

Appendix 2-3:
Energy Storage Data Sheet

SAMSUNG SDI

Energy Storage System Battery Business

Global Network

KOREA(HQ) 150-20 Gongse-ro, Giheung-gu, Yongin-si, Gyeonggi-do 17084, Korea
TEL +82-31-210-8209 E-mail energy.storage@samsung.com

GERMANY Reichenbachstrasse 2, 85737 Ismaning, Germany
TEL +49-89-9292-7799(19) E-mail sintaek.yim@samsung.com

USA 3655 North 1st Street, San Jose, CA 95134, USA
TEL +1-408-544-4491 E-mail hk1.kim@samsung.com

CHINA No.788, Mingchuan Rd. Boyan Science & Technology Park.Hefei State Hi-tech Zone.P.R.China.
TEL +86-551-6532-7500 E-mail hgleo.ryu@samsung.com

JAPAN (108-0075) Shinagawa Grand Central Tower 9F, 2-16-4, Konan, Minato-ku, Tokyo, Japan
TEL +81-3-6369-6414 E-mail m.goto@samsung.com

TAIWAN 7F-1, No.399, Ruiguang Rd., Neihu Dist., Taipei City 114, Taiwan
TEL +886-2-8178-5974 E-mail allen01.chen@samsung.com

Feb. 2019

www.samsungsdi.com

© 2018 SAMSUNG SDI Co., Ltd. All right reserved.

SAMSUNG SDI reserves the right to modify the design, packaging, specifications and features shown herein, without prior notice or obligation.

Legal Notice and Disclaimer

While SAMSUNG SDI Co. Ltd., ("Samsung SDI") uses reasonable efforts to include accurate and reliable information presented in this brochure, SAMSUNG SDI makes no warranties or representations with respect to the contents of this brochure (the "Information"). Further, Samsung SDI does not endorse, approve, or certify the Information, nor does it guarantee the accuracy, completeness, efficiency, timeliness, or correct sequencing of the Information. Use of the Information is voluntary, and reliance on it should only be undertaken after an independent review of its accuracy, completeness, efficiency, and timeliness. Reference herein to any specific commercial product, process, or service by trade name, trademark, service mark, manufacturer, or otherwise does not constitute or imply endorsement, recommendation, or guarantees by SAMSUNG SDI.

ESS Batteries by Samsung SDI

Top Safety & Reliability Solutions

SAMSUNG SDI

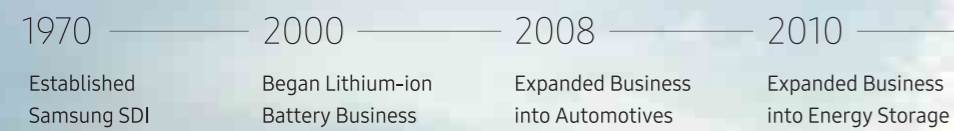
SAMSUNG SDI

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 BoT (Battery of Things) in which Samsung SDI will provide solutions for the world.



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 Battery Platform

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

Samsung SDI optimizes battery systems with advanced cell technology.

Safety First

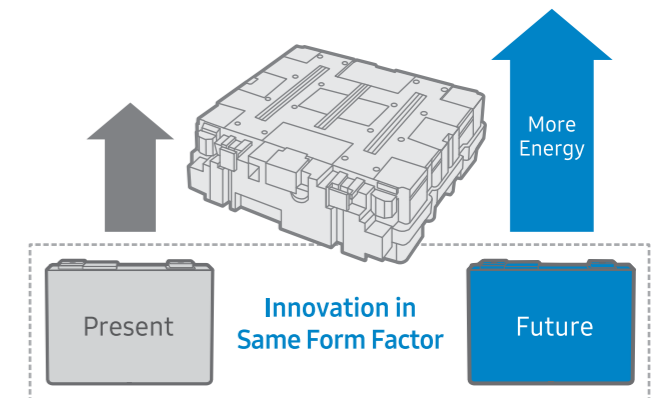
Multi-Layered Protection



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.

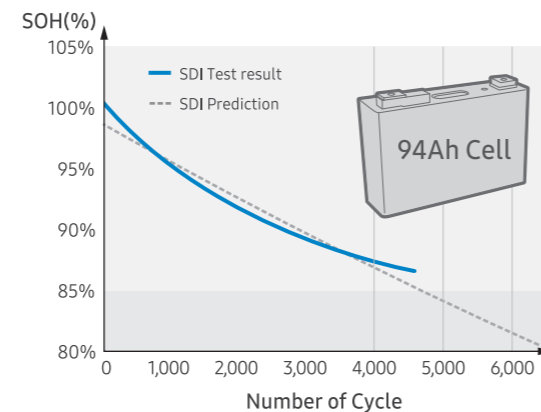
Long Cycle Life

Industry Leading Cycle Life Performance

6,000 Cycles

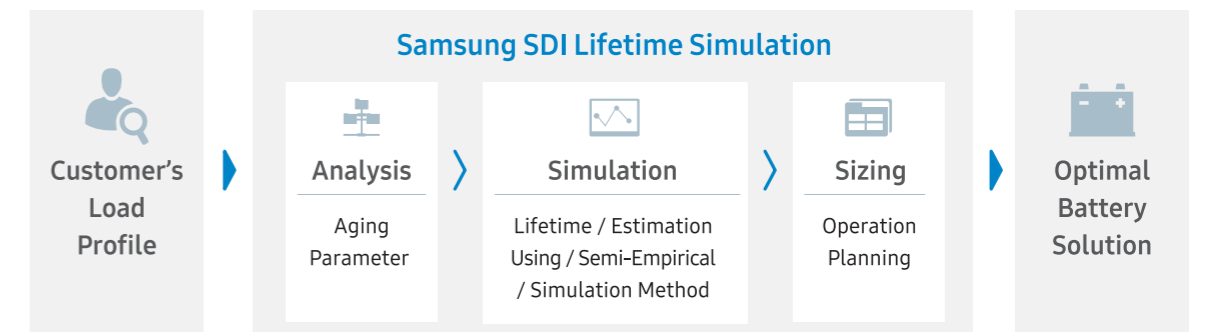
@continuous 1C /1C, SOH 80%

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.



(Test Condition at 25°C, 1C/1C, DoD 100%)
*Warranty condition could be different depending on the load profile

Accurate Lifetime Simulation

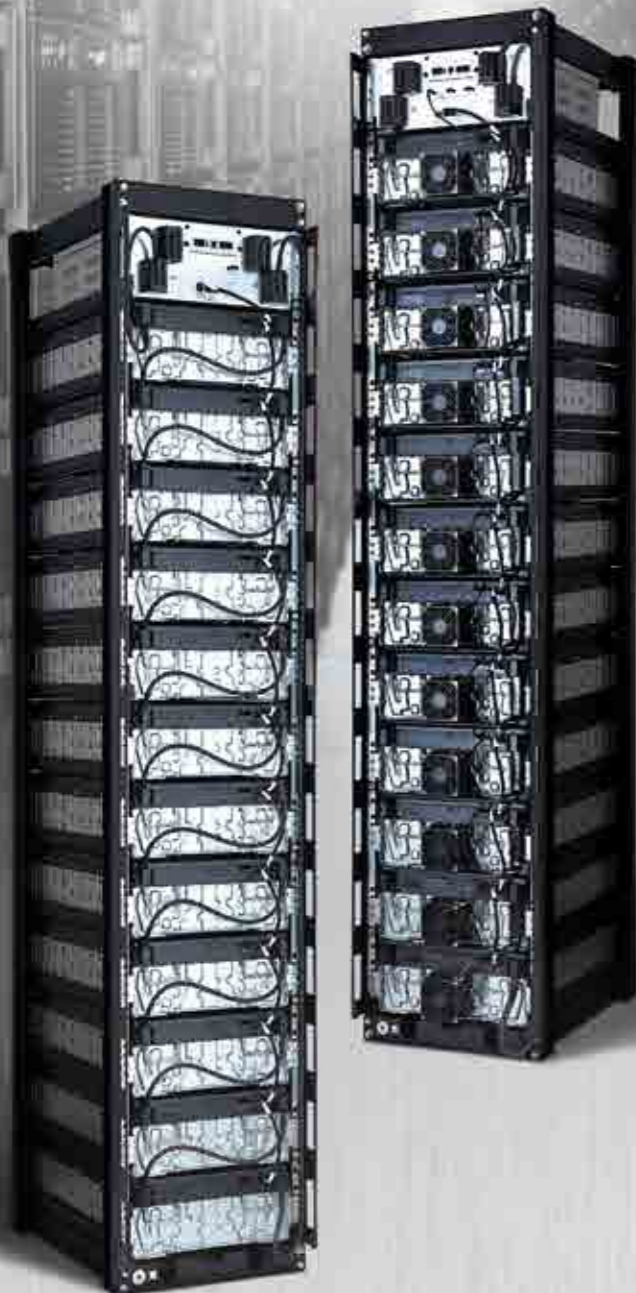


Samsung SDI offers optimal battery solution with its superior lifetime prediction technology. We design and propose a battery system with analyzing the various parameter such as purpose, operation period and installation environment.

Battery Platform for Utility & Commercial ESS

Optimized Battery Platforms Based on High-Density Design Technology

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



Standard Platform

Energy Platform New

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



Item		Module	Rack		
Model		E3-M088	E3-R168	E3-R203	E3-R221
Cell Capacity	Ah	100	100	100	100
Energy	kWh	8.8	168	203	221
Operating Voltage	V	38.4~49.8	730~946	883~1,145	960~1,245
Dimension (W x D x H)	mm	370 x 637 x 160	876 x 711 x 1,791	876 x 711 x 2,123	876 x 711 x 2,289
Weight	kg	61	1,268	1,523	1,650

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



Item		Module	Rack		
Model		M3-M081	M3-R073	M3-R089	M3-R097
Cell Capacity	Ah	100	100	100	100
Energy	kWh	8.1	73	89	97
Operating Voltage	V	70.4~91.3	634~822	774~1,004	845~1,096
Dimension (W x D x H)	mm	370 x 650 x 160	438 x 711 x 1,791	438 x 711 x 2,123	438 x 711 x 2,289
Weight	kg	56	564	683	742

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.



Item		Module	Rack		
Model		P3-M063	P3-R057	P3-R070	P3-R076
Cell Capacity	Ah	78	78	78	78
Energy	kWh	6.3	57	70	76
Operating Voltage	V	68.2~90.2	614~812	750~992	818~1,082
Dimension (W x D x H)	mm	370 x 650 x 160	438 x 711 x 1,791	438 x 711 x 2,123	438 x 711 x 2,289
Weight	kg	54	560	675	734

Battery Platform for Utility & Commercial ESS

Optimized Battery Platforms Based on High-Density Design Technology



Solar & Wind Farm



Grid (Substation)



Building, Factory



Special Platform

1,500 High Voltage Platform New

- 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

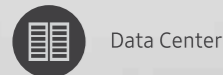
Product Lineup

Item		Rack		
Model		E3-R256	M3-R130	P3-R101
Platform		Energy	Medium	Power
Backup Time		2 hours	1 hour	30 minutes
Cell Capacity	Ah	100	100	78
Energy	kWh	256	130	101
Operating Voltage	V	1,114~1,444	1,126~1,461	1,091~1,443
Dimension (W x D x H)	mm	876 x 711 x 2,750	438 x 711 x 3,082	438 x 711 x 3,082
Weight	kg	1,929	1,001	965

Batteries for UPS

Uninterruptible Power Supply

Proven High-Voltage LIB Solutions
Compatible with Premium UPS



Data Center



Factory



Benefits of Lithium-ion Batteries

Less Space / Weight



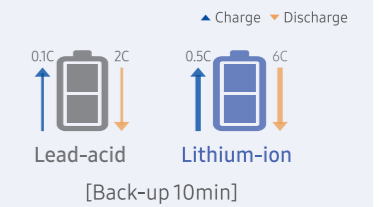
- Less Space for Battery Room
- No Structure Reinforcement Required

Longer Life



- Battery Replacement Deferral
- Enhanced Reliability

Fast Charge / Discharge Rate



- No Oversizing Required
- Shorter Charging Time

*This comparison above is based on each material's characteristic. The Battery life time may vary depending on the environmental condition which the device are used in and the customer's 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



(Certified by TÜV)

Product Lineup



Item		Module	Rack
Model		U6-M020	U6-R035
Cell Capacity	Ah	67	67
Energy	kWh	2.0	35
Operation Voltage	V	24~33.6	408~572
Dimension (W x D x H)	mm	216 x 414 x 163	650 x 600 x 2,055
Weight	kg	17	550

*It is compatible with global UPS solution

Residential & Telecom

Scalable Standard Battery Pack for Customized ESS

- PV Home
- Telecom

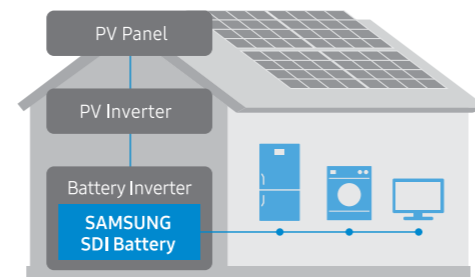
Utility & Commercial ESS

UPS

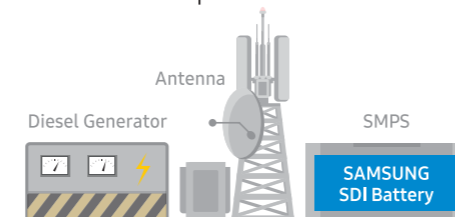
Residential & Telecom

PV Storage / Off-Grid Backup

PV Storage



Off-Grid Backup



High Energy Cell

- Advanced High Capacity and Long Lifecycle

Easy Installation

- Easy Installation by Simple Module Structure

Scalability

- Easy to Expand Capacity

Standard Module

- Standard Module for Various Customer Needs

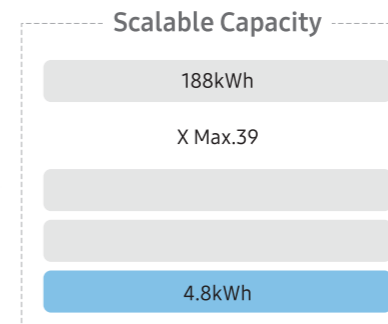
Compatibility

- Compatible with Various Standard Inverters

* Inverter for Residential, SMPS for Telecom

48V Solution

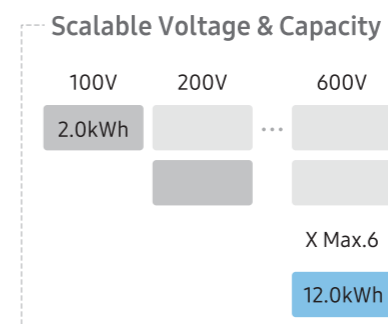
- High Energy 94Ah Prismatic Cell
- High Energy Density & Long Cycle Life
- Available up to 1C-rate
- Fits on 19 inch Standard Rack
- Wide Temperature Range



Item		R1-M048
Component		Battery Module, BMS
Nominal Energy	kWh	4.8
Operating Voltage	V	44.8~58.1
Dimension (W x D x H)	mm	446 x 440 x 158
Weight	kg	35
Operating Temperature	°C	-10~50

HVS Solution New (High Voltage System)

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



Item		R3-M020
Component		Battery Module, BMS
Nominal Energy	kWh	2.0
Operating Voltage	V	88.2 ~ 112.5
Dimension (W x D x H)	mm	191 x 433 x 172
Weight	kg	17.5
Operating Temperature	°C	0~60

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.

SINCE
'10
COUNTRIES
30+
TOTAL GWh
10+



Americas

USA

California 150MWh Deployed 2017~



- Austin, TX 36MW / 14MWh
- El Cajon/Escondido, CA 37.5MW / 150MWh
- Pomona, CA 20MW / 80MWh
- Indianapolis, IN 20MW / 20MWh
- El Centro, CA 30MW / 20MWh
- Tucson, AZ 10MW / 5MWh
- Punta Gorda, FL 10MW / 40MWh

Canada

Sault Sainte Marie, Ontario 8MW / 8MWh

Europe

Germany

Schwerin 15MWh Deployed 2014/17~



- Schwerin 15MW / 15MWh
- Chemnitz 10MW / 10MWh
- Hassfurth 10MW / 10MWh

UK

Leighton Buzzard 10MWh Deployed 2014~



- Leighton Buzzard 6MW / 10MWh
- Barrow in Furness 49MW / 25MWh
- Broxburn 20MW / 22MWh
- Port of Tyne 36MW / 28MWh
- Tynemouth 25MW / 17MWh
- Pelham 50MW / 50MWh

Italy

Potenza 2MW / 2MWh

Netherlands

Zeeland 10MW / 10MWh

Spain

Carboneras 20MW / 12MWh

Asia & Oceania

Korea

KEPCO F/R 38MWh Deployed 2015~



- KEPCO(5 Sites) 128MW / 38MWh
- KOEN(3 Sites) 22MW / 63MWh
- PyeongChang 6MW / 18MWh
- Ulsan 24MW / 51MWh

China

Tibet 28MWh(2 Sites) Deployed 2016~



- Tibet Shuanghu 4MW / 14MWh
- Tibet Gaize 4MW / 14MWh

Japan

Hokkaido 25+MWh(3 Sites) Deployed 2017~



- Hokkaido Shinhidaka 17MW / 9MWh
- Hokkaido Chitose 17MW / 14MWh

Australia

- Alice Spring 6MW / 2MWh
- Western Australia 4MW / 2MWh
- Adelaide 30MW/15MWh

(As of Dec, 2018 Installation & Award)