Samsung Lithium Ion Battery Management System

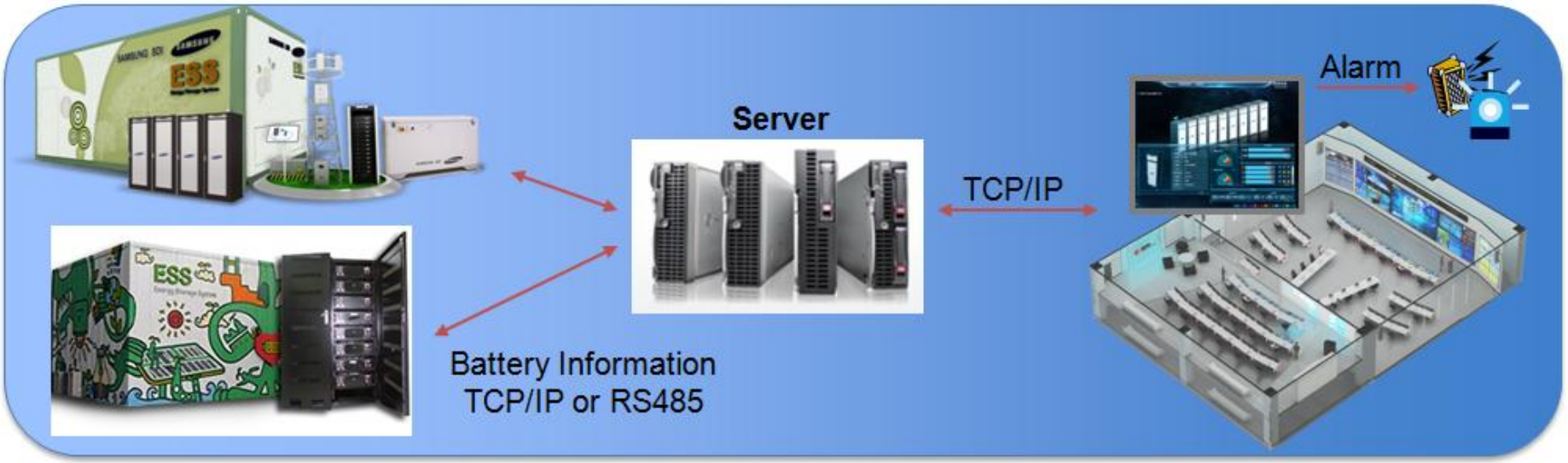
October 2014

SAMSUNG SDI | Energy Solution Division

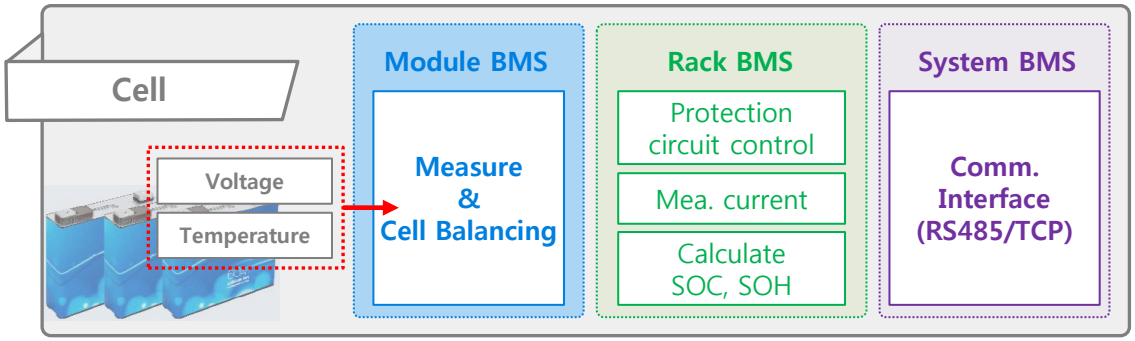
Overview

■ **The Battery Management System monitors the performance data of Li-ion battery by remote access based on web monitoring through the internet or local network on a real time.**

Directly Access	Web based monitoring Easy maintenance Reduce operating cost
Real-Time Information	System voltage, current, SOC, SOH Cell voltage, temperature Notice fault-signs previously
Fault Diagnostics	Warning/Fault Report History management



Performance Data of Li-ion Battery



Module Info.	Rack Info.	System Info.
- Cell Voltage - Cell Temperature	- Rack Voltage - Current, SOC & SOH - Rack MCCB Status - Fuse, Relay Status - Warning, Fault - Etc.	- System Voltage - SOC & SOH - ACB Status, - SMPS(DC24V) Status - Warning, Fault - Etc.

[Data Gathering Interval] Every 1 Second

Battery performance optimization

- Maximize the lifetime of battery through the direct diagnosis & control.
- Predict the capacity and lifetime of battery.

Fault diagnostic

- Safety Design: The BMS controls relay and circuit breaker at the event (fault) situation.
- Save the alarm history and prepare for emergency situation.

Increase the operational efficiency

- Check the battery voltage and the power condition through the real time monitoring.
- Make a report with 1-click and simplify the operating work.

Fault Diagnostics & Control

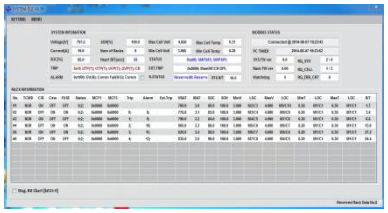
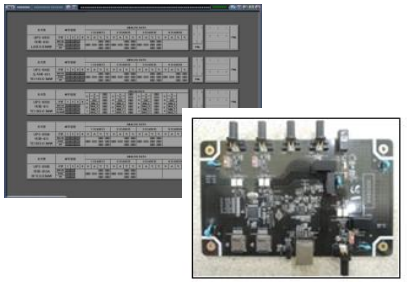
■ The BMS manages the event with 3 grades.

Item	The backup capability	The event termination
Fault	**Charge / Discharge are not available**	Terminated by the reset command only after maintenance work.
Warning	**Discharge** is available / **Charge** is available restrictively	
(Inspect) Status	**Charge / Discharge** are available	Terminate automatically if the event situation is released.

Grade	Event Name	Condition	Rack MCCB
Fault	Over Voltage (Cell/Rack)	Max Cell V ≥ 4.2V (or Rack V)	**OFF**
	Over Temperature (Cell)	Max Cell T ≤ 75℃	**OFF**
	Over Current (Rack)	|Current| ≥ 300A	**OFF**
	BCP ACB, Rack MCCB, Rack Fuse	The component is opened.	Don't care
Warning	Under Voltage (Cell/Rack)	Min Cell V ≤ 2.4V (or Rack V)	ON
	Under Temperature (Cell)	Min Cell T ≤ 0℃	ON
	Voltage / Temperature Imbalance	△ Cell V ≥ 1000mV / △ Cell T ≥ 40℃	ON
	Communication, Connector, Sensing, …	The feedback signals are failed	ON
Status	Reset Button, SMPS, SPD, …	Up to the feedback signals	ON

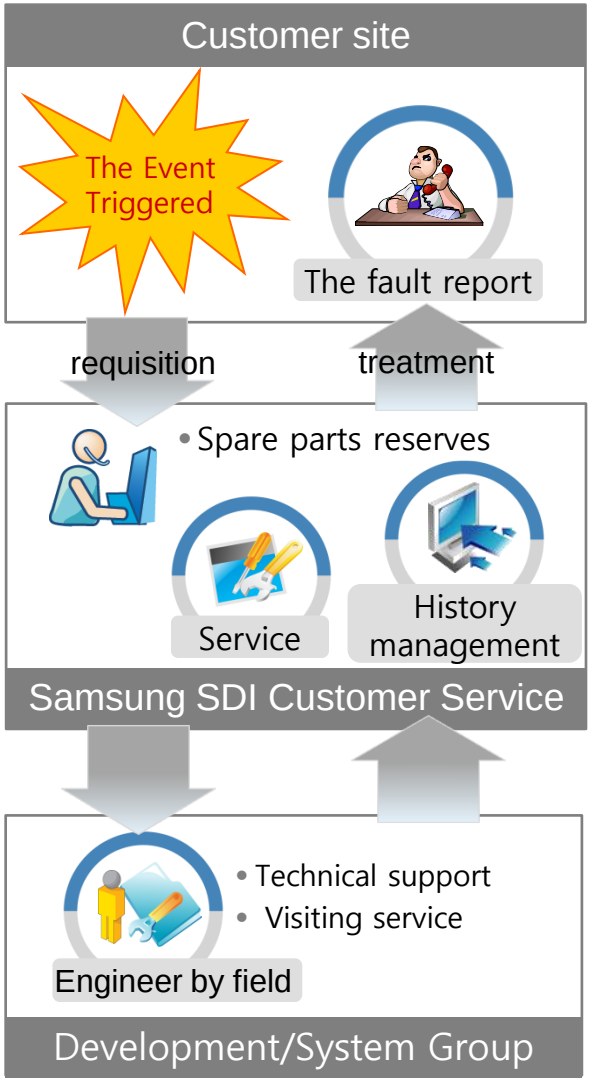
* ACB: Air circuit breaker
* MCCB: Molded case circuit breaker

Monitoring Software

	Bundled Software		Big data server	EMS (FMS) + DBMS
Track Record	· Samsung SDI Korea · Samsung SDI Malaysia · DUZON	· Korea Electric Power Corp. · Korea Ministry of Security of Public Service · Korea Southern Power Co.Ltd	· Shinhan Bank IDC · Samsung SDC(Partially) · Samsung SEC(Partially)	· Samsung SDC 7L, 8L, A3 · Samsung SEC SR1 · Samsung SDS IDC
Constraint Condition (# of SBMS)	· under **2** unit	· under **5** unit	· under **25** unit / 1 server · The extra server is necessary if the # of SBMS exceed 25 unit.	· No constraint condition
Installation & Remark	· Personal computer · ModBus TCP/IP Only · **Not providing maintenance and repair**		· The high-performance server is needed. **(cost ↑)** · ModBus-TCP/IP Only	· Server computer · **ModBus-TCP/IP & RS485**
Data Management	· All data (including each cell) · Stored in a file, but can not do the self-managing. → User has to do personally.	· System Info. · Event Details. · Excluded each Cell.	· All data (including each cell)	· FMS: System Info. Event Flag Only · DBMS: Cell Info. Event Details
Interface (Appendix)				

Data Management of Monitoring Software

■ **The user can observe the information from the BMS through the monitoring system. And the monitoring system manages the BMS-data as below:**



- How is the period of data storage:
  - The data server stores all data which the BMS collects **every 1sec for 1 month.**
  - After 1month, the data is converted to **statistical data of 1day unit and stored as Min/Max/Avg. → The statistic data can be stored more than 15 years**

- How to display the battery data:
  - All data which saved can be display in the form of the **text/graph/file.**

- The notification of the event situation (fault, warning) :
  - Text messages and alarm sound @ the control room
  - The flashing beacon and alarm sound @ the battery site

  - Even if the event condition of the field was cleared, the event situation is not cleared without the confirmation of the administrator.

Appendix

1. **Data BMS**

2. **EMS**
   a. EMS of Samsung SDI
   b. Outsourcing CASE I

3. **Big Data Server**
   a. Outsourcing CASE I
   b. Outsourcing CASE II

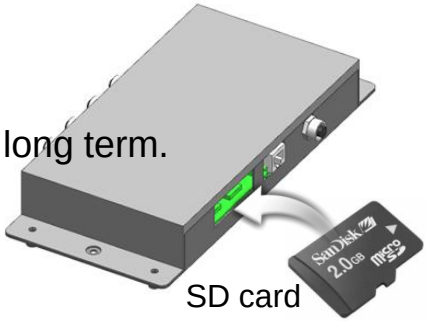
4. **Bundled Software**
   a. Professional
   b. Non-professional

1. DATA BMS (1/2)

■ What is Data BMS?

1. The device that stores the collected data from SBMS.
2. **Usually,** the trend of the LIB cell is confirmed by stored data from DBMS in the long term.
3. **In event situation**, DBMS helps to confirm the cause of the event.

* SBMS: System BMS, * DBMS: Data BMS

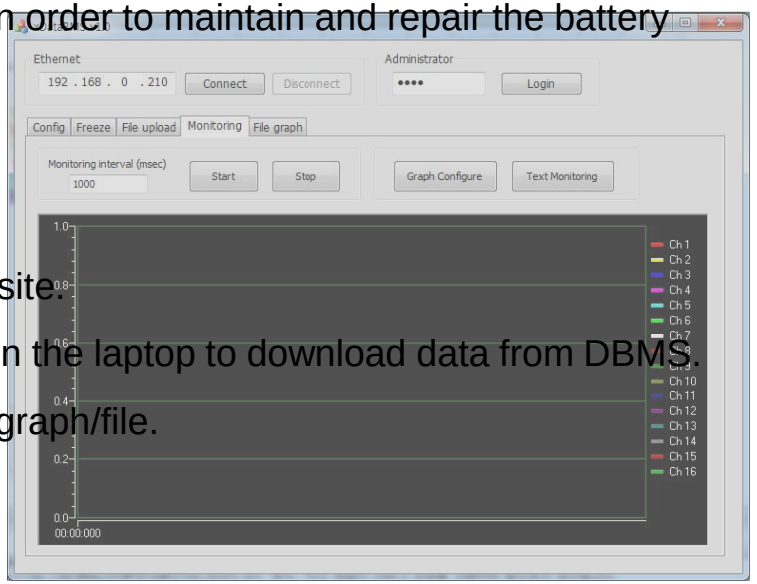


■ EMS (FMS) + DBMS :

1. **The DBMS complements the defect of EMS that stores only the specified data from SBMS.**
2. EMS stores only the specified data in order to reduce the burden of data server management.
3. DBMS stores detail information about event and cell data in order to maintain and repair the battery system.

■ How to use DBMS.

1. Connect DBMS and laptop using LAN cable at the battery site.
2. The data analyzing software (xDataBMS) should installed in the laptop to download data from DBMS.
3. All data which saved can be display in the form of the text/graph/file.



1. DATA BMS (2/2)

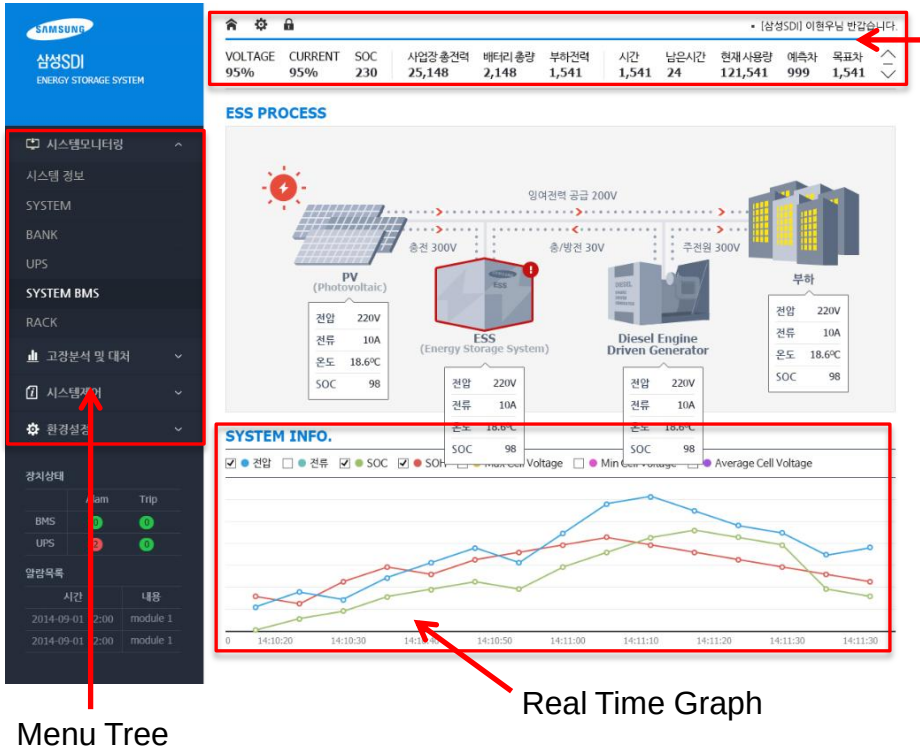
■ **DBMS stores detail information about event and cell in order to maintain and repair the battery system.**

FUNCTION	FILE TYPE	EFFECTIVITY
Stores data & Fault diagnostic	**DATA FILE**	• It stores all data as 1sec unit including each cell • **Storage period: last 10 days** → 10days/32GB
	REPORT FILE	• It stores all data as hourly, daily • **Storage period:** **- hourly: last 2 months** **- daily: more than 10 years** • Check the trend of the long-term data
	EVENT FILE	• It stores the event information only when a new event occurs. - The details of fault/warning information • **Storage period: more than 10 years** - It is possible to check the event history from the time when the product was installed.

2. EMS (1/2). EMS of Samsung SDI

■ **The screen of EMS is composed of the depth of 5 steps.**

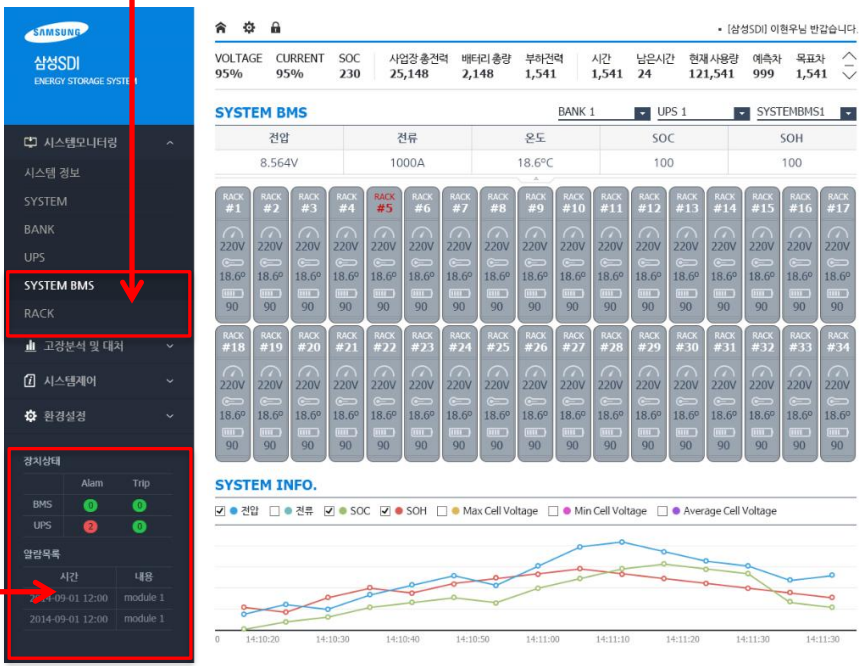
- System Power Grid → ESS (UES) → Bank → PCS (UPS) → LIB System



• Display System power, Present used power, Voltage, Current, SOC of battery pack, Power of battery pack, Available backup time with the battery and Etc.

• It is possible to change the sort order and the define of items on the screen. (Apply the customer's request)

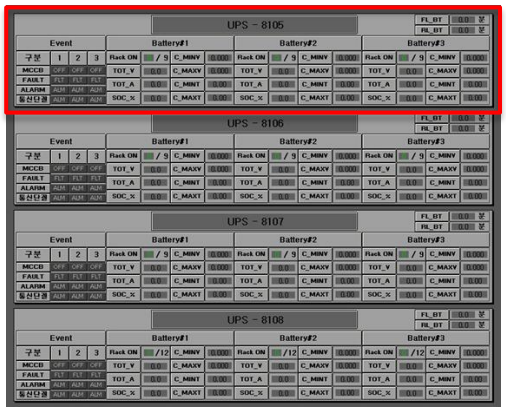
• The user can confirm the detailed information of each RACK by selecting BMS-menu.

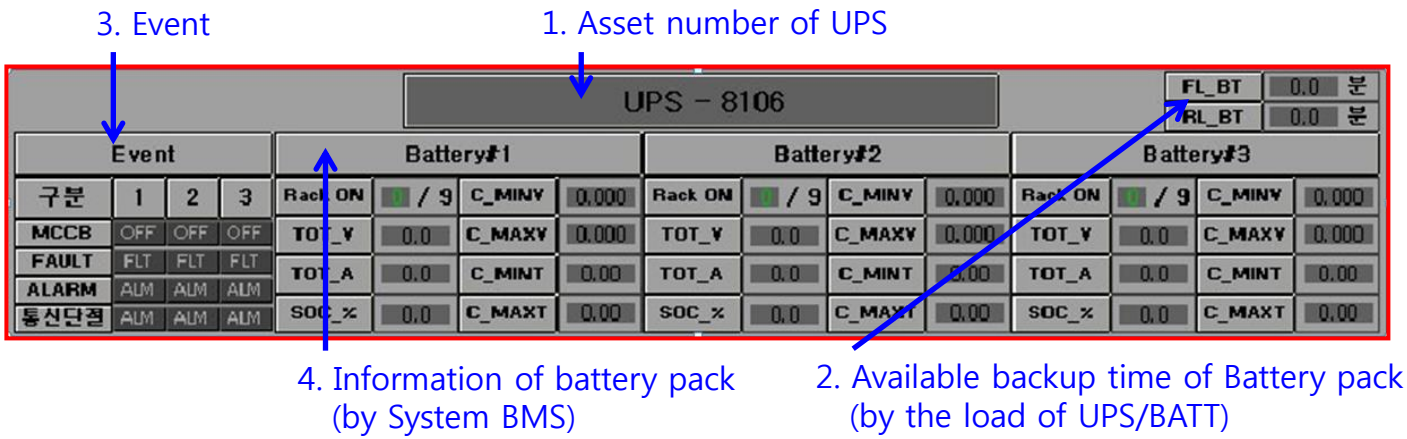


Event History
- The time of Warning or Fault event occurred.
- The type of the event and content.

2. EMS (2/2). Outsourcing CASE I

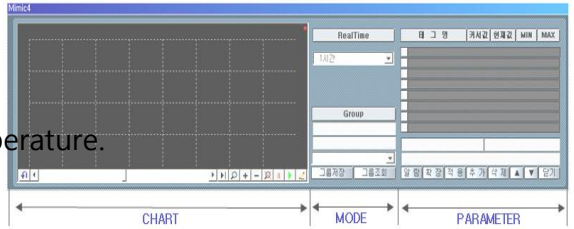
■ The information of Battery system by UPS is displayed to 1 layer.





1. **Asset number of UPS**
   - **The number of UPS that displayed battery was installed.**
   - In case of the picture: the batteries of 3sets is installed in 1UPS (8106).
2. **Available backup time**
   - **Display the backup time available with current state of battery**

     in consideration of the battery charging rate and output power of the UPS.
3. **Event**
   - **Display the state of MCCB (ACB), FAULT, ALARM (Warning), Communication Error.**
4. **Battery #**
   - **Display the specified important information about each battery set.**
   - RACK ON/OFF, Total Voltage, Total Current, min/max Cell Voltage, min/max Cell Temperature.
   - Provide "the Analog Data Trend Graph" function.



3. Big Data Server: Outsourcing CASE I

■ **The information of battery system is displayed by the selection of mouse.**

- The screen is divided dynamically.

Battery information
- Total Voltage, Current
- SOC, SOH
- Information of each rack
- Information of each cell

Asset information for management

A kind of event and count

Module Information
- Including each cell

Real Time Graph

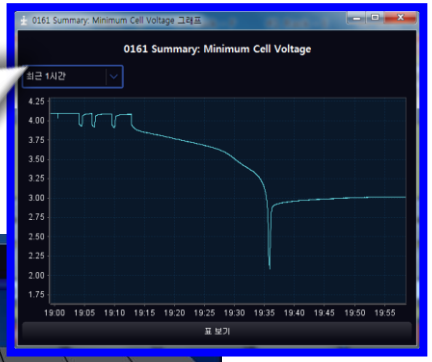
Event Details (HIDE)

3. Big Data Server: Outsourcing CASE II

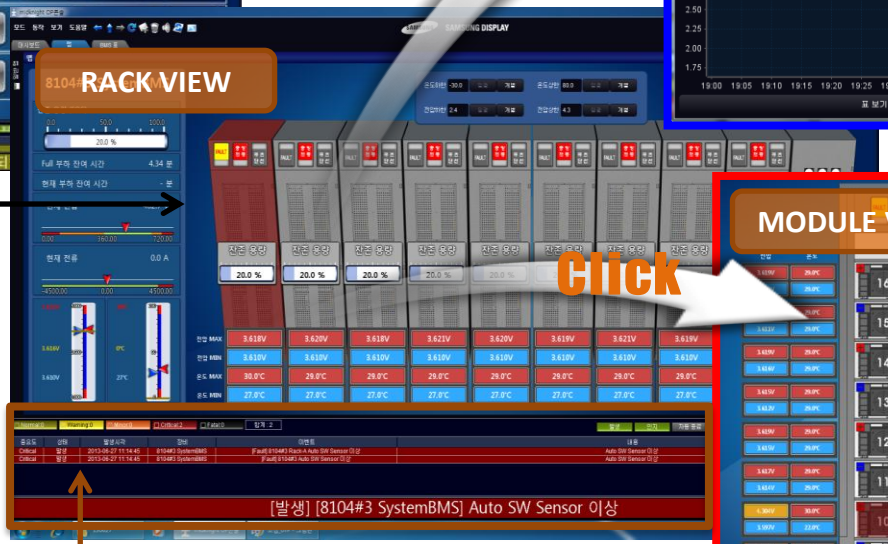
■ **The information of battery system is displayed by the selection of mouse.**

- The screen is composed of the depth of 3 steps.
- Device View(All of the system BMS) → Rack View → Module View

Real Time Graph

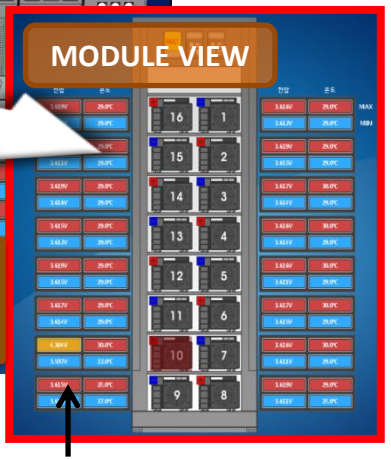


Click

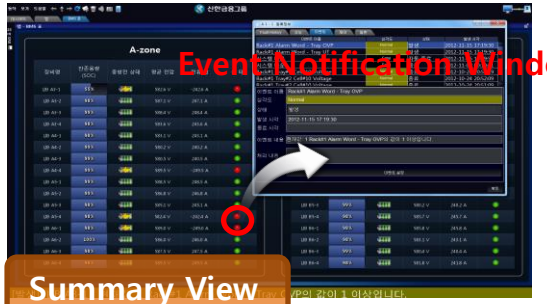


Rack information
- Voltage, Current
- SOC, SOH
- Information of each rack
- Min/Max cell voltage
- Min/Max cell temperature

Click



Module information
- Information of each cell

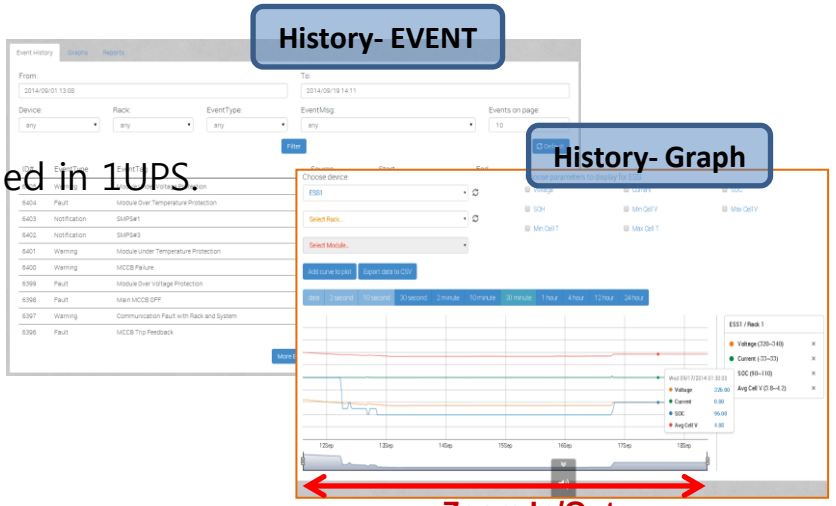


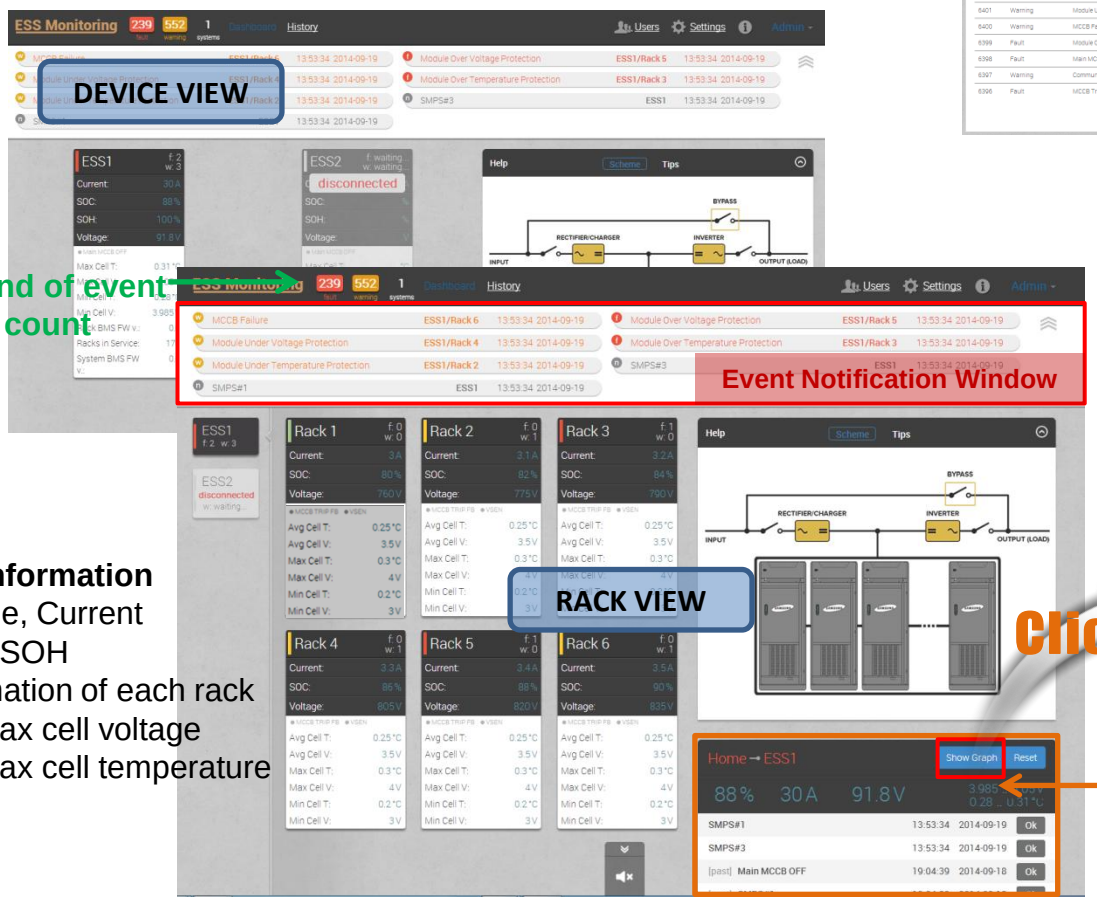
Event Details

4. Bundled Software: Non-Professional

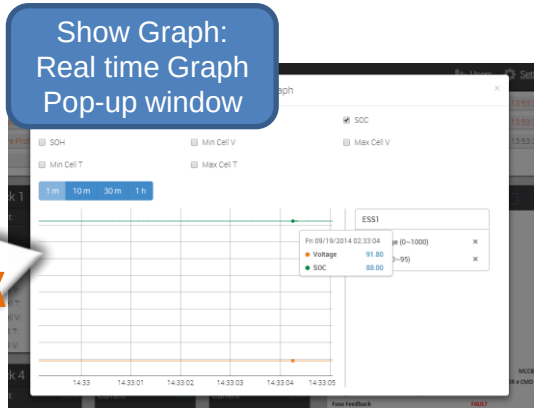
■ **The screen of EMS is composed of the depth of 2 steps.**

- Device View → Rack View: Display real time data
- History View: Search & Display the past event or data
- In case of the picture: the batteries of 2sets is installed in 1UPS.





Rack information
- Voltage, Current
- SOC, SOH
- Information of each rack
- Min/Max cell voltage
- Min/Max cell temperature

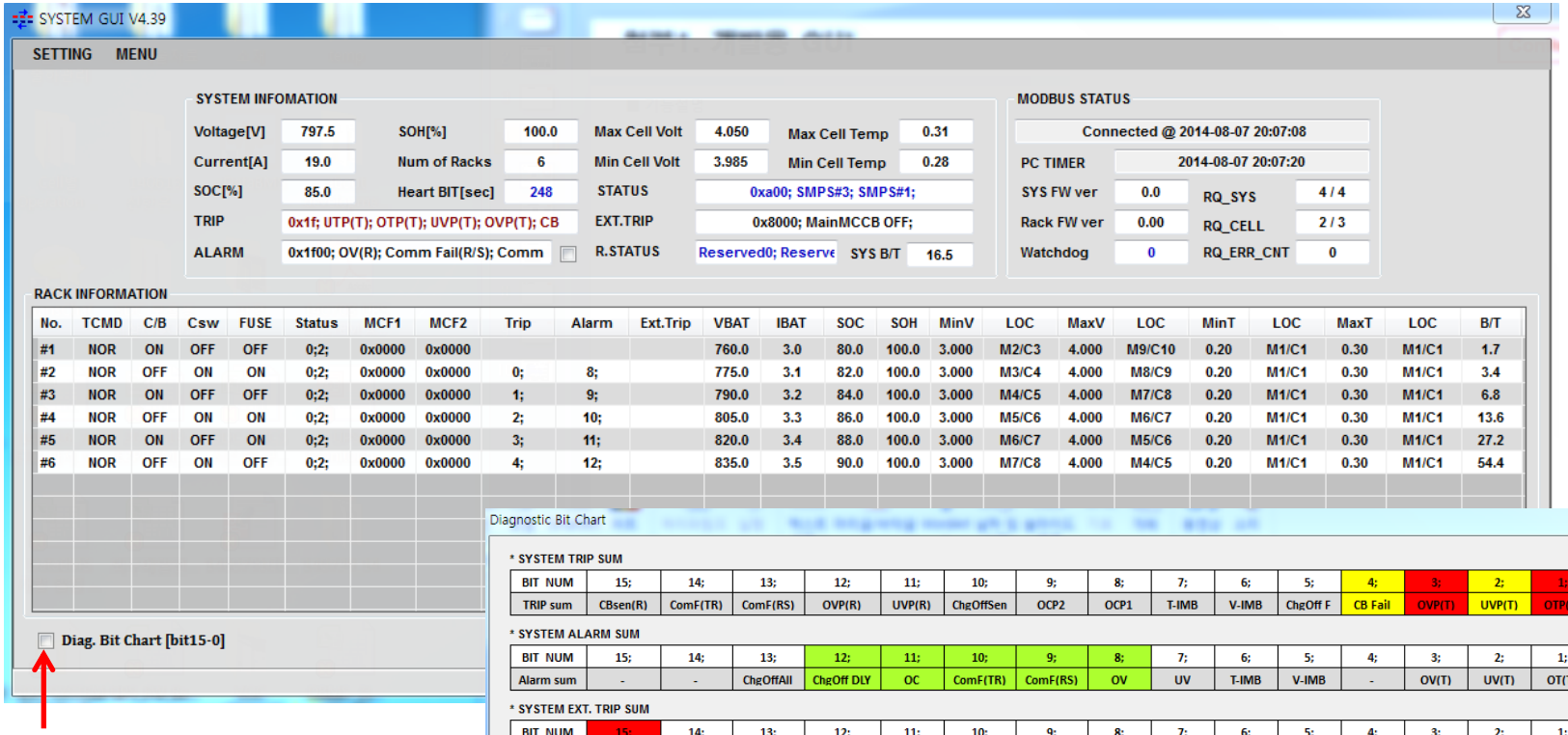


Summary information of selected device (System BMS, ESS1)
- Current parameter value
- Event details

Bundled Software: Professional

■ The software for the developer

- It can check all information of BMS in one screen easily.
- The file storage is possible but it cannot manage the past data / files.



Check box for Event Details