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SAMSUNG SDI

Creative Energy & Materials Solution Leader

Samsung SDI is leading the change of a new era with lithium-ion batteries.

Through our constant innovation towards excellence, we led with the technological superiority of our innovative IT devices and expanded into electric cars which have now become reality. In addition, we are contributing to the expansion of an eco-friendly environment by the deployment of batteries for energy storage.

We are all dreaming of a better future with the Internet of Things in which Samsung SDI will provide solutions for the world.

1970 2000 2008 2010
Established Samsung SDI
Began Lithium-ion Battery Business
Expanded Business into Automotives
Expanded Business into Energy Storage

Powering Tomorrow, Samsung SDI Battery Solution for Energy Storage

Samsung SDI’s technology supplies eco-friendly energy solutions for the present and the future. We provide safe, reliable and long-lasting performance with our Energy Storage solutions. ESS projects are deployed using Samsung SDI’s battery solutions optimized for a range from residential to utility-scale projects.

Utility & Commercial

Optimized Battery Platforms Based on High-Density Design Technology

- Solar & Wind Farm
- Grid Substation
- Building, Factory

UPS

Lithium-Ion Solution
Proven High-Voltage LIB Solutions Compatible with Premium UPS

- Data Center
- Factory

Residential & Telecom

Battery Pack Solution
Scalable Standard Battery Pack for Customized ESS

- PV Home
- Telecom
Why Samsung SDI

Safety First

Multi-Layered Protection

Safety first is Samsung SDI priority. Prismatic cell has multi-layered protection at the cell level resulting in best in class safety. In addition, the aluminum exterior has excellent thermal conductivity and cooling performance, and it releases high temperature safely and efficiently from the inside to the outside.

Sustainable Design

Easy to Upgrade

Capacity without Design Change

We are continuously innovating to increase the energy density while maintaining the same form factor and cell dimensions, thus facilitating future upgrades to higher capacity, higher energy density, ESS with no change to pack design.

Long Cycle Life

Industry Leading Cycle Life Performance

6,000 cycles

@ continuous 1C /1C, SOH 80%

Samsung SDI ESS leverages our manufacturing experience in IT and automotive battery cells resulting in superior and adaptive technology. Samsung SDI ESS is recognized as the industry leader in the market, providing our customers with the safest and long lasting batteries.

Accurate Lifetime Simulation

Samsung SDI Lifetime Simulation

Customer's Load Profile

Analysis

Aging Parameter

Simulation

Lifetime / Estimation Using/Semi-Empirical / Simulation Method

Sizing

Operation Planning

Optimal Battery Solution

Samsung SDI offers optimal battery solution with its superior lifetime prediction technology. We design and propose a battery system with analyzing the various parameter such as purpose, operation period and installation environment.
Battery Platform for Utility & Commercial ESS

Standard Platform

**Energy Platform**
Over 2 hours

- Energy density has increased more than 16% with upgrades to Samsung SDI’s new advanced module
- Higher density enables better footprint and installation cost savings

<table>
<thead>
<tr>
<th>Item</th>
<th>Module</th>
<th>Rack</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>E3-M088</td>
<td>E3-R168</td>
</tr>
<tr>
<td>Cell Capacity (Ah)</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Energy (kWh)</td>
<td>8.8</td>
<td>168</td>
</tr>
<tr>
<td>Operating Voltage</td>
<td>38.4–49.8</td>
<td>730–946</td>
</tr>
<tr>
<td>Dimension (W x D x H)</td>
<td>570 x 657 x 160</td>
<td>876 x 771 x 1,791</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>61</td>
<td>1,268</td>
</tr>
</tbody>
</table>

**Medium Platform**
1+ hour up to 45 minutes

- Unique Platform in the ESS Industry with Mid-range Capabilities
- Optimized Solution for around One hour of Grid Service
- The Highest Lifetime Performance in a Continuous Charge/Discharge for 1 hour

<table>
<thead>
<tr>
<th>Item</th>
<th>Module</th>
<th>Rack</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>M3-M081</td>
<td>M3-R073</td>
</tr>
<tr>
<td>Cell Capacity (Ah)</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Energy (kWh)</td>
<td>8.3</td>
<td>73</td>
</tr>
<tr>
<td>Operating Voltage</td>
<td>70.4–91.3</td>
<td>636–822</td>
</tr>
<tr>
<td>Dimension (W x D x H)</td>
<td>370 x 650 x 160</td>
<td>438 x 771 x 1,791</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>56</td>
<td>564</td>
</tr>
</tbody>
</table>

**Power Platform**
30 minutes up to 20 minutes

- High Power Platform Optimized for Less than 30 minutes of Use
- Optimized Solution for Power Applications such as F/R, Railway, Ship, etc.

<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-R076</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>57</td>
</tr>
<tr>
<td>Operating Voltage</td>
<td>68.2–90.2</td>
<td>614–812</td>
</tr>
<tr>
<td>Dimension (W x D x H)</td>
<td>370 x 650 x 160</td>
<td>438 x 771 x 1,791</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>54</td>
<td>560</td>
</tr>
</tbody>
</table>
Battery Platform for Utility & Commercial ESS

Special Platform

1,500 High Voltage Platform

- High Efficiency Battery Solution for 1,500V PCS

Minimize Power Loss by Enabling High Power Output

Minimize Total Footprint by Reducing Footprint of PCS and Battery System

Maximize Economics & Efficiency

Product Lineup

<table>
<thead>
<tr>
<th>Item</th>
<th>ES-8256</th>
<th>MS-8130</th>
<th>PS-8101</th>
</tr>
</thead>
<tbody>
<tr>
<td>Backup Time</td>
<td>2 hours</td>
<td>1 hour</td>
<td>30 minutes</td>
</tr>
<tr>
<td>Cell Capacity (Ah)</td>
<td>100</td>
<td>100</td>
<td>78</td>
</tr>
<tr>
<td>Energy (kWh)</td>
<td>266</td>
<td>130</td>
<td>101</td>
</tr>
<tr>
<td>Operating Voltage (V)</td>
<td>1,114–1,444</td>
<td>1,126–1,461</td>
<td>1,091–1,443</td>
</tr>
<tr>
<td>Dimension (W x D x H)</td>
<td>876 x 711 x 2,750</td>
<td>438 x 711 x 3,082</td>
<td>438 x 711 x 3,082</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>1,929</td>
<td>1,001</td>
<td>965</td>
</tr>
</tbody>
</table>
Benefits of Lithium-ion Batteries

**Less Space / Weight**
- Lead-acid (Equal Capacity)
- Lithium-Ion

- Less Space for Battery Room
- No Structure Reinforcement Required

**Longer Life**
- Lead-acid
- Lithium-Ion

- Battery Replacement Deferral
- Enhanced Reliability

**Fast Charge / Discharge Rate**
- Lead-acid
- Lithium-Ion

- No Oversizing Required
- Shorter Charging Time

*This comparison above is based on each material’s characteristics. The battery life time may vary depending on the environmental conditions which the device are utilized and the current usage pattern.

Why Samsung SDI

- Only Samsung SDI can provide a 10 minute backup battery solution
- Compatible with Global UPS Battery Solutions
- Proven Safety & Quality
- Global Reference to IDC, a Factory in Operation for over 5 years

IDC (Internet Data Center)
2012, Shinhan Bank
World’s First LIB Solution

Factory
2016, Samsung Display / Semiconductor
World’s Largest factory

**Product Lineup**

<table>
<thead>
<tr>
<th>Item</th>
<th>Module</th>
<th>Rack</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>U6-M020</td>
<td>U6-M033</td>
</tr>
<tr>
<td>Cell Capacity</td>
<td>Ah</td>
<td>67</td>
</tr>
<tr>
<td>Energy</td>
<td>kWh</td>
<td>2.0</td>
</tr>
<tr>
<td>Operation Voltage</td>
<td>V</td>
<td>24-33.6</td>
</tr>
<tr>
<td>Dimension (W x D x H)</td>
<td>mm</td>
<td>216 x 414 x 163</td>
</tr>
<tr>
<td>Weight</td>
<td>kg</td>
<td>17</td>
</tr>
</tbody>
</table>

*This product is compatible with global UPS solution*
PV Storage / Off-Grid Backup

- PV Storage
  - PV Panel
  - PV Inverter
  - Battery/Inverter
  - SAMSUNG SDI Battery

- Off-Grid Backup
  - Diesel Generator
  - Antenna
  - SMPS
  - SAMSUNG SDI Battery

48V Solution

- High Energy 94Ah Prismatic Cell
- High Energy Density & Long Cycle Life
- Available up to 1C-rate
- Fits on 19 inch Standard Rack
- Wide Temperature Range

HVS Solution (High Voltage System)

- Advanced 21700 Cylindrical Cell
- High Conversion Efficiency (DC to AC)
- Optimized for High Voltage PCS
- Superior Performance at High Temperature

<table>
<thead>
<tr>
<th>Scalable Capacity</th>
<th>R3-M048</th>
<th>R3-M020</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>185KWh</td>
<td>12.0KWh</td>
</tr>
<tr>
<td></td>
<td>X Max.39</td>
<td>X Max.6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Item</th>
<th>R3-M048</th>
<th>R3-M020</th>
</tr>
</thead>
<tbody>
<tr>
<td>Component</td>
<td>Battery Module, BMS</td>
<td>Battery Module, BMS</td>
</tr>
<tr>
<td>Nominal Energy</td>
<td>kWh</td>
<td>kWh</td>
</tr>
<tr>
<td></td>
<td>4.8</td>
<td>2.0</td>
</tr>
<tr>
<td>Operating Voltage</td>
<td>V</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td>44.8 – 58.1</td>
<td>88.2 – 112.5</td>
</tr>
<tr>
<td>Dimension (W x D x H)</td>
<td>mm</td>
<td>mm</td>
</tr>
<tr>
<td></td>
<td>446 x 440 x 158</td>
<td>191 x 433 x 172</td>
</tr>
<tr>
<td>Weight</td>
<td>kg</td>
<td>kg</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>17.5</td>
</tr>
<tr>
<td>Operating Temperature</td>
<td>°C</td>
<td>°C</td>
</tr>
<tr>
<td></td>
<td>-10–50</td>
<td>0–60</td>
</tr>
</tbody>
</table>
Global Track Record

Since 2010, Samsung SDI’s ESS products have been successfully operating in over 30 countries.

Today, Samsung SDI continues to make history by leading the growing global ESS market, based on best-in-class battery technology and strong partnerships.

USA
- California: 150MWh Deployed 2017+
- Austria, TX: 50MWh / 10MWh
- El Cajon/Escondido, CA: 57.5MWh / 150MWh
- Phoenix, AZ: 72MWh / 180MWh
- Indiana, IN: 20MWh / 20MWh
- El Centro, CA: 30MWh / 22MWh
- Tucson, AZ: 10MWh / 5MWh
- Punta Gorda, FL: 10MWh / 40MWh

Germany
- Schwerm: 15MWh Deployed 2014/15
- Schwarzwald: 10MWh / 10MWh
- Herzolau: 10MWh / 10MWh

USA
- Leighton Buzzard: 10MW Deployed 2014+
- Leighton Buzzard: 6MW / 10MWh
- Rotherham: 4MW / 7.5MWh
- Beeston: 20MWh / 22MWh
- Port of Tyne: 55MWh / 28MWh
- Tynemouth: 25MWh / 17MWh
- Patham: 50MWh / 105MWh

Japan
- Hokkaido: 20MWh (5 sites) Deployed 2017+
- Hokkaido: 15MWh / 9MWh
- Hokkaido: 10MWh / 13MWh

Italy
- Potenza: 2MW / 2MWh

Netherlands
- Zeeland: 10MWh / 10MWh

Spain
- Carboneras: 20MW / 12MWh

Korea
- KEPCO/J&R: 50MWh Deployed 2015+
- KEPCO15 (Jeju): 282MWh / 58MWh
- KEDS15 (Jeju): 272MWh / 55MWh
- PyeongChang: 6MW / 16MWh
- Ulsan: 40MWh / 50MWh

China
- Tibet: 18MW/28MW (1 site) Deployed 2016+
- Tibet: 4MW / 10MWh
- Tibet: Gaize: 4MW / 16MWh

Australia
- Alice Spring: 6MW / 2MWh
- Western Australia: 4MW / 2MWh
- Adelaide: 10MW/105MWh

(Since Dec 2016: Instalation & Award)