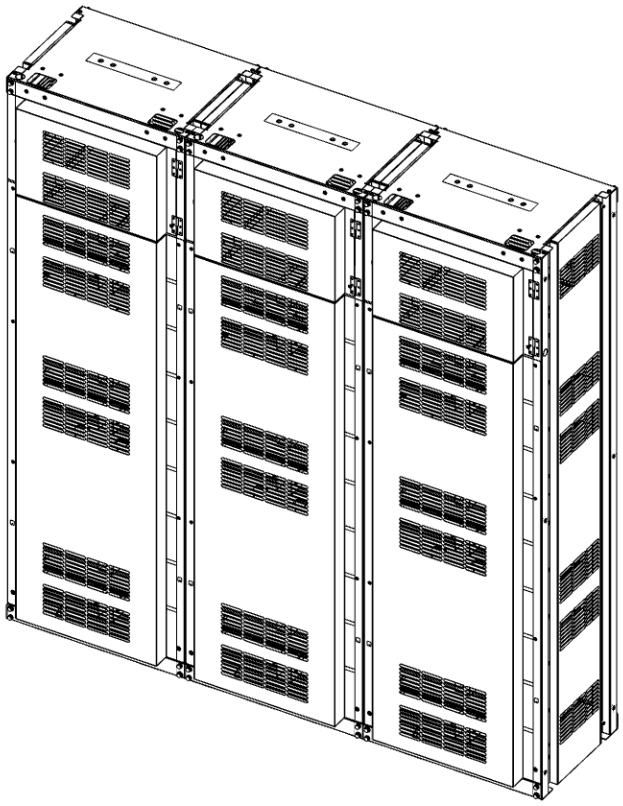
LIB System for UPS – U6A4

Operation and Maintenance Manual
For End Customers



Safety Instructions

Read and follow these instructions!

The following precautions are intended to ensure the user's safety and to prevent equipment and property damage. Before installing, handling, or operating this product, be sure to read all safety instructions in this document.

	**DANGER** Failure to comply with the instructions that have this symbol may result in a serious accident, causing death or severe injury.

	**WARNING** Failure to comply with the instructions that have this symbol may result in a serious accident, causing severe injury.

	**CAUTION** Failure to comply with the instructions that have this symbol may result in minor or moderate injury.

	***NOTICE*** Provides information considered important but not hazard-related. The information relates mainly to potential equipment or property damage if not followed.

	**Important** Indicates valuable tips for optimal installation and proper operation of the product.

General Instructions

Be aware that a battery system presents a serious risk of electrical shock, arc flash, and other hazards when not switched or operated as described in this manual and other supplemental documentation. Follow all safety precautions while installing, handling, or operating any part of the battery system.

- Remove watches, jewelry, rings, and other metallic items.
- Use tools with insulated switches to avoid inadvertent short circuits.
- Wear proper personal protective equipment.
- Do not rest or place tools or any other metal parts on any component of the battery system.
- Disconnect the charging source and/or load before connecting or disconnecting power terminals.
- Use proper lifting means when moving batteries.
- Batteries must be switched, transported and recycled or discarded in accordance with federal, state and local regulations. Refer to the Appendix in this manual for more details on disposal and recycling.
- Do not open or mutilate the batteries.
- Only authorized, properly trained and qualified technicians should perform maintenance.
- Only qualified personnel who are familiar with the batteries and safety precautions should installer maintain the battery system.
- Do not allow unauthorized personnel to contact the batteries.

DANGER

Failure to comply with the instructions that have this symbol may result in a serious accident, causing death or severe injury.

Safety Precautions

The following precautions are general safety guidelines that should be followed when working with or near the Energy Storage System (ESS). The user should develop complete, site-specific safety parameters and procedures.

- Review and refer to all safety warnings and cautions in this manual before installation.
- Build a clear, permanent, restricted access area around the system.
- Only authorized, properly trained electrical operators should be able to access the system.

The interior of this equipment must be considered a “no-go area except for qualified personnel who are familiar with the batteries and safety precautions.” Consult local codes and applicable rules and regulations to determine permit requirements. If required, mark enclosures appropriately before beginning work.

NOTICE

This product shall be installed in a restricted access area where only the qualified personnel who are trained and have the knowledge of the product and the related safety precautions of the installation manual.

“Restricted access area” is area accessible only to the electrically skilled persons and electrically instructed persons with the proper authorization.

Disclaimer

Samsung SDI is given an exemption from warranty for defect and performance in the event of a battery failure for the following reasons, and consequent costs and liabilities are the responsibility of the user.

1) Faults resulting from not following the manuals (Battery Specification, Installation Manual, Operation and Maintenance Manual, Safety & Operation Checksheet) provided by Samsung SDI
2) Battery faults resulting from inadequate storage and transportation
3) Battery faults resulting from arbitrary installation without following the Installation Manual
4) Direct/indirect battery faults resulting from not following Operation and Maintenance Manual
5) Battery faults resulting from operation without installation inspection or operation approval of Samsung SDI
6) Inadequate battery operation or mishandling
7) Operation of the battery system under an inadequate air-conditioning system
8) Disassembly or modification of the battery system by an unauthorized engineer
9) Product damage caused by unforeseen natural disasters
10) Product damage caused by abnormal installation & operating environments including flooding & condensation
11) Use the battery system for purposes that have not been discussed in advance
12) Distribution of the battery system under conditions that have not been discussed and approved by Samsung SDI

Recycling & Disposal Guide

If the battery to be disposed is reused (including disassembly and repair), distributed, or arbitrarily disposed without notice, the customer shall take all necessary measures at the request of the SDI and compensate the SDI for all damages caused by the act above.

Battery System Handling Instructions

1) It is strictly prohibited to disassemble/modify the products without the consent of Samsung SDI.
2) It is strictly prohibited to use the battery system for purposes that have not been agreed in advance. Samsung SDI is not responsible for any consequent tangible/intangible losses.

Personnel and Equipment Warnings

Personnel in contact with the battery system should be aware of the following hazards:

WARNING—SHOCK HAZARD

Do not make contact with high voltage system connectors or terminals. Do not open the enclosure doors unless proper lock out and tag out procedures and related trainings have been followed in accordance with local codes and regulations.

WARNING—ARC FLASH HAZARD

All electrical equipment presents an arc flash hazard. There is a serious risk of arc flash relating to any equipment modification, such as opening doors. Serious injuries can occur in arc flash incidents. Appropriate training is required in accordance with local codes and regulations.

WARNING—FIRE HAZARD

Certain faults may cause a fire.

In case of fire involving electrical equipment, use only carbon dioxide fire extinguishers or those approved for use in fighting electrical fires.

CAUTION—PINCH POINTS

Multiple pinch points are present in most system components. Be aware that there is a serious risk of injury while working around and in equipment enclosures.

CAUTION—STATIC SENSITIVE

Electronic devices can be damaged by electrostatic discharge. Proper handling procedures are required. Be sure to wear a grounded anti-static wrist strap and to discharge static electricity by touching a grounded surface near the equipment before touching any system components.

Dangerous Voltages

DANGER

The Energy Storage System (ESS) is powered by multiple power sources. Hazardous voltages may be present in the equipment even when it does not appear operational. The user is responsible for ensuring that all cautions and warnings in this manual are understood with no exceptions. Failure to do so may result in serious injury or death. Follow all manufacturer-published safety procedures.

Electrical equipment can present a risk of electrical shock and can cause an arc flash. The following precautions must be observed when working on or around electrical equipment:

- Remove watches, jewelry, rings, and other metallic items.
- Use tools with insulated switches to avoid inadvertent short circuits.
- Wear proper personal protective equipment.

Lock Out/Tag Out Guidelines

DANGER

Failure to follow all the applicable lock out/tag out (LOTO) procedures at all times may result in serious injury or death.

With power applied to the ESS, hazardous voltages are present on some components. To prevent death or injury, do not touch any components within the enclosure unless specifically directed to do so. To reduce the risk of electrical shock, make sure that all equipment is properly grounded. For more information, refer to the Installation Manual.

WARNING

Enclosure doors must remain closed except when access to the enclosure interior is required. Personnel should keep a safe distance from enclosures whenever the equipment is energized. Always comply with local, state, and national lock out/tag out guidelines when working with or near the ESS. The LOTO procedures must meet or exceed the requirements of all guidelines presented in Samsung SDI safety documentation. Follow all requirements and recommendations in this manual before entering potentially hazardous areas or beginning work on the ESS.

- Wear proper personal protective equipment.
- Identify and remove all power and stored energy sources. Then, open all MCCBs and confirm that the voltage on the high voltage DC battery bus is zero.
- Apply appropriate LOTO devices (not Samsung SDI scope). When applying a LOTO device to the ESS, do not touch anything within the enclosure except as specifically directed in the work procedures.
- Complete the site-specific LOTO procedure and safety checklist before beginning any work.

General Warnings

DANGER

When energized, the equipment presents a hazard of electric shock, death, and injury. Only authorized, properly trained personnel who are thoroughly familiar with the equipment shall install, operate, and maintain this equipment.

DANGER

To avoid death, injury, and property damage, follow all safety procedures promulgated by local, state, and federal Environmental Health and Safety (EHS) guidelines.

DANGER

To minimize exposure to hazards such electrical shock, death, and injury, approved grounding practices and procedures described in this document must be strictly followed.

WARNING

To avoid injury and equipment damage, personnel must adhere to the site protocol concerning working at heights.

WARNING

To avoid personal injury or equipment damage caused by equipment malfunction, only authorized, qualified, and trained personnel should modify any hardware or software component in the battery system.

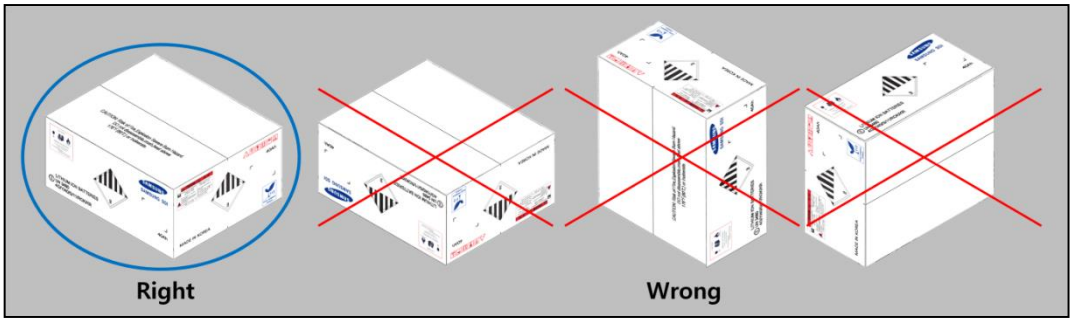
WARNING

Always ensure that applicable standards and regulations are followed and only properly certified equipment is used as a critical component of a safety system. Never assume that a safety-critical control loop is functioning correctly.

Storage Instructions

- When storing or transporting the module in its packaging box, keep the box upright as shown in the figure below. Do not keep the box upside down or on its side.
- Do not stack more than 5 boxes.
- For the long-term storage of modules, SOC shall be kept between 10 and 25% SOC. If long-term storage of modules is required after installation, control power to the system shall be removed (disabled) to prevent cell over-discharge. The storage environmental conditions, including temperature and humidity, and maintenance charge frequency as stated in the table below shall be followed.

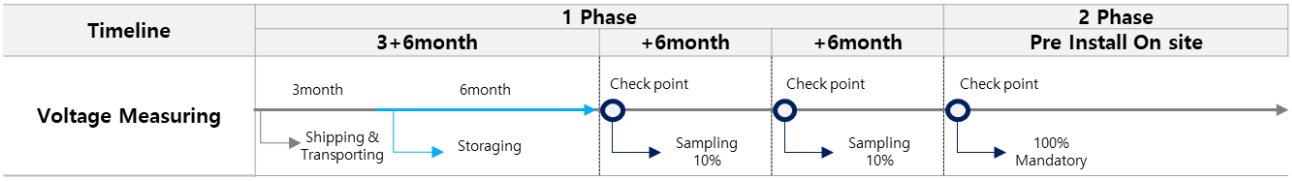
- Batteries have the properties of self-discharge (3% per year). M-BMS to measure the voltage and temperature of each cell, has cells as a power supply (5% per year, when there's communication to the external system). Therefore, regular voltage measurements are required to prevent electric damage resulting from the long-term storage. If necessary, recharge should be performed.



[Fig 1] Module Storage Method

[Table 1] Storage Environment

Item		Standard	Comment
Voltage		**28.712 V – 29.104 V**	It is required to measure the module voltage every 6 months.(After first 9month) Recharge is required if the measured module voltage falls below the range specified in the following guidance. Any cell over-discharge that occurs due to the absence of regular voltage monitoring (and charging, as necessary) beyond the 9-month storage period will be deemed the fault of the customer and will void any product warranty. 1) The module voltage shall remain between the following voltages at all times during storage: 28.712 V (3.589 V/cell) - 29.104 V (3.638 V/cell) 2) The module voltage can be discharged/charged within the following range prior to installation: 21.6 V (2.7 V/cell) - 28.712 V (3.589 V/cell) ※ should charge over 28.712 V(3.589 V/cell) when the module voltage is under 28.712V (3.589V/cell). 3) Notify Samsung SDI if any module measures below 21.6V (2.7 V/cell). 4) After storage and prior to installation, the customer must confirm that the voltage difference between all modules within one rack frame is within 300 mV. 5) After storage and prior to installation, the customer must measure all the modules to install. If SDI request measurement records as needed, it will be Warranty out if submission is not possible.
Temp.	**Module**	**5-28°C**	For convenient battery installation, one of the storage conditions below can be temporarily allowed before installation. The customer should provide Samsung SDI with the records of the storage period and the temperature & humidity management during storage, upon request. - Maximum 6 months: 5 to 28°C - Maximum 1 month: -20 to 40°C - Maximum 3 months: -20 to 40°C, Mean daily maximum temperature within 30°C. If storage is required after installation, the condition of 5 to 28 °C should be maintained for the module. Additional battery degradation may occur depending on the storage period after installation.
	BCU	**5-40°C**	
	Uniformity	**Within 5°C**	Temperature uniformity should be within 5°C during the storage period.
Humidity		**≤ 80%**	There must be no condensation.
Altitude		**≤ 2000m**	-
Pollution Degree		**PD2 or better**	The battery system should be stored under a condition where no foreign substances are generated. (Normally only nonconductive pollution occurs.)



NOTICE

Li-ion batteries may experience lifetime degradation or voltage deviation between each battery cells if they are stored for a long time after shipment or are not charging/discharging. This is an electrochemical phenomenon of li-ion batteries, which is not a significant issue. As this may, however, undermine the system performance, it is, therefore, required to perform cell balancing for two to seven days after installation and before battery operation. Contact Samsung SDI for details.

Personal Protective Equipment (PPE)

Please be aware that batteries have a risk of electric shocks including high short-circuit current. Follow all the safety precautions when operating the battery system. Personnel must wear appropriate PPE according to the table below when installing and maintaining the system. The presented results of arc flash calculation are theoretical values and the calculation is based on the 1P configuration. Therefore, one-level-higher PPE should be applied when actually working with the system.

In order to reduce the risks of arc flash, each battery module is equipped with a fusible link inside, and fast-acting fuses are mounted on the BCU (+) and (-). Arc flash risks are analyzed using the peak current and arc time that are measured through a rack-level assessment, and protective measures are recommended accordingly.

Arc Flash Calculation

Arc energy is calculated like the table below using the arc time identified in the fault current and then PPE is determined according to the arc energy calculation. The incident arc energy will change depending on the platform configuration, contact Samsung SDI for accurate calculations specific to the delivered system.

Fault current will be reduced at EOL (SOH 80%), so the arcing time will increase but the cell impedance will increase about 20%. As a result, the arc energy value will be similar.

[Table 2] Arc Energy Calculation

U6A4 136S		Unit	Derived	Module	Rack w/o BCU	Rack (BOL, 100% SOC, 100% SOH)	Rack (EOL, 100% SOC, 80% SOH)
V_{sys}	System voltage	V	Measured	33.6	571.2	571.2	571.2
R_{sys}	Impedance	Ω	Calculation	0.0036	0.0677	0.0733	0.0856
I_{bf}	Fault current	A	Calculation, Vsys/Rsys	9,333	8,437	7,793	6,673
I_{arc}	Arcing current	A	Calculation, Ibf/2	4,667	4,219	3,896	3,336
T_{arc}	Arcing time	Sec	Measured	0.04	0.0005	0.0005	0.0006
IEm	**Arc Energy at 18”**	**Cal/cm²**	**Calculation**	**0.03001**	**0.005764**	**0.005323**	**0.005470**

U6A4 128S		Unit	Derived	Module	Rack w/o BCU	Rack (BOL, 100% SOH)	Rack (EOL, 80% SOH)
V_{sys}	System voltage	V	Measured	33.6	537.6	537.6	537.6
R_{sys}	Impedance	Ω	Calculation	0.0036	0.0641	0.0693	0.0809
I_{bf}	Fault current	A	Calculation, Vsys/Rsys	9,333	8,387	7,758	6,645
I_{arc}	Arcing current	A	Calculation, Ibf/2	4,667	4,193	3,879	3,323
T_{arc}	Arcing time	Sec	Measured	0.04	0.0005	0.0005	0.0006
IEm	**Arc Energy at 18”**	**Cal/cm²**	**Calculation**	**0.03001**	**0.005392**	**0.004988**	**0.005127**

The L/R time constant values for the 136S configuration are as follows:

- **BOL**: 33.0 µH / 73.3 mΩ
- **EOL**: 33.0 µH / 85.6 mΩ

Approach Boundaries to Live Parts for Shock Protection

Refer the NFPA 70E Tables 130.4(D)(b) for DC System

Arc flash boundary : 1.2m (Under 600V System)

But in case of Event Live Parts are in Enclosure. The Opening increases the energy. recommended Arc Flash Boundary 3.0m(10feet)

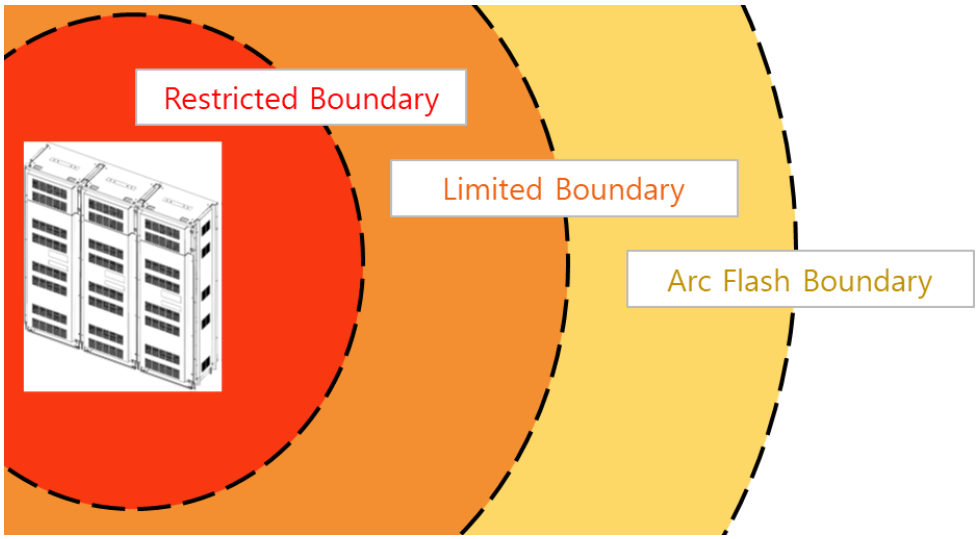
For systems that are 600Volts are less, The Arc Flash Boundary shall be a min of 4feet. An engineering analysis must be performed to determine the Arc Flash Boundary for systems that are above 600Volts
That's the distance where a worker without appropriate PPE would receive second-degree burns.
Sometimes this boundary is the furthest one from the exposed equipment, other times the limited approach boundary is the furthest out. When the arc flash boundary is the furthest away, it becomes the line no one should pass without training and PPE. If the limited approach boundary is further out, then that should be treated as the line no one should pass without training and PPE.

Limited approach boundary : 1.0m by table(DC 301V~1kV)

Within this boundary, it is still possible to be exposed to a shock hazard. Appropriate PPE should be worn by qualified workers in the limited space (space between the limited approach boundary and the restricted boundary). Non-qualified workers should stay outside of this boundary unless wearing proper PPE and being escorted by a worker with specialized training.

Restricted boundary : 0.3m by table(DC 301V~1kV)

The area closest to the live, exposed equipment is within the restricted boundary. In order to pass this boundary, you must be a qualified worker with the proper training and PPE. If you need to perform work on the energized equipment, you may also need a work permit and documentation.



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1. About this Manual

This section describes the purpose, audience, organization, revision history, and acronyms and abbreviations that are used in this document.

1.1 Purpose

The purpose of this manual is to provide the user with information required for the safe and successful operation and maintenance of this product.

1.2 Target Audience

This manual is intended for system administrators, operators, and technicians who are authorized and trained to install, operate, maintain, and configure this product.

1.3 Organization

This manual is composed of the following main sections:

- Section 1, “About this Manual ” provides a description of the purpose and the target audience for this document.
- Section 2, “Product Description” describes the major components that make up the battery system and the main interfaces of each of these components.
- Section 3, “Battery System Operation” explains the various operation modes of the battery system.
- Section 4, “Maintenance Checks” lists items that the user is recommended to inspect at daily, monthly, and annual intervals.

1.4 Revision History

Rev.	Description	Author	Date
0.0	First Release		2025.04.28
0.1	Document Error Correction		2025.05.20

Acronyms and Abbreviations

The following acronyms and abbreviations are used in this manual.

Abbreviations	Full Name
BCU	Battery Control Unit
BMS	Battery Management System
CC-CV	Constant Current-Constant Voltage
CP	Constant Power
EHS	Environmental Health and Safety
EODV	End of Discharge Voltage
ESS	Energy Storage System
LOTO	Lock Out/Tag Out
MCCB	Molded Case Circuit Breaker
OTP	Over Temperature Protection
OVP	Over Voltage Protection
SMPS	Switched Mode Power Supply
BCU	Battery Control Unit
SOC	State Of Charge
SOH	State Of Health
UTP	Under Temperature Protection
UVP	Under Voltage Protection
UPS	Uninterruptible Power Supply

2. Product Description

Before operating the battery system, all users must be familiar with its components.

2.1 Major Components

Samsung SDI's Lithium Ion Battery System is comprised of the following components:

- Battery Module (Type A / Type B)
- BCU
- Rack BMS (embedded in BCU)
- Rack Frame
- SMPS Assembly (Type A / Type B)
- System BMS (embedded in SMPS Assembly Type A)

Component for UL	Model No.	Note
67Ah Cell	CM0630R0002A	
67Ah 8S1P Battery Module Type A	EM2031AE003A	EM2031AE001A for Customer Group B
67Ah 8S1P Battery Module Type B	EM2031AE004A	EM2031AE002A for Customer Group B
Battery Control Unit (BCU)	V049-0011AA or V049-0036AA	UL
SMPS Assembly 3 Phase Type A	V044-0006AA	3 Phase AC input, System BMS
SMPS Assembly 3 Phase Type B	SJ94-00238B	3 Phase AC input, no System BMS
SMPS Assembly 1 Phase Type A	V044-0004AA	1 Phase AC input, System BMS
SMPS Assembly 1 Phase Type B	V044-0005AA	1 Phase AC input, no System BMS
Rack Frame	V808-00068A	Black For general customer

Component for CE	Model No.	Note
67Ah Cell	CM0630R0002A	
67Ah 8S1P Battery Module Type A	EM2031AE003A	EM2031AE001A for Customer Group B
67Ah 8S1P Battery Module Type B	EM2031AE004A	EM2031AE002A for Customer Group B
Battery Control Unit (BCU)	V049-0012AA or V049-0035AA	CE
SMPS Assembly 3 Phase Type A	V044-0006AA	3 Phase AC input, System BMS
SMPS Assembly 3 Phase Type B	SJ94-00238B	3 Phase AC input, no System BMS
SMPS Assembly 1 Phase Type A	V044-0004AA	1 Phase AC input, System BMS
SMPS Assembly 1 Phase Type B	V044-0005AA	1 Phase AC input, no System BMS
Rack Frame	V808-0101BA	Black For general customer

2.1.1 Battery Module (Type A / Type B)

The battery module is the most basic component of the Battery System and it includes serially-connected/parallel-connected battery cells that store the electrochemical energy and a module BMS. The module BMS measures the battery characteristics such as cell voltage and temperature, and monitor the status of each battery. The module BMS digitizes the measured voltage and temperature of each cell, delivers the data to the rack BMS, and receives a command from the rack BMS to control cell balancing. The module BMS communicates with the rack BMS in the BCU via UART interface.

There are two types of battery modules depending on the position of terminal's polarity. A Type A module has its positive (+) terminal is on the right side (when looking from the front), whereas a Type B module has its positive (+) terminal on the left side.

Customer Group A
Type A: EM2031AE003A
Type B: EM2031AE004A

Customer Group B
Type A: EM2031AE001A
Type B: EM2031AE002A

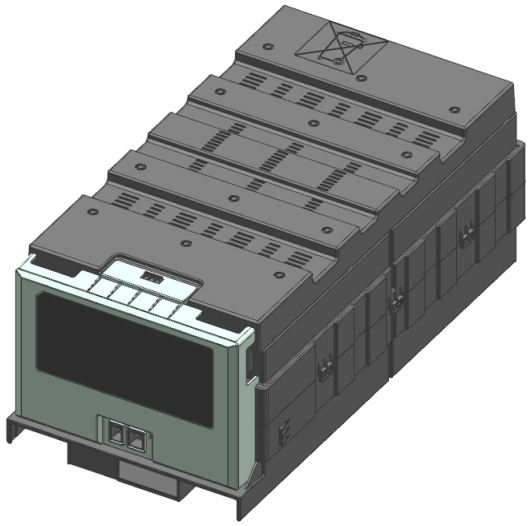
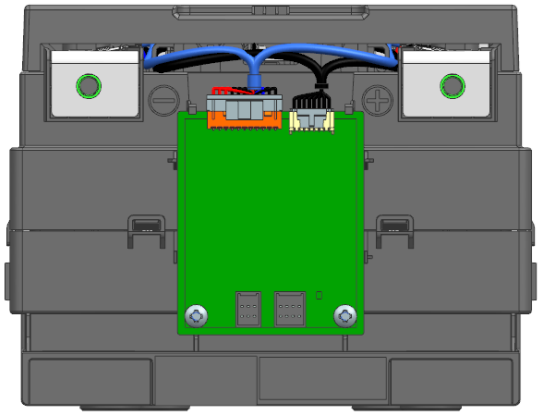
Battery Module Type A (Isometric View)	**Battery Module Type A (Front cover removed)**
	

Figure 2-1: Battery Module Type A

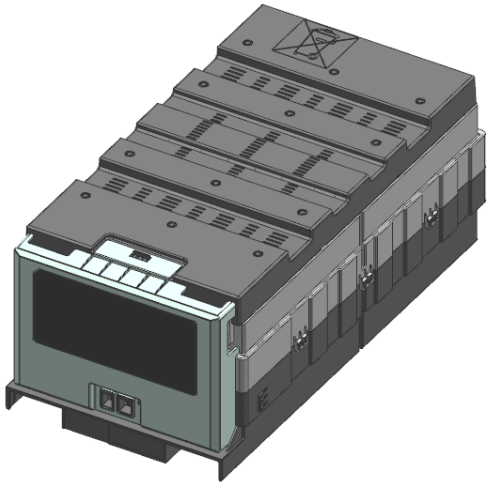
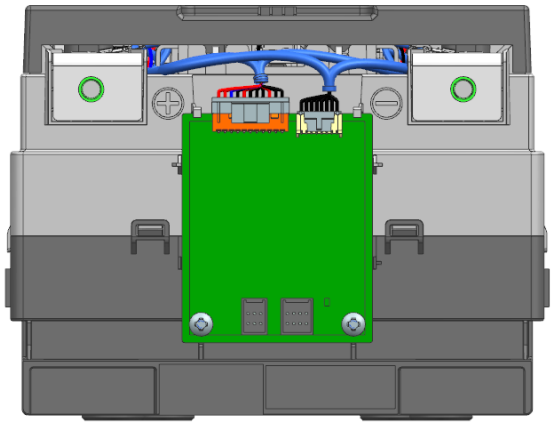
Battery Module Type B (Isometric View)	Battery Module Type B (Front cover removed)
	

Figure 2-2: Battery Module Type B

2.1.2 BCU (Battery Control Unit)

The BCU collects all data and status information from the modules that reside in the same string and it also controls the main power line switch and enables cell balancing. The BCU calculates the SOC and SOH of the battery system. Key components in the BCU include the Rack BMS, a MCCB, and a shunt resistor to measure the rack current. The Rack BMS is the main string-level controller that collects all data from the Module BMS, measures the string voltage and current, determines the state of the battery string, and controls the MCCB.

Customer Group A
UL: V049-0011AA or V049-0036AA
CE: V049-0012AA or V049-0035AA

Customer Group B
UL: V049-0011BA
CE: V049-0012BA

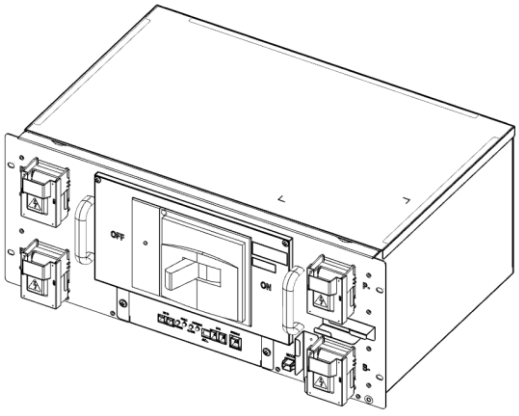


Figure 2-3: BCU

The BCU provides an optional, auxiliary breaker switch that can be connected to the building monitoring system, if desired.

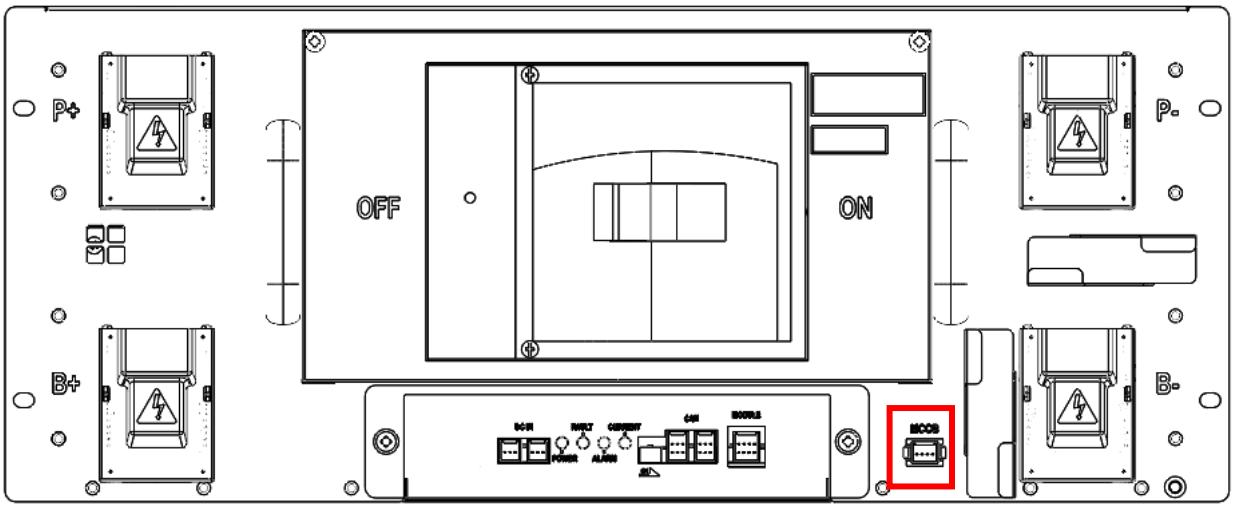


Figure 2-4: Optional Auxiliary Breaker Switch

The P+ and P- terminal blocks connect to the DC link from the UPS. The B+ and B- terminal blocks connect internal to the string before the MCCB. Cables that connect between the BCU and the Battery Modules are provided as part of Samsung SDI's scope of supply. The system integrator is responsible for sourcing the cable and lug terminals that connect to the P+ and P- terminal blocks; these should be selected according to the terminal block's size and material.

Figure 2-5: Terminal Block Isometric View

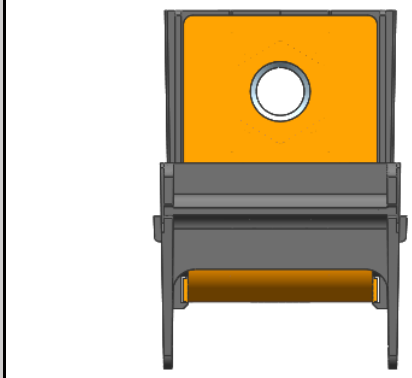
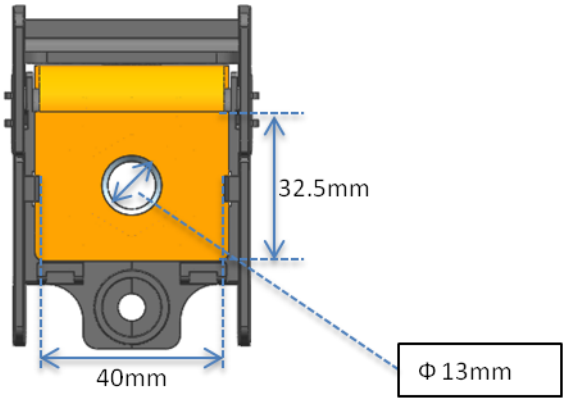
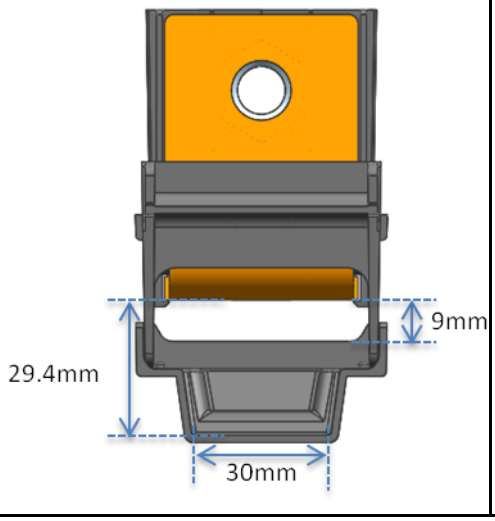
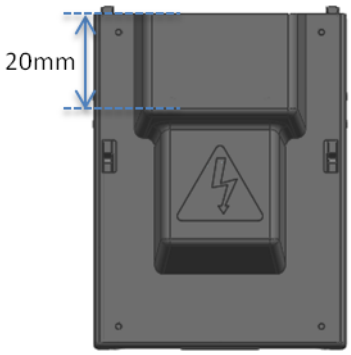
	Top View	Front View
COVER OPEN		
COVER CLOSED		

Figure 2-6: Terminal Block Front / Top View (Cover Opened/Closed)

Table 2-1: Terminal Block Description

Item	Detail	Description
Conducting Material	Cu	C1100
Insulating Material (Guide)	PA66	GF25%
Insulating Material (Cover)	PC	
Conductive Area	32.5mm x 40.0mm	
Rated Current	473A	Calculated in accordance with DIN 43670 MELSON & BOTH equation

Table 2-2: Cable and lug terminal requirements

Terminal Name	Wire No.	Terminal Type	Description
P+	300 sq mm or thicker	M12 Single Hole Lug Terminal	Connects to DC link positive
P-	300 sq mm or thicker	M12 Single Hole Lug Terminal	Connects to DC link negative

The BCU features a CAN bus termination resistor that can be set to either ON or OFF, depending on the rack's position in the battery bank. Only the last rack in a CAN bus daisy chain shall have its termination resistor switch set in the ON position (i.e. terminated), while all other racks in the bank shall have the switch set in the OFF position (i.e. unterminated). Incorrect termination resistor switch settings will result in loss of communications with rack BMS.

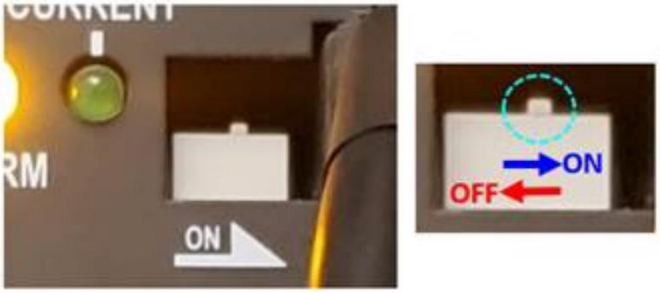


Figure 2-7: Termination Switch Setting

2.1.3 SMPS Assembly (Type A / Type B)

Customer Group A

- 3-Phase Type A (with System BMS): V044-0006AA
- 3-Phase Type B (without System BMS): SJ94-00238B
- 1-Phase Type A (with System BMS): V044-0004AA
- 1-Phase Type B (without System BMS): V044-0005AA

Customer Group B

- 3-Phase Type A (with System BMS): V044-0006BA
- 1-Phase Type A (with System BMS): V044-0004BA

The SMPS Assembly houses both the System BMS (if Type A) and redundant SMPS units, which accepts external AC power and converts to DC control power used by the System BMS and BCU. Two options are available for the SMPS depending on the AC input range and cabling: 3-Phase AC and 1-Phase AC. The System BMS assembly provides data to the external systems (i.e. building management system, UPS, etc.) while controlling and monitoring all connected Rack BMS units. The max number of racks that can be controlled by a single System BMS in a battery bank is 20.

There are two types of SMPS Assembly: Type A includes the System BMS and Type B excludes the System BMS.

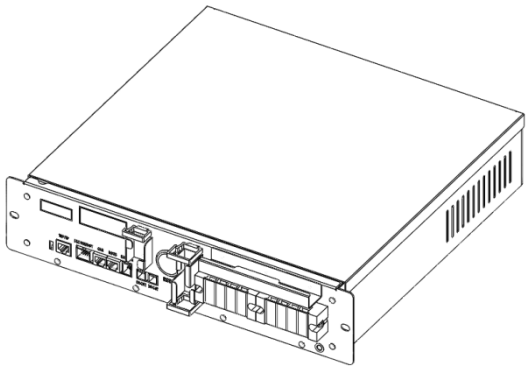
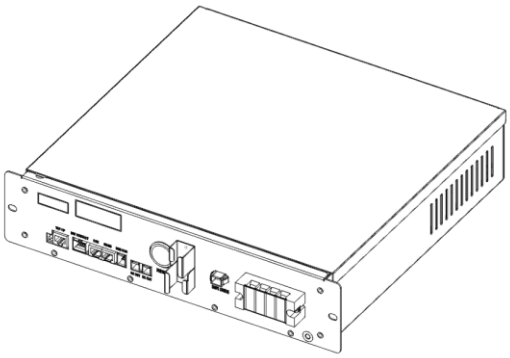
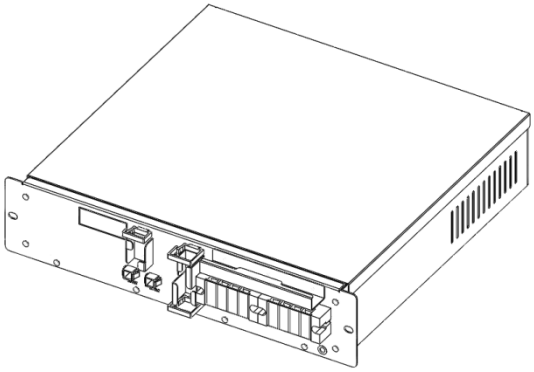
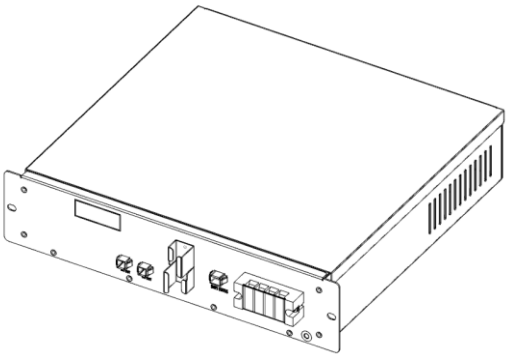
SMPS Assembly with 3-Phase AC Input	SMPS Assembly with 1-Phase AC Input
	
Type A (with System BMS)	
	
Type B (without System BMS)	

Figure 2-8: SMPS Assembly

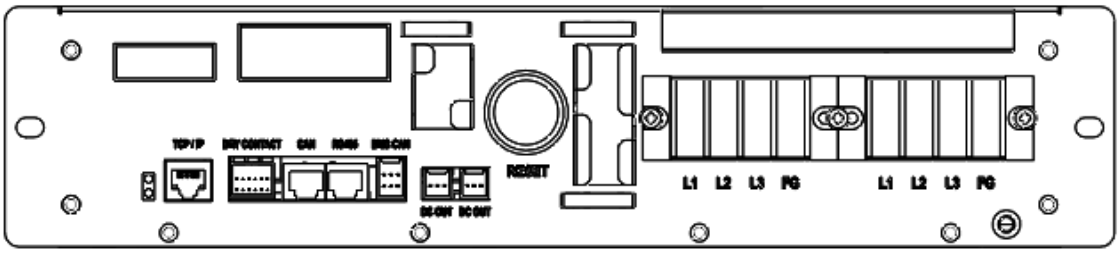


Figure 2-9: Front View of SMPS Assembly Type A, 3-Phase AC Input

There are two SMPSs that connected with left and right AC input terminal block by OR connection method.

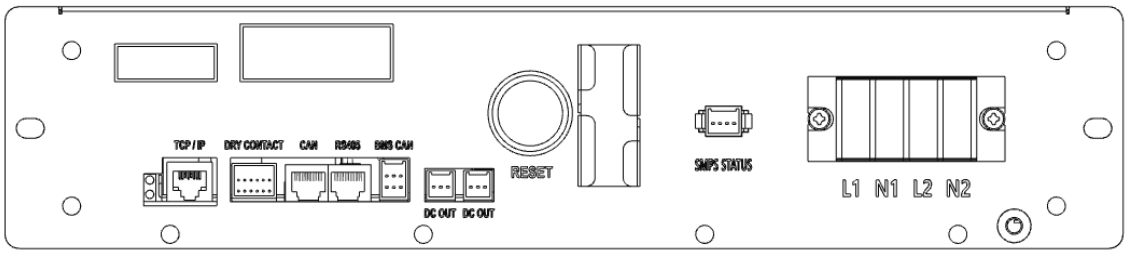


Figure 2-10: Front View of SMPS Assembly Type A, 1-Phase AC Input

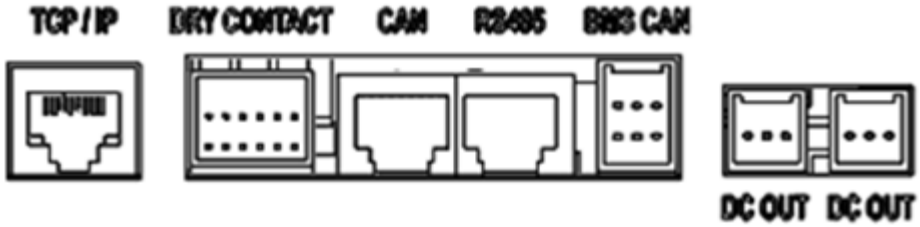


Figure 2-11: SMPS Assembly Type A – System BMS Connections

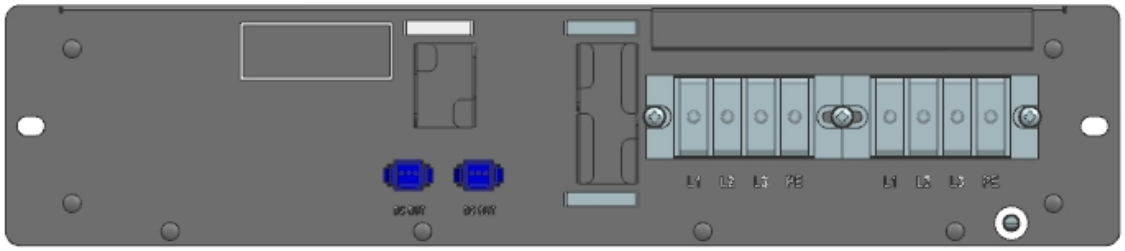


Figure 2-12: Front View of SMPS Assembly Type B, 3-Phase Input

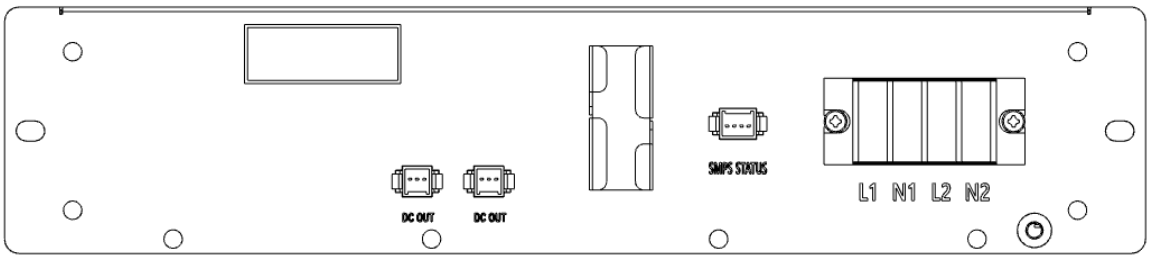


Figure 2-13: Front View of SMPS Assembly Type B, 1-Phase Input

2.1.4 Rack Frame

Customer Group A
UL: V808-00068A
CE: V808-0101BA

Customer Group B
UL: V808-00066A
CE: V808-0100BA

The Rack Frame is used to mount the modules, the BCU, and the SMPS Assembly and also provides ground connections for the BCU and the SMPS Assembly.

Grounding cable/busbar for the rack frame is necessary for the BCU and the SMPS Assembly as they are grounded to the rack frame when installed.

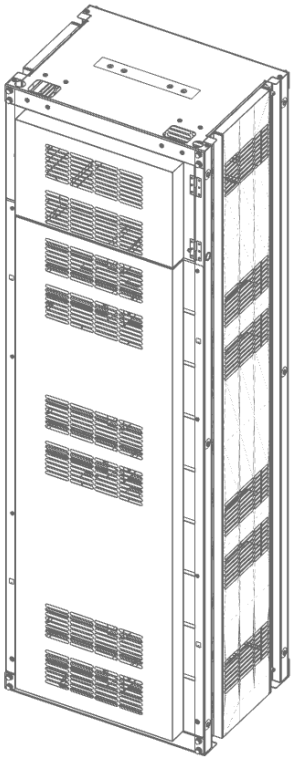


Figure 2-14: Rack Frame

2.2 Product Specification

Table 2-3: Battery System General Specification

No.	Item		Specification	Remarks
1	Dimension [mm (inch)]	BCU	583 x 359.6 x 235.6 (22.95 x 14.16 x 9.28)	
		Battery Module	403.5 x 214 x163 (15.89 x 8.43 x 6.42)	Type A and Type B
		SMPS Assembly 3-Phase	397.4 x 355.6 x 85.5 (15.64 x 14 x 3.37)	Type A and Type B
		SMPS Assembly 1-Phase	397.4 x 355.6 x 85.5 (15.64 x 14 x 3.37)	Type A and Type B
		Rack Frame	650 x 530 x 2055 (25.59 x 20.87 x 80.91)	
2	Weight [kg (lb)]	BCU	About 18 (40)	
		Battery Module	About 16.5 (36)	Type A and Type B
		SMPS Assembly	About 5 (11)	Type A and Type B
		Rack Frame	About 163.4 (360)	
		136S Battery System	About 510 (1124)	
		128S Battery System	About 493 (1087)	
		112S Battery System	About 459 (1012)	
		104S Battery System	About 44, (974)	
		96S Battery System	About 425 (937)	
		80S Battery System	About 391 (862)	
3	Minimum String Capacity		67 Ah	1/3C (22.3A) charge and discharge @ 25˚C
4	Recommended Operation Temperature		23 ± 5°C	
5	Recommended Operation Humidity		Less than 60% RH	Noncondensing
6	Recommended Storage Period		Less than 6 months	
7	Communication (Internal)		Differential UART, 2 Mbps	BCU – Battery Module
8	Communication (External) 1		Modbus RS485	UPS – SMPS Assembly No Support Multi-drop Communication
9	Communication (External) 2		Modbus TCP/IP	UPS – SMPS Assembly
10	Communication (External) 3		Dry contact	UPS – SMPS Assembly
11	IP Rating		IP20	
12	Protective Class		I	

.

Table 2-4: 136S String Specification

No.	Item	Specification	Remarks
1	**Number of Module**	17	8 Type A 9 Type B
2	**Nominal Capacity**	34.6kWh	1/3C @25°C
3	**Nominal Voltage[1]**	516.8V DC	3.8V/cell
4	**Maximum Voltage[1]**	571.2V DC	4.2V/cell
5	**Discharging Method #1**	Constant Power	
	Discharging Method #2	Constant Current	Max 450A
	End of Discharge Voltage[1]	408V DC	3.0V/cell
	Recommended End of Discharge Voltage[1]	435.2V DC	3.2V/cell
	Standard Discharging Current[1]	22.3A	1/3C @25°C
	Rated Continuous Discharge Power[1]	183.6kW	Peak 450A @ EODV
6	**Charging Method**	CC-CV, Floating	
	Floating Charging Voltage[1]	571.2V DC	4.2V/cell
	Standard Charging Current[1]	22.3A	1/3C
	Maximum Peak Charging Current[1]	250A	2 second pulse
	Maximum Continuous Charging Current[1]	67A	1C

[1] Specified voltage and current must be satisfied in all load and charging conditions.

NOTICE

Notice: After a full discharge at maximum continuous discharge power, cool the battery for at least 12 hours before another discharge in order to avoid over-temperature protection. Immediate recharging is allowed with standard charging current. For optimal performance, wait until the battery temperature returns to at least ±3°C within the room temperature.(Ex, for using maximum current discharging after maximum current charging(1C), cool the battery for at least 12hours after charging in order to avoid over-temperature protection)

Table 2-5: 128S String Specification

No.	Item	Specification	Remarks
1	**Number of Module**	16	8 Type A 8 Type B
2	**Nominal Capacity**	32.6kWh	1/3C@R.T
3	**Nominal Voltage[1]**	486.4V DC	3.8V/cell
4	**Maximum Voltage[1]**	537.6V DC	4.2V/cell
5	**Discharging Method #1**	Constant Power	
	Discharging Method #2	Constant Current	Max 450A
	End of Discharge Voltage[1]	384V DC	3.0V/cell
	Recommended End of Discharge Voltage[1]	409.6V DC	3.2V/cell
	Standard Discharging Current[1]	22.3A	1/3C@R.T
	Rated Continuous Discharge Power[1]	172.8kW	Peak 450A @ EODV
6	**Charging Method**	CC-CV, Floating	
	Floating Charging Voltage[1]	537.6V DC	4.2V/cell
	Standard Charging Current[1]	22.3A	1/3C
	Maximum Peak Charging Current[1]	250A	2 second pulse
	Maximum Continuous Charging Current[1]	67A	1C

[1] Specified voltage and current must be satisfied in all load and charging conditions.

NOTICE

Notice: After a full discharge at maximum continuous discharge power, cool the battery for at least 12 hours before another discharge in order to avoid over-temperature protection. Immediate recharging is allowed with standard charging current. For optimal performance, wait until the battery temperature returns to at least ±3°C within the room temperature.(Ex, for using maximum current discharging after maximum current charging(1C), cool the battery for at least 12hours after charging in order to avoid over-temperature protection)

Table 2-6: 112S String General Specification

No.	Item	Specification	Remarks
1	Number of Module	14	6 Type A 8 Type B
2	Nominal Capacity	28.5kWh	1/3C@R.T
3	Nominal Voltage[1]	425.6V DC	3.8V/cell
4	Maximum Voltage[1]	470.4V DC	4.2V/cell
5	Discharging Method #1	Constant Power	
	Discharging Method #2	Constant Current	Max 450A
	End of Discharge Voltage[1]	336V DC	3.0V/cell
	Recommended End of Discharge Voltage[1]	358.4V DC	3.2V/cell
	Standard Discharging Current[1]	22.3A	1/3C@R.T
	Rated Continuous Discharge Power[1]	151.2kW	Peak 450A @ EODV
6	Charging Method	CC-CV, Floating	
	Floating Charging Voltage[1]	470.4V DC	4.2V/cell
	Standard Charging Current[1]	22.3A	1/3C
	Maximum Peak Charging Current[1]	250A	2 second pulse
	Maximum Continuous Charging Current[1]	67A	1C

[1] Specified voltage and current must be satisfied in all load and charging conditions.

Notice: After a full discharge at maximum continuous discharge power, cool the battery for at least 12 hours before another discharge in order to avoid over-temperature protection. Immediate recharging is allowed with standard charging current. For optimal performance, wait until the battery temperature returns to at least ±3°C within the room temperature.(Ex, for using maximum current discharging after maximum current charging(1C), cool the battery for at least 12hours after charging in order to avoid over-temperature protection)

Table 2-7: 104S String General Specification

No.	Item	Specification	Remarks
1	Number of Module	13	6 Type A 7 Type B
2	Nominal Capacity	26.5kWh	1/3C@R.T
3	Nominal Voltage[1]	395.2V DC	3.8V/cell
4	Maximum Voltage[1]	436.8V DC	4.2V/cell
5	Discharging Method #1	Constant Power	
	Discharging Method #2	Constant Current	Max 450A
	End of Discharge Voltage[1]	312V DC	3.0V/cell
	Recommended End of Discharge Voltage[1]	332.8V DC	3.2V/cell
	Standard Discharging Current[1]	22.3A	1/3C@R.T
	Rated Continuous Discharge Power[1]	140.4kW	Peak 450A @ EODV
6	Charging Method	CC-CV, Floating	
	Floating Charging Voltage[1]	436.8V DC	4.2V/cell
	Standard Charging Current[1]	22.3A	1/3C
	Maximum Peak Charging Current[1]	250A	2 second pulse
	Maximum Continuous Charging Current[1]	67A	1C

[1] Specified voltage and current must be satisfied in all load and charging conditions.

Notice: After a full discharge at maximum continuous discharge power, cool the battery for at least 12 hours before another discharge in order to avoid over-temperature protection. Immediate recharging is allowed with standard charging current. For optimal performance, wait until the battery temperature returns to at least ±3°C within the room temperature.(Ex, for using maximum current discharging after maximum current charging(1C), cool the battery for at least 12hours after charging in order to avoid over-temperature protection)

Table 2-8: 96S String General Specification(CE only)

No.	Item	Specification	Remarks
1	Number of Module	12	6 Type A 6 Type B
2	Nominal Capacity	24.4kWh	1/3C@R.T
3	Nominal Voltage[1]	364.8V DC	3.8V/cell
4	Maximum Voltage[1]	403.2V DC	4.2V/cell
5	Discharging Method #1	Constant Power	
	Discharging Method #2	Constant Current	Max 450A
	End of Discharge Voltage[1]	288V DC	3.0V/cell
	Recommended End of Discharge Voltage[1]	307.2V DC	3.2V/cell
	Standard Discharging Current[1]	22.3A	1/3C@R.T
	Rated Continuous Discharge Power[1]	129.6kW	Peak 450A @ EODV
6	Charging Method	CC-CV, Floating	
	Floating Charging Voltage[1]	336V DC	4.2V/cell
	Standard Charging Current[1]	22.3A	1/3C
	Maximum Peak Charging Current[1]	250A	2 second pulse
	Maximum Continuous Charging Current[1]	67A	1C

[1] Specified voltage and current must be satisfied in all load and charging conditions.

Notice: After a full discharge at maximum continuous discharge power, cool the battery for at least 12 hours before another discharge in order to avoid over-temperature protection. Immediate recharging is allowed with standard charging current. For optimal performance, wait until the battery temperature returns to at least ±3°C within the room temperature.(Ex, for using maximum current discharging after maximum current charging(1C), cool the battery for at least 12hours after charging in order to avoid over-temperature protection)

Table 2-9: 80S String General Specification

No.	Item	Specification	Remarks
1	Number of Module	10	4 Type A 6 Type B
2	Nominal Capacity	20.4kWh	1/3C@R.T
3	Nominal Voltage[1]	304V DC	3.8V/cell
4	Maximum Voltage[1]	336V DC	4.2V/cell
5	Discharging Method #1	Constant Power	
	Discharging Method #2	Constant Current	Max 450A
	End of Discharge Voltage[1]	240V DC	3.0V/cell
	Recommended End of Discharge Voltage[1]	256V DC	3.2V/cell
	Standard Discharging Current[1]	22.3A	1/3C@R.T
	Rated Continuous Discharge Power[1]	108kW	Peak 450A @ EODV
6	Charging Method	CC-CV, Floating	
	Floating Charging Voltage[1]	336V DC	4.2V/cell
	Standard Charging Current[1]	22.3A	1/3C
	Maximum Peak Charging Current[1]	250A	2 second pulse
	Maximum Continuous Charging Current[1]	67A	1C

[1] Specified voltage and current must be satisfied in all load and charging conditions.

Notice: After a full discharge at maximum continuous discharge power, cool the battery for at least 12 hours before another discharge in order to avoid over-temperature protection. Immediate recharging is allowed with standard charging current. For optimal performance, wait until the battery temperature returns to at least ±3°C within the room temperature.(Ex, for using maximum current discharging after maximum current charging(1C), cool the battery for at least 12hours after charging in order to avoid over-temperature protection)

Table 2-10: String Configurations

Configurations	1P136S	1P128S	1P112S	1P104S	1P96S	1P80S
Model Name	PHR3462-001A	PHR3262-001A	PHR2852-001A	PHR2652-001A	PHR2442-001A	PHR2042-001A
Nominal Energy (kWh)	34.6	32.6	28.5	26.5	24.4	20.4
Nominal Voltage (Vdc)	516.8	486.4	425.6	395.2	364.8	304
Nominal Capacity (Ah)	67	67	67	67	67	67
Recommended CC (A)	22.3	22.3	22.3	22.3	22.3	22.3
Recommended CV (Vdc)	571.2	537.6	470.4	436.8	403.2	336.0
End Charge Current (A)	3.35	3.35	3.35	3.35	3.35	3.35
Voltage Range (Vdc)	408.0 - 571.2	384.0 - 537.6	336.0 - 470.4	312 - 436.8	288 - 403.2	240 - 336
Number of Modules	17 EA. Type A: 8 EA. Type B: 9 EA.	16 EA. Type A: 8 EA. Type B: 8 EA.	14 EA. Type A: 6 EA. Type B: 8 EA.	13 EA. Type A: 6 EA. Type B: 7 EA.	12 EA. Type A: 6 EA. Type B: 6 EA.	10 EA. Type A: 4 EA. Type B: 6 EA.
Weight (kg)	510	493	459	442	425	391

2.3 System Block Diagram

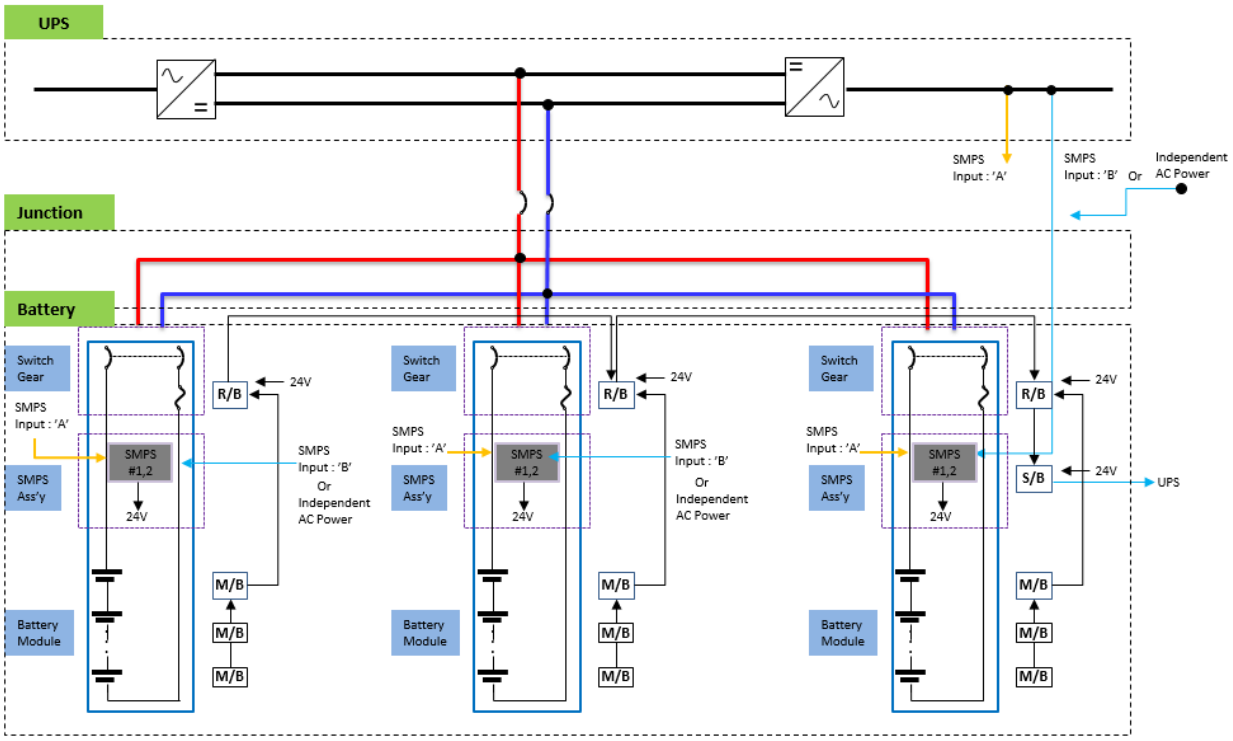


Figure 2-15: System Block Diagram

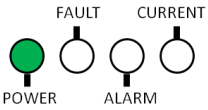
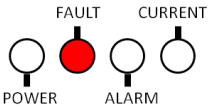
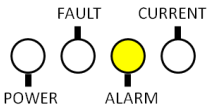
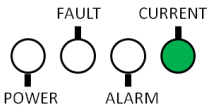
3. Battery System Operation

The battery system for a UPS application is designed to be always on and in standby. The UPS and the critical load must be set up so that the battery system's minimum and maximum allowable voltage and maximum allowable current are never exceeded. This section includes information regarding the different operating modes as well as system status indicators that can be monitored by the user.

3.1 BCU Status LED Panel

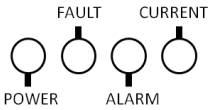
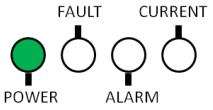
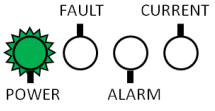
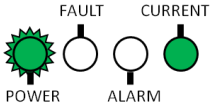
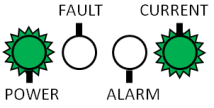
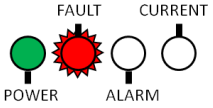
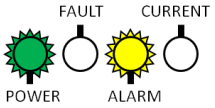
There are four status LED's on the front of each BCU in each rack that displays the status of the string. Table 3-1 shows each LED's color and the status definition.

Table 3-1: Status LED Definitions

Items	POWER(Green)	FAULT(Red)	ALARM(Yellow)	CURRENT(Green)
Location				
Status	On: MCCB Off (Open) Off: Power Off Blink: MCCB On (Closed)	On: N/A Off: No Major Protection Blink: Major Protection Active	On: N/A Off: No Minor Protection Blink: Minor Protection Active	On: Discharging Off: Idle Blink: Charging

Depending on the operating conditions, each status LED may be on, blinking, or off. Table 3-2 presents the status of each rack depending on which combination of LEDs are on or off..

Table 3-2: Indicated Codes

LED Status	Rack Status	Remarks
 All LED's Off	BMS Power Off	MCCB Off (Open)
 POWER LED Steady	Normal	MCCB Off (Open)
 POWER LED Flashing	Normal	MCCB On (Closed)
 POWER LED Flashing CURRENT LED Steady	Normal	Discharging
 POWER LED Flashing CURRENT LED Flashing	Normal	Charging
 POWER LED Steady FAULT LED Flashing	Major Protection Active MCCB Tripped (Open)	Overvoltage Protection Undervoltage Protection Overtemperature Protection Overcurrent Protection Voltage Imbalance Error Voltage Sensing Error (CE model only)
 POWER LED Flashing ALARM LED Flashing	Minor Protection Active MCCB On (Closed)	Voltage Sensing Error (UL model only) Under temperature Protection Temperature Imbalance Error

3.2 Environmental Conditions of Operation

As battery modules are sensitive to temperature, the temperature characteristics specified in the table below shall be observed at all times. Periodic inspection is required to prevent any abnormalities that could cause accelerated capacity loss. Humidity, water leakage, and condensation can negatively impact battery safety, so periodic inspection is required. Temperature and humidity management records should be stored by customers in a designated server. Customers have the responsibility of submitting the records to Samsung SDI, if required.

Table 3-3: Environmental Conditions of Operation

Parameter			Specification	Comment
Temperature / Humidity Management in the Battery Room	Temp.	Mean Value	≤ 23°C	1) Daily average temperature of the entire battery room 2) Measure at the front of the module 3) Customers determine the measurement location that can represent the entire battery room temperature.
		Deviation	±5°C	1) Hourly average 2) Ambient temperature
		Uniformity	≤ 5°C	1) Rack temperature difference between the maximum and minimum 2) Ambient temperature
	Humidity		less than 60%, Non-condensation	

The outside air shall go through a dust filter to prevent the deterioration of the insulation performance resulting from dust. Sea water filters are also required if there is a possibility of intrusion by sea salt aerosols. The battery room should be sealed from the external environment to prevent condensation from forming on the battery system due to the temperature difference between internal and external air. The sealed areas must be checked regularly for condensation build up.

If the temperature condition of operation cannot be met due to HVAC failure or control power problem, stop the battery operation immediately and take necessary measures for HVAC restart. If the battery is operated even when the HVAC fails or the HVAC is out of operation for a long time, the battery system can be excluded from all product and performance warranties.

3.2.1 Normal Operation

During normal operation, the battery system is available for charge or discharge. The system operator must follow the guidelines below to ensure safe and optimal performance from the battery.

- The battery must be in a fully charged state to power the critical load for the full backup duration.
- After a high power discharge, the battery must cool for at least 12 hours before another discharge in order to avoid over-temperature protection. For optimal performance, wait until the battery temperature returns to at least 3^{o}C within the room temperature.
- Immediate recharging at any rate above the standard charging current (C/3) after a high power discharge may degrade the battery performance.

3.2.2 Minor Protection Operation

When a minor protection occurs, the battery system will send a message to the UPS or other systems and request to correct the problem. Battery system will not be disconnected in minor protection status to maximize the battery's availability.

Contact the Supplier Service Agent for solutions to clear minor protection status.

3.2.3 Major Protection Operation (Fault)

If the system detects a major protection (fault status), it will trip (open) the MCCB to disconnect the affected string(s) from the UPS to prevent damage to the battery. After a major protection event, measures must be taken to identify and correct the cause of the event, before clearing the fault and returning the strings to normal operation. Personnel must be on-site to manually return the MCCB from the "trip" to the "on" position after returning the system status to normal.

Contact the Supplier Service Agent for solutions to clear major protection status.

4. Maintenance Checks

The components that make up the battery system are designed to be free of regular maintenance. However, regular inspection of components and power connections are recommended to ensure proper performance. Refer to Section 3.3 “Environmental Conditions of Operation” for more information on the range of operating conditions.

4.1 Daily Checks

The following is a list of tasks that the user should check daily.

- Each rack voltage should be at its floating charge voltage.
- The cell voltage range internal to each string (i.e. difference between the maximum and minimum cell voltage) should be within 300 mV; however, a well-balanced string’s cell voltage range should be within 20 mV. Contact the Supplier Service Agent for more details on how to correct cell voltage imbalance.
- The MCCB shall be ON for all racks.
- There must be no active minor protection (alarms) or active major protection (faults) broadcasted by the system BMS.
- The ambient room temperature and the relative humidity shall comply with the range of operating conditions described in this document and must be recorded / logged.

4.2 Monthly Checks

Personnel shall visually inspect the battery system at least on a monthly basis and review battery and environmental log data. The following is a list of items that the user shall perform monthly.

- The battery shall have no visible damage (rust, bent structure, damaged or missing cables or busbars, etc.). Discontinue battery operations and contact Samsung SDI if you suspect damage to any part of the system.
- Check the recorded data of the battery system for the voltage and current readings by Blue lite S/W.
- Record the date and time of charge and discharge cycles.
- Record whether any minor protection (alarms) or major protection (faults) were triggered.

4.3 Annual Check

A trend analysis of the recorded data (battery and environment) is recommended.

4.4 Maintenance Checklist

Refer to the following checklist template for scheduled checks. Detailed recordings may be necessary depending on the level of maintenance required by the user. Use the table below to check the criteria for each item. Refer to the Product Specification and Installation Manual for more details.

Table 4-1: Maintenance Checklist Template

Items	Criteria	Location	Schedule	Result
Battery Status	1. Battery voltage a) Rack voltage check b) Cell voltage check (max/min difference) 2. Alarm or faults: No alarms or faults were set 3. MCCB status: All ON (closed)	Control room	Daily	
	1. Alarm or protection: No alarms or protections set Check the indicator LED's in each rack 2. MCCB status: All ON (closed) Check the position of the MCCB switch	On-Site	Weekly	
	Visual Inspection: check for physical damages to the system (rust, bent structure, damaged or missing cables, etc.)	On-Site	Monthly	
	Measure the contact resistance of battery terminal and busbar and confirm that it is less than 40μΩ. It is recommended to keep the contact resistance in all terminals below 30μΩ.	On-Site	Semi-annual	
Environment	Record ambient temperature (measured from facility's HVAC unit or other measurement devices). The daily average shall be ≤ 23°C. Confirm that the battery room temperature is uniform and is < 5°C across a rack.	Control Room and/or On-Site	Daily	
	Humidity (measured from facility's HVAC unit or other measurement device)		Daily	
Recorded Data	1. Recorded voltage and current 2. Date and time of charge and discharge cycles 3. Number of alarms and faults recorded	Control Room	Monthly	
	1. Recorded voltage and current 2. Date and time of charge and discharge cycles 3. Number of alarms and faults recorded 4. Record of temperature and humidity (measured from facility's HVAC unit or other measurement device)	Control Room	Annual	

5. Appendix

5.1 Disposal and Recycling

For recycling, contact the manufacturer. Contaminated packaging must be disposed in accordance with local regulations.

1) Samsung SDI li-ion batteries are recyclable.

2) Do not dispose Samsung batteries with general waste. Please follow the regulations and disposal instructions provided by manufacturers. Please contact the sales for the disposal instructions.

3) The customer is responsible for module disposal. The battery shall be disposed through an authorized waste disposal company in accordance with local regulations. In the following situations, do not use the battery and dispose it according to local regulations.

   - The battery is exposed to accidents, such as condensation, drop, shock, fire (including high temperature exposure), moisture inflow, etc.
   - Battery is damaged or deformed.
   - Battery usage is terminated due to customer situation
   - Battery status after EOL (SOH70% or less)
   - If the battery to be disposed is reused (including disassembly and repair), distributed, or arbitrarily disposed without notice, the customer shall take all necessary measures at the request of the SDI and compensate the SDI for all damages caused by the act above.

5.2 Data Log Requirement

For performance warranty and fault analysis, customers should keep the usage patterns and battery data in an additional server and provide them to Samsung SDI, if required.

5.2.1 Warranty Claim Upon Failure / Alarm / Protection

Tables 6-1 and 6-2 outline the data required for analysis by Samsung SDI if any failure event (alarm, protection, communication loss, etc…) occurs. Table 6-1 shows the required data 7 days leading up to the failure event. This data must be saved on the customer server for at least 7 days. Table 6-2 shows the required log data 24 hours before and after the failure event. (A total of 72 hours of data are required, including 24 hours on the day of occurrence). This data must be saved on the customer server for at least 1 year. The data storage requirements outlined can be met using Samsung SDI's Data BMS. Just in case (Data BMS is destroyed by fire, etc. at the site)
It is recommended to operate a monitoring server for separate data storage.
The data log format must be equivalent to the BATTMON program provided by Samsung SDI for an accurate analysis when it is sent.

※ Data logging requirements in the contract are prioritized over the O&M Manual.

※ The cell detail information data collected 1 hour before and after (total 2 hours) the alarm p rotection should be saved every second.

Table 6-1: Real time Data for analyze of issue (Overwritten every 7 days)

Data	Unit	Accuracy	Resolution
Cell Summation Voltage	V	0.1	10 min
Rack Voltage	V	0.1	10 min
Rack Current Real - real current	A	0.1	10 min
Rack Current Avg - 3s moving average current	A	0.1	10 min
Rack SOC	%	0.1	10 min
Rack SOH	%	0.1	10 min
Rack Alarm	bit	0.1	10 min
Rack Minor Protection	bit	1	10 min
Rack Major Protection	bit	1	10 min
Rack Switch Control Info.	bit	1	10 min
Rack Switch Sensor Info.	bit	1	10 min
Rack External Sensor Info.	bit	1	10 min
Rack Min Cell Voltage	V	0.001	1 sec
Rack Max Cell Voltage	V	0.001	1 sec
Rack Min Temperatures	℃	0.01	1 sec
Rack Max Temperatures	℃	0.01	1 sec

Table 6-2: Event Data for analyze of issue - Logged upon ALM/PROTECTION (24h/Event/24h)

Data	Unit	Accuracy	Resolution
Cell Summation Voltage	V	0.1	1sec
Rack Voltage	V	0.1	1sec
Rack Current Real - real current	A	0.1	1sec
Rack Current Avg - 3s moving average current	A	0.1	1sec
Rack SOC	%	0.1	1sec
Rack SOH	%	0.1	1sec
Rack Alarm	bit	0.1	1sec
Rack Minor Protection	bit	1	1sec
Rack Major Protection	bit	1	1sec
Rack Switch Control Info.	bit	1	1sec
Rack Switch Sensor Info.	bit	1	1sec
Rack External Sensor Info.	bit	1	1sec
All Cell Voltage	V	0.001	1 sec
All Cell Temperatures	℃	0.01	1 sec

5.2.2 Performance Warranty

Save the battery data necessary for performance warranty by referring to the table below. Data is analyzed on a yearly basis. Data can be deleted after analysis. Data is to be logged during the entire performance warranty period.

Table 6-3: Data for Operation Status 1 (Condition : Discharge Current 10A ↑)

Data	Unit	Accuracy	Resolution
Cell Summation Voltage	V	0.1	6 sec
Rack Voltage	V	0.1	6 sec
Rack Current Avg - 3s moving average current	A	0.1	6 sec
Rack SOC	%	0.1	6 sec
Rack SOH	%	0.1	6 sec
Rack Min Temperatures	℃	0.01	6 sec
Rack Max Temperatures	℃	0.01	6 sec

Table 6-4: Data for Operation Status 2 (Logged every 1hour regardless of conditions)

Data	Unit	Accuracy	Resolution
Rack Min Cell Voltage	V	0.001	1 hour
Rack Max Cell Voltage	V	0.001	1 hour
Rack Min Temperatures	℃	0.01	1 hour
Rack Max Temperatures	℃	0.01	1 hour
Rack Current Avg - 3s moving average current	A	0.1	1 hour

5.3 SW Open Source License

Item	Component	Copyright / National	License
Rack BMS	STM32F1xx CMSIS	ARM Limited - STMicroelectronics / Switzerland	SLA0047 Apache License 2.0
	STM32F1 HAL	STMicroelectronics / Switzerland	SLA0047 BSD-3-Clause
	STM32 Projects	STMicroelectronics / Switzerland	SLA0047 BSD-3-Clause
	STM32 Utilities	STMicroelectronics / Switzerland	SLA0047 BSD-3-Clause
	Class B library	X-CUBE-CLASSB / Switzerland	SLA0047 BSD-3-Clause
System BMS	Microchip Libraries for Applications	Microchip Technology Inc / USA	MLA
BATTMON	BATTMON - C#, .Net	Microsoft Corporation / USA	MS-PL
	BATTMON - MetroFramework	2013 Jens Thiel, 2011 Sven Walter / Private ownership	MIT
	BATTMON - COMM	2016-2017 HMS Technology Center Ravensburg GmbH / Germany	MIT

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