, CA

Battery Solutions for ESS

Samsung SDI provides optimal lithium-ion battery solutions ranging from residential to utility-scale ESS.

Applications of ESS

- ESS (Energy Storage System)
- EMS (Energy Management System)
- PCS (Power Conversion System)

Product Lineup

- Utility & Commercial
  - Module, Rack, Enclosure
- UPS
  - Module, Enclosure
- Residential & Telecom
  - Module

Lithium-ion Cells
Why Samsung SDI

Samsung SDI designs optimized battery systems through its excellence in cell technology.

Safety First

Multi-layered protection at the cell level resulting in best in class safety.

- **Fuse**: Interrupts current in case of an external short.
- **Separator**: Stops the chemical reaction at excessive temperatures.
- **NSD**: Protects against shorts induced by penetration.
- **Vent**: Degasses in case of excessive internal pressure.
- **Aluminum Can**: Prevents swelling due to solid cell housing and corrosion due to positive polarity.
- **SFL**: Prevents short between anode and cathode.

Long Cycle Life

Samsung SDI’s prismatic cell has sufficient electrolyte and a stable structure resulting in extended cycle life.

- **Winding** (Prismatic type)
- **Stack & Folding** (Pouch type)

Sustainable Design

Increasing the capacity of the cell while maintaining the same form factor and cell dimensions achieves higher density while retaining battery pack design.

Higher Capacity in Same Form Factor

1.0ℓ / 2kg

Higher Capacity without Change in Pack Design

Accurate Lifetime Simulation

Samsung SDI offers optimal battery solutions with its superior lifetime prediction technology.

Samsung SDI Lifetime Simulation

- Analysis
- Simulation
- Sizing

Optimal Battery Solution

Customer’s Load Profile

- Aging Parameter
- Lifetime Estimation Using Semi-Empirical Simulation Method
- Operation Planning
Battery Platform for Utility & Commercial ESS

2017 Innovations

Samsung SDI provides optimized, reliable and innovative battery solutions for ESS applications.

**ENERGY**

- Innovative module/rack arrangement
- By deploying innovative configurations, a 90%* capacity increase (Max. 9.1MWh) in 40ft enclosure has been achieved.
- New cell increases capacity and energy density by 15%
- Increased capacity up to Max. 3.9 MWh in 40ft. standard enclosure.

**POWER**

- New cell increases capacity and energy density by 15%
- Increased capacity up to Max. 3.9 MWh in 40ft. standard enclosure.

**Specifications**

<table>
<thead>
<tr>
<th>Item</th>
<th>Module</th>
<th>Rack</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>E2-M076</td>
<td>E2-R068</td>
</tr>
<tr>
<td>Cell Capacity Ah</td>
<td>94</td>
<td>94</td>
</tr>
<tr>
<td>Energy kWh</td>
<td>7.6</td>
<td>68</td>
</tr>
<tr>
<td>Operating Voltage V</td>
<td>70.4–91.3</td>
<td>634–822</td>
</tr>
<tr>
<td>Dimension (W x D x H) mm</td>
<td>370x588x160</td>
<td>442x702x1,792</td>
</tr>
<tr>
<td>Weight kg</td>
<td>55</td>
<td>550</td>
</tr>
</tbody>
</table>

**Medium**

<table>
<thead>
<tr>
<th>Item</th>
<th>Module</th>
<th>Rack</th>
</tr>
</thead>
<tbody>
<tr>
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<td>68</td>
</tr>
<tr>
<td>Operating Voltage V</td>
<td>70.4–91.3</td>
<td>634–822</td>
</tr>
<tr>
<td>Dimension (W x D x H) mm</td>
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<td>442x702x1,792</td>
</tr>
<tr>
<td>Weight kg</td>
<td>55</td>
<td>550</td>
</tr>
</tbody>
</table>

**Power**

<table>
<thead>
<tr>
<th>Item</th>
<th>Module</th>
<th>Rack</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>P3-M063</td>
<td>P3-R056</td>
</tr>
<tr>
<td>Cell Capacity Ah</td>
<td>78</td>
<td>78</td>
</tr>
<tr>
<td>Energy kWh</td>
<td>6.3</td>
<td>56</td>
</tr>
<tr>
<td>Operating Voltage V</td>
<td>68.2–90.2</td>
<td>634–812</td>
</tr>
<tr>
<td>Dimension (W x D x H) mm</td>
<td>370x580x160</td>
<td>442x702x1,792</td>
</tr>
<tr>
<td>Weight kg</td>
<td>51</td>
<td>520</td>
</tr>
</tbody>
</table>

*Comparison with 2016 max. 78Ah
Batteries for UPS

Samsung SDI’s lithium-ion battery for UPS is capable of supplying a large current (450A) and is compatible with major global UPS companies.

Benefits of Lithium-ion Battery for UPS

<table>
<thead>
<tr>
<th>Less Space / Weight</th>
<th>Longer Life</th>
<th>Fast Charge / Discharge Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="equal_capacity" alt="Lead-acid" /></td>
<td>![Lithium-ion](3-7 years)</td>
<td>![Lithium-ion](15 years)</td>
</tr>
<tr>
<td>![Lithium-ion](3-7 years)</td>
<td>![Lithium-ion](15 years)</td>
<td>![Lithium-ion](Steady-up 10ms)</td>
</tr>
</tbody>
</table>

- Less space for battery room
- Battery replacement deferral
- No oversizing required
- Enhanced reliability
- Shorter charging time

Product Lineup

**4C UPS**
- Data center, Factory
- Up to 15min

**6C UPS**
- Data center, Factory
- Up to 10min

**12C UPS**
- Data center, Factory
- Up to 5min

Specifications

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</tr>
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<tr>
<td>Model</td>
<td>U4-M020, U6-M020, UC-M101</td>
<td></td>
</tr>
<tr>
<td>Cell Capacity (Ah)</td>
<td>67, 67, 35</td>
<td></td>
</tr>
<tr>
<td>Energy (kWh)</td>
<td>2.0, 2.0, 1.0</td>
<td></td>
</tr>
<tr>
<td>Operating Voltage (V)</td>
<td>24-33.6, 24-33.6, 24-33.6</td>
<td></td>
</tr>
<tr>
<td>Dimension (W x D x H)</td>
<td>216x414x163, 216x414x163, 216x414x163</td>
<td></td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>17, 17, 17</td>
<td></td>
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**48V Solution**

- Advanced lithium-ion battery
- High performance technology for long duration operation
- Compatible with 48V PCS

**Product Lineup**

**R3-M010**
- 1kWh x 16ea
- Max. 16kWh

**R1-M048**
- 4.8kWh x 39ea
- Max. 188kWh

Specifications

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<th>Item</th>
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<tr>
<td>Component</td>
<td>Battery Module, BMS</td>
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</tr>
<tr>
<td>Energy (kWh)</td>
<td>1.0</td>
<td>4.8</td>
</tr>
<tr>
<td>Scalability (kWh)</td>
<td>16 (16ea)</td>
<td>188 (39ea)</td>
</tr>
<tr>
<td>Operating Voltage (V)</td>
<td>42-56</td>
<td>44-59</td>
</tr>
<tr>
<td>Dimension (W x D x H)</td>
<td>169x377x86</td>
<td>484x450x159</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>8</td>
<td>37</td>
</tr>
<tr>
<td>Operating Temperature</td>
<td>-10 ~ 60°C</td>
<td>-10 ~ 50°C</td>
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**Benefits of Lithium-ion Battery for UPS**

- Advanced lithium-ion battery
- High performance technology for long duration operation
- Compatible with 48V PCS

- No oversizing required
- Enhanced reliability
- Shorter charging time

**Product Lineup**

**4C UPS**
- Data center, Factory
- Up to 15min

**6C UPS**
- Data center, Factory
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**12C UPS**
- Data center, Factory
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Global Track Record

Since 2010, more than 1.3GWh of Samsung SDI ESS batteries are being successfully operated in over 30 countries.

Samsung SDI Leads the Global ESS Market

Awarded and completed the world’s largest ESS project located in the USA (2016)
Leading the market as the global #1 battery supplier for premium UPS
#1 Residential ESS battery provider in Japan (2013~)

Total Installation (As of Mar. 2017)
1.3+GWh

USA
Austin, TX 56MW / 14MWh
El Cajon/Escondido, CA 37.5MW / 150MWh
Pomona, CA 20MW / 80MWh
Indianapolis, IN 20MW / 20MWh
Clinton, OH 10MW / 4MWh

Canada
Sault Sainte Marie, Ontario 8MW / 8MWh

China
Tibet Shuanghu 4MW / 4MWh

Germany
Zeeland 10MW / 10MWh
Anholt 3MW / 3MWh
Chemnitz 10MW / 16MWh

Italy
Potenza 2MW / 2MWh

Japan
Hokkaido Shinboku 17MW / 9MWh
Hokkaido Chitose 3MW / 14MWh

Korea
KEPCO (F/R 5 sites) 128MW / 38MWh
PyeongChang 6MW / 18MWh
Yangyang 4MW / 14MWh

Australia
Alice Springs 6MW / 2MWh
Western Australia 4MW / 2MWh

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