$LiFePO_4$ – MPLHP-5125528 & MPLHP-5125525 Battery Systems

Operation and Maintenance Manual

Read this manual carefully before starting the installation of the battery system.

Retain these instructions for reference.

History of Version Upgrade

Revision	Date	Change
1.0	25/09/2020	First edition
1.1	08/10/2020	Updates on HMI, Tools, BMS Configuration
2.0	11/05/2020	Update BMS, HMI, Error code
3.0	03/08/2021	Update to BMS, HMI, Error code
4.0	06/03/2021	Second edition
4.1	8/19/2021	Updated system diagram and images
4.2	11/4/2021	
4.3	3/22/2022	Updated to reflect SPI Comm changes
4.4	9/12/2022	Updated file name, and removed all NESP references
4.5	12/1/2022	Added Startup procedure and Updated HMI screens, alarm parameters,
4.6	1/30/2023	Updated system images, file name and format
4.7	5/30/2023	Updated Charge Voltage and Aux Contacts
4.8	8/10/2023	Updated Charging procedure, alarm parameters
4.9	12/20/2023	Updated start up procedure
5.0	01/25/24	Updated start up procedure
6.0	4/12/2024	Updated start up procedure and aux contacts
7.0	6/5/2024	Updated Control Box Aux Contacts, added 9 Module variant
8.0	1/31/2025	Added Charge Instructions, Storage Guidelines, Self Discharge warning

Contents

Important Safety Instructions

Please read and follow these instructions!

The following precautions are intended to ensure your safety, extend the service life of your product, and prevent property damage. Before installing this product, be sure to read all safety instructions in this document for proper installation.

The system location shall address and minimize personnel exposure to electrical hazards. All electrical work shall be done in accordance with latest local electrical, building, fire and other codes, standards, regulations, or utility requirements as applicable to the installation, by qualified service personnel who has been appropriately trained and authorized in accordance with the related instructions and appropriate practices.

NESP Series is a high-voltage Lithium Iron Phosphate (LFP) battery system. When dealing with the battery system, it is important to follow all safety recommendations.

The following warnings, safety instructions and notes are given as safety measures for the user as well as measures to prevent damage to the product or parts of the connected equipment. Warnings, safety notes, and notes that are generally valid when working with the NESP battery system are summarized.

Safety Precautions

The following precautions provide general safety guidelines that should be followed when working with or near the High Voltage Lithium Battery System. Complete safety parameters and procedures are site-specific and should be developed by the customer for the installation site.

Review and refer to all safety warnings and cautions in this manual before installation.

Only authorized, adequately trained electrical operators should be able to access the system.

Depending on the location. Consult local codes and applicable rules and regulations to determine permit requirements. If required, mark enclosures appropriately before beginning work.

Qualified Personnel

The personnel must be thoroughly familiar with all the warnings and installation procedures described in the installation instructions!

Only qualified personnel with valid proof or certificate of electrical knowledge with code requirements, safety standards, and experienced in the type of work may work on electrical circuits and equipment.

Only qualified personnel who are familiar with the batteries and safety precautions should perform installation or maintenance of the battery.

Only authorized, trained technicians should perform annual preventive maintenance. Do not allow unauthorized personnel to contact the batteries.

Safe Electrical Work

All live electrical work requires a live work permit. A qualified person shall verify the equipment is de-energized and proper Lockout/Tag out procedures implemented prior to beginning electrical work.
When work is performed near energized overhead power cables, equipment such as boom, mast, crane, or its load shall never be permitted within evaluated distance limit from the power cables.
A site electrical installation, even if considered as provisional, must be planned and made in a proper manner using materials and industrial electrical components in order to ensure the proper functioning of the equipment and employees' integrity.

Safe Battery Handling

Please be aware that a battery presents a risk of electrical shock including high short-circuit current.
Follow all safety precautions while operating the batteries.
Do not smoke or use fire near batteries!
Do not use organic solvent to wash batteries!
Do not dispose of the batteries in a fire, or it could be exploded!
Do not dismantle batteries, it contains electrolyte that can do harm to the skin and eyes! Do not put tools or any metal parts on the top of the batteries!
Remove watches, rings, and other metallic accessories!
Use only insulated tools to avoid inadvertent short circuits!
Disconnect charging source and load before connecting or disconnecting terminals!
Use proper lifting means when moving batteries and wear all appropriate safety clothing and equipment!
Keep 0.5m away from heat sources or any places may occur sparks (such as breakers, fuse box, etc.)!
The risk of local overheating such as direct sunlight over the battery rack should be avoided!
Batteries must be handled, transported, and recycled or discarded in accordance with federal, state, and local regulations!

Warning Signs Table

 Danger	 High Voltage Shock Hazard	 Arc Flash Hazard	 Read the manual
 Warning	 Fire Hazard	 Pinch Point	
 Caution	 Static Sensitive	 No Smoking	

1. Scope

This manual stipulates system specifications and detailed steps and attentions during installation of Narada MPLHP high-voltage lithium battery system.

2. Definitions

2.1 **Cell:** The basic unit of lithium iron phosphate battery consisting of positive, negative electrodes and electrolyte, with rated voltage of 3.2V and rated capacity of 55Ah.

2.2 **Module:** The NLHP51255 module with rated voltage of 51.2V and rated capacity of 55Ah, is composed of 55 Ah cells.

2.3 **Rack:** Several modules and control boxes are connected in series through electrical connectors, delivers voltage up to 512V (10 or 9 Pcs of NLHP51255 modules) in rated voltage and 55 Ah in rated capacity.

2.4 **System:** Several racks of modules connected in parallel through electrical connectors delivers up to 512V and 55Ah (10 Racks) rated capacity

2.5 **Control box:** Is maintenance free and provides isolation and protection for single rack (multiple battery modules). It integrates the BCU, High voltage management unit, circuit breakers, main contactors, pre-charge resistors, fuses, current sensors and switching power supply.

2.6 **BMS:** Battery Management System, is a collection of electronic devices used to monitor, evaluate, and protect battery operating parameters. It consists of BMU, BCU, Control box, BAMS, HMI and other components. It has 3 levels that control and monitor information related to operational status, battery cells, battery racks, and battery system units, such as battery voltage, current, temperature, and protection, etc., evaluating and calculating the state of charge (SOC) and state of health (SOH).

2.7 **BMU:** Battery Management Unit, the first rank of BMS (Module BMS). It is responsible for cell voltage and temperature acquisition, balancing management, real-time cell monitoring and upward communication.

2.8 **BCU:** Battery Cluster Management Unit, the second rank of BMS (Rack BMS). It is responsible for the current collection of the battery string. It integrates multiple CAN communication circuits and multiple wet and dry contacts. It is responsible for communicating with the managed BMUs, collecting information, alarms and protecting in case of overvoltage/ undervoltage/ overcurrent /short circuit /over temperature of the battery string. The information is sent to the next level BAMS, enabling the BAMS to resolve the problems of the lower-level system (BMU and battery) to ensure safe, reliable, and efficient operation of the battery management system.

2.9 **BAMS:** Battery Administration Management System, the third level of BMS (System BMS), composed of Battery Administration Management Unit (BAU) and HMI.

2.10 **BAU:** Battery Administration Unit. The third level of BMS system responsible to resolve problems of the lower-level system (BMU and BCU) to ensure safe, reliable, and efficient operation of the battery system.

2.11 **HMI:** Human Machine Interface, enabling data reading and parameter setting.

3. Acronyms and Abbreviations

The following acronyms and abbreviations are used in this manual.

Abbreviations	Full Name
BMS	Battery Management System
BMU	Battery Management Unit (Module level)
BCU	Battery Cluster Management Unit (String level)
BAMS	Battery Administration Management System (HMI and BAU)
BAU	Battery Administration Unit (System level)
HMI	Human Machine Interface
PPE	Personal Protection Equipment
EHS	Environmental Health and Safety
LFP	Lithium iron phosphate
BAT	Battery
SOC	State of Charge
SOH	State of Health
UVR	Under Voltage Release

4. Product Description

4.1 Introduction

4.1.1 MPLHP 55Ah battery system is a high-voltage high power lithium (LFP) system which is primarily used in emergency power supply, and data center applications. Both the lithium-ion (LFP) batteries and the BMS use a standard modular design.

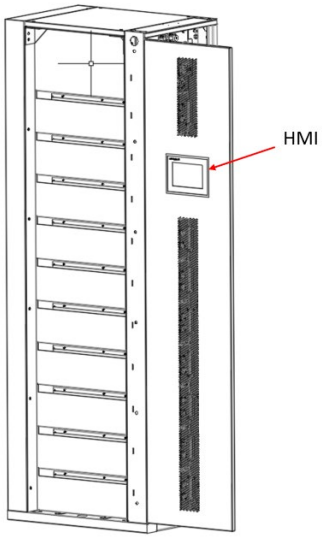
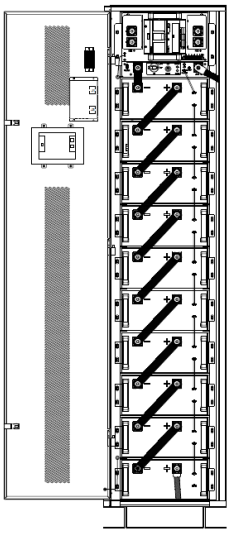
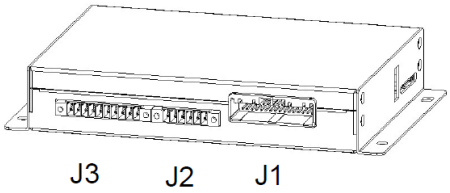
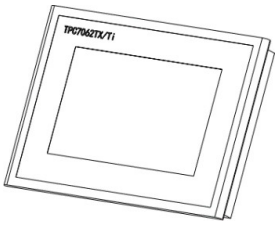
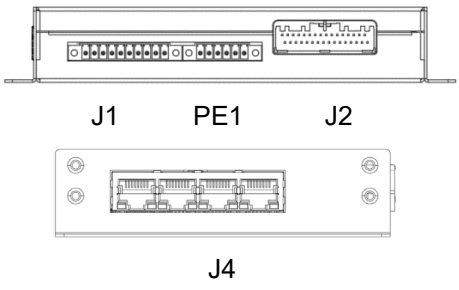
4.2 BMS

4.2.1 The BMS is based on 3 Level architecture, which consists of BMU, BCU, and BAMS, the parameters of BMS are as below.

Table 4-1 Specifications of BMS Components

Unit Level	Unit Name	Specifications
Module Level	BMU	• Battery type: High Rate LFP • Voltage detection range: 0.5-5.0V • Voltage acquisition of cells in strings: 16 • Voltage sampling accuracy: 0.1% or ≤5mV • Temperature sampling accuracy: ±2℃ • Balance type: Active balance • Balance current: ≤2.5A • Communication interface: SPI • Supply voltage: 20-28Vdc (typical 24Vdc)
Rack Level	BCU	• Max BMU number: 10 • Current sampling accuracy: ±(1%FS + 1%RD) • Voltage sampling interval: 100ms • Supply voltage: 20-28Vdc (typical 24Vdc) • High voltage detection: 0-900 Vdc, Accuracy: 0.5% • Insulation resistance detection: 100K-5MΩ, Accuracy ≤10%
System Level	BAU/HMI	• Communication interface: RS 485*3, SPI, Ethernet1 • Supply voltage: 20-28Vdc (typical 24Vdc)

4.2.2 The locations and interfaces of BAU and HMI are shown as below.

BAMS-Front	BAMS-Rear
	
BAU- Interface side	**HMI- Interface side**
	
BAU Interface- Front	**HMI Panel-Front**
	

4.2.3 There are several interfaces in the BAU, namely J1 as Power and Communication Port and dry contact 1 and 2, J3 for dry contacts 3 and 4 and J4 as Ethernet Communication Port.

4.2.4 When the BMS system is in a normal operating state, the BAU dry contact outputs are closed. For alarm or failure status, the dry contact is open. The dry contacts can be connected to < 60VDC.

4.2.5 J1 and J3 power communication port pin out – refer to cable drawing LHP-CCOM-J1J3

4.2.6 When the BMS system is in normal state, the BAU dry contact outputs a closed signal, and the BAU output breaks when the BMS system fails. This dry contact can only be connected to the <DC60V signal system.

5. Battery Systems Operation

5.1 System Diagram

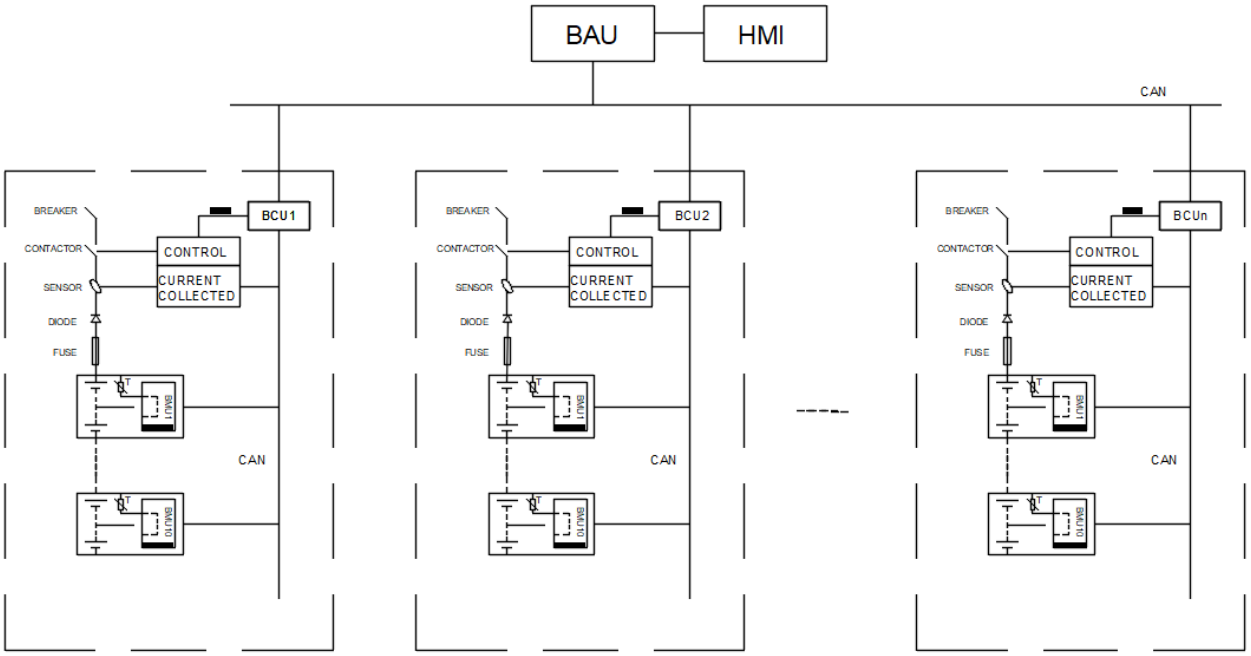


Fig 5.1 System topology

5.1.1 In Figure 5.1, the whole battery system is composed of multiple battery racks, BAMS, and HMI. Each battery rack is composed of multiple battery modules and a control box connected in series. Each battery module is equipped with a BMU to monitor the battery status.

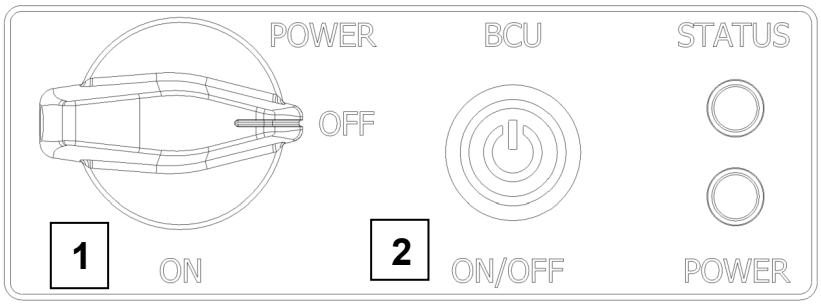
5.1.2 Each battery rack functions as a complete subsystem of BMS. The battery management system directly detects and manages the entire battery rack operation, including basic battery operation information collection, capacity estimation, balancing between cells, and system operation state analysis, battery system fault diagnosis and protection, system policy control, system leakage detection, battery data monitoring and display, data communication, etc.

5.1.3 Multiple battery racks can be connected in parallel in order to expand the system capacity. The BAMS can communicate the racks with the outside world through HMI, SPI, and RS485.

5.2 Basic Operation Procedures

5.2.1 Starting the Battery System

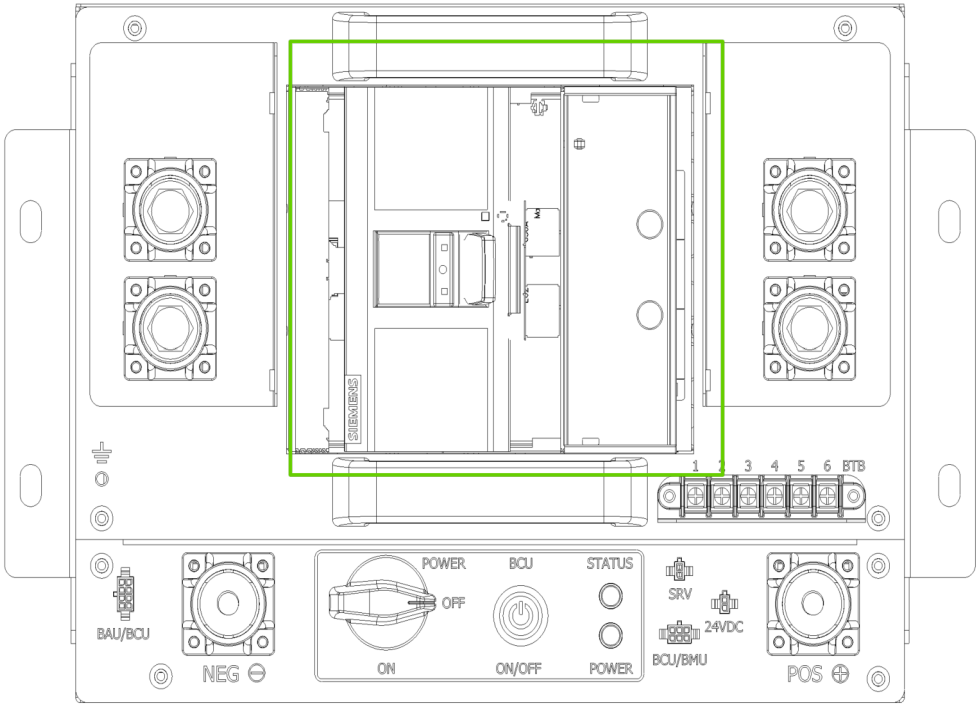
5.2.1.1 On Cabinet 1, Rotate the Power Switch (1) from OFF to ON. The POWER LED should be illuminated, and the STATUS LED should be off.



5.2.1.1 Press the BCU on/off push button (2) STATUS LED should illuminate RED. On cabinet 1, the HMI will power up. After a short time, the STATUS LED will illuminate green.

5.2.1.2 Repeat for each additional cabinet.

5.2.1.3 Close battery breaker when required by UPS start-up procedure.

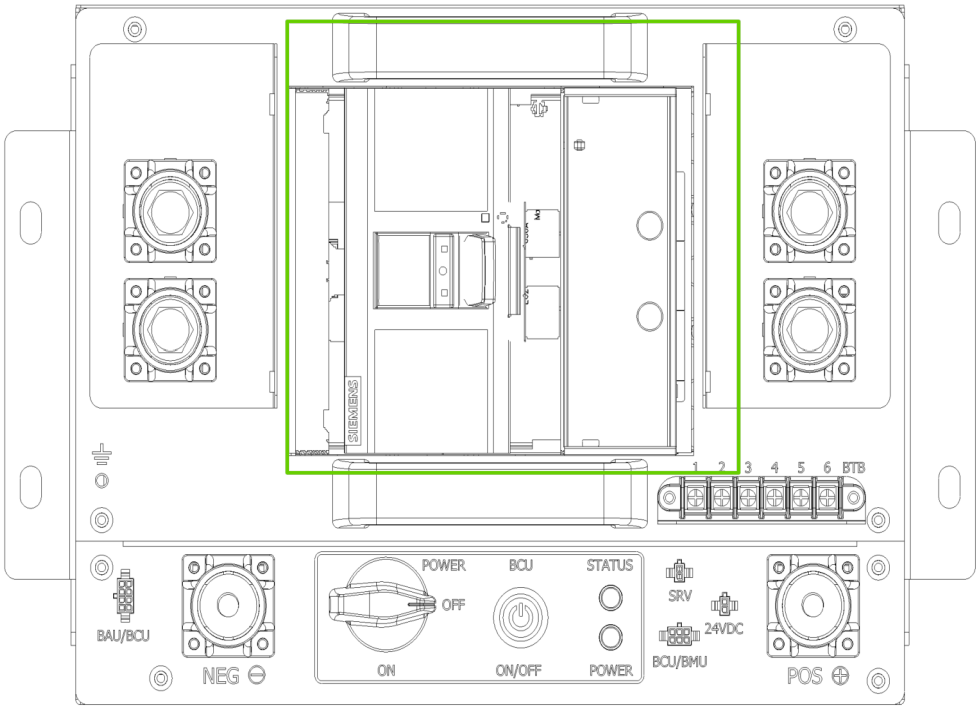


5.2.1.4 Verify no alarms on HMI display.

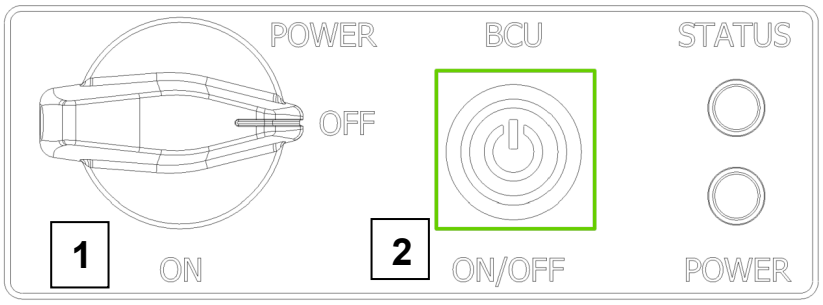
5.2.1.5 Battery System is now online.

5.2.2 Battery System Power Down Procedure

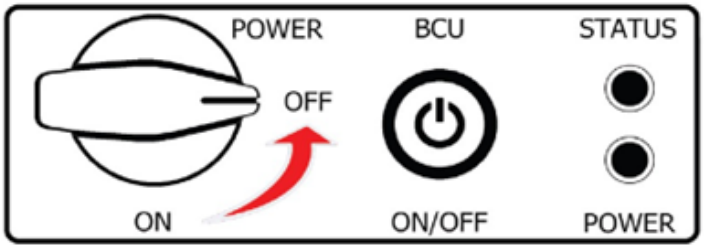
5.2.2.1 Open the battery breaker on all cabinets.



5.2.2.2 Depress the BCU on/off push button on all cabinets. The STATUS LED will turn red then off. HMI will power off on cabinet 1.



5.2.2.3 Rotate the Power ON/OFF switch to the off position on each cabinet. The power LED will dim and then go out with the last cabinet.



5.2.2.4 The battery system is now powered off. Shutdown UPS or restart the battery system as needed.

5.3 Charge and Balance Procedure

5.3.1 Charging

5.3.1.1 For 10 Module system set the UPS Charge Voltage to **550V** and The UPS shut down voltage to **420V**. The system will charge and balance until the Min/Max Cell Voltage (VPC) differential is within 0.03V. (Max VPC – Min VPC = Differential)

5.3.1.2 Increase the UPS Charge Voltage to **560V.** The UPS shut down voltage can be adjusted up if desired to **440V** if operation is at or above 25C.

5.3.1.3 For 9 Module system set the UPS charge voltage to **495V** and The UPS shut down voltage to **378V**. The system will charge and balance until the Min/Max Cell Voltage (VPC) differential is within 0.03V. (Max VPC – Min VPC = Differential)

5.3.1.4 Increase the UPS Set Voltage to **504V**. The UPS shut down voltage can be adjusted up if desired to **396V** if operation is at or above 25C.

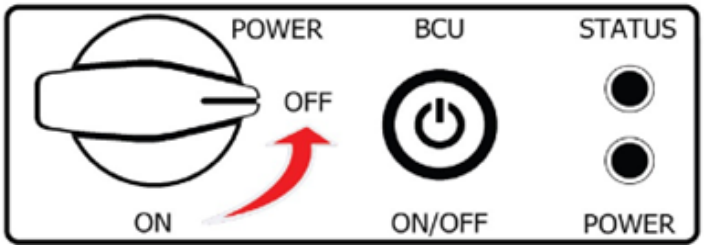
NOTE: The system is available for discharge during this period of time and the charge contactor may open and close as needed to allow the system to balance.

5.3.2 Balancing

5.3.2.1 The BMU automatically places a small load across the higher voltage cells to drain energy from them until the cell voltages are within 0.030mV of each other. This process depending on the length of time in storage may take approximately 72 hours. A rack will stop charging for 1 hour when a high cell voltage (3.75V) is detected. The charge contactor will close again when the high cell recovery value (3.45V) has been reached. The rack is available for discharge when this occurs.

WARNING

Failure to place the power switch and BCU on/off PB in the OFF position when there is no active battery charging, the breaker is tripped or disconnected from the UPS will result in battery self-discharge and permanent damage to the battery modules should power not be restored within ONE day and loss of warranty coverage.



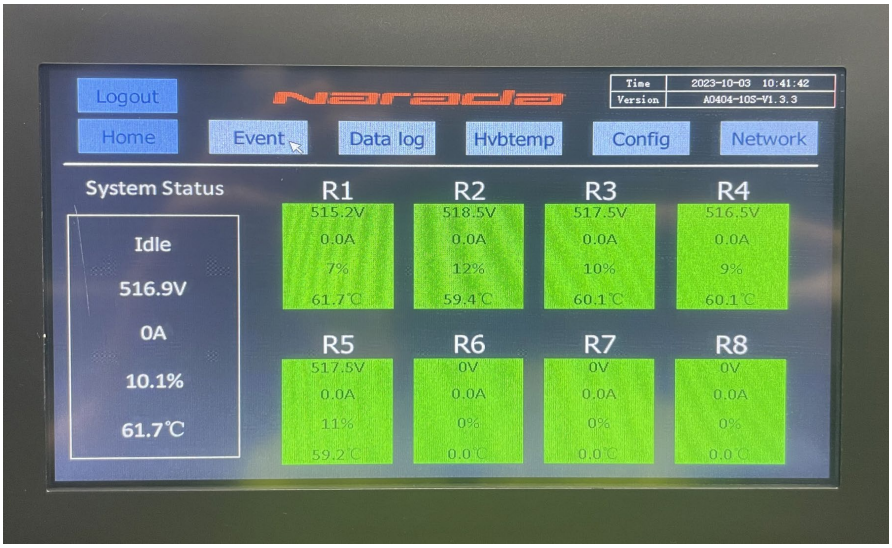
5.4 BMS Operations

This section introduces the functions and instructions of the human-machine interface (HMI).

5.4.1 Main Display

After the system is powered on, the home page will be shown on the screen automatically (as shown in the figure below). The home page displays 2 major categories:

- System Status
- Rack level Information.



5.4.2 **Operation function:** with a Touch of the following buttons, the system will enter different pages for controlling the following functions:

Button	Linked Interface
Login	Touch the button to enter the user login page
Events	Touch the button to enter the alarm display page
Data Log	Touch the button to enter the manual storage page
HVBTemp	Touch the button to enter the control box temperature page
Config	Touch the button to enter the configuration interface
Network	Touch the button to enter the Network and BAU IP and Time setting page
R#	Touch on R1, R2, etc. to enter the Rack data page

5.4.3 **System status**: This portion displays the overall system status including voltage, current, % Capacty and temperature. When the system is not running, the status will show “Idle”.

5.4.4 **Rack status:** Each box displays the status of the voltage, current,% Capacity, and temperature. If the green box turns red, it indicates there is a communication error or rack failure.

5.4.5 **Events:** When any of the Alarms are present the **Events** tab turns Yellow. Rack blocks turn **Red** when a Critical alarm is triggered. Touch the **Events** button to check for Active alarms. Refer to the following table for the detailed description of the alarm parameters and contactor operation. There are 3 levels of alarm: warning, alarm, critical. These values are only for verification**. Alarm threshold values are not to be adjusted except by an authorized MPINarada service technician.**

5.4.6 Alarm parameters (10 module system) and contactor operation

BMS Parameters 10 Module									
#	Parameter	Level	Alarm Value	Recovery Value	Trigger Duratio	Recovery Duratio	Charge Contactor Operation	Discharge Contactor Operation	HMI Rack Color
1	Total Voltage High	Warning	570	550	3s	3s	Closed	Closed	green
		Alarm	572	550	3s	3s	Open	Closed	green
		Critical	578	550	3s	3s	Open	Open	Red
2	Cell Voltage High	Warning	3650	3450	3s	3s	Closed	Closed	green
		Alarm	3750	3450	3s	3s	Open	Closed	green
		Critical	3900	3700	1s	3s	Open	Open	Red
3	Total Voltage Low	Warning	448	480	3s	3s	Closed	Closed	green
		Alarm	440	480	3s	3s	Closed	Closed	green
		Critical	432	480	3s	3s	Open	Open	Red
4	Cell Voltage Low	Warning	2500	2800	3s	3s	Closed	Closed	green
		Alarm	2400	2800	3s	3s	Closed	Closed	green
		Critical	2300	2800	3s	3s	Open	Open	Red
5	Discharge Temperature High	Warning	55	50	3s	3s	Closed	Closed	green
		Alarm	60	55	3s	3s	Closed	Closed	green
		Critical	65	60	3s	3s	Open	Open	Red
6	Discharge Temperature Low	Warning	0	5	3s	3s	Closed	Closed	green
		Alarm	-5	0	3s	3s	Closed	Closed	green
		Critical	-10	-5	3s	3s	Open	Open	Red
7	Charge Temperature High	Warning	55	50	3s	3s	Closed	Closed	green
		Alarm	60	55	3s	3s	Open	Closed	green
		Critical	65	60	3s	3s	Open	Open	Red
8	Charge Temperature Low	Warning	10	15	3s	3s	Closed	Closed	green
		Alarm	5	10	3s	3s	Open	Closed	green
		Critical	0	5	3s	3s	Open	Open	Red
9	Charge Current High	Warning	100	55	3s	10s	Closed	Closed	green
		Alarm	110	100	3s	10s	Open	Closed	green
		Critical	165	110	3s	10s	Open	Open	Red
10	Discharge Current High	Warning	380	300	3s	10s	Closed	Closed	green
		Alarm	400	300	3s	10s	Closed	Closed	green
		Critical	460	400	3s	10s	Open	Open	Red
11	Insulation Low	Critical	80	300	1s	1s	Open	Open	Red
12	Control Box Temperature High	Warning	80	70	3s	3s	Closed	Closed	green
		Alarm	90	80	3s	3s	Closed	Closed	green
		Critical	100	90	3s	3s	Open	Open	Red

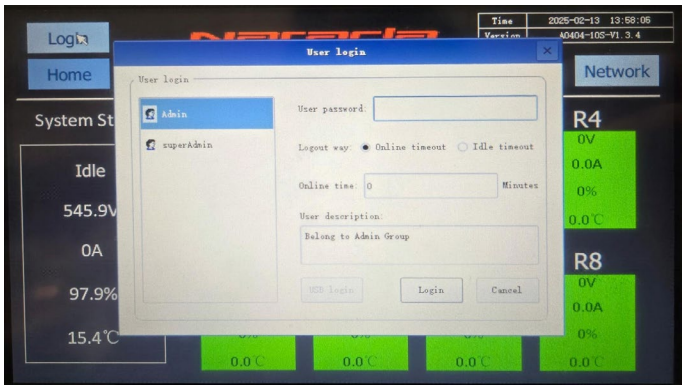
5.4.7 Alarm parameters (9 module system) and contactor operation

BMS Parameters 9 Module

#	Parameter	Level	Alarm Value	Recovery Value	Trigger Duration	Recovery Duration	Charge Contactor Operation	Discharge Contactor Operation	HMI Rack Color
1	Total Voltage High	Warning	512	494	3s	3s	Closed	Closed	green
		Alarm	515	494	3s	3s	Open	Closed	green
		Critical	520	494	3s	3s	Open	Open	Red
2	Cell Voltage High	Warning	3650	3450	3s	3s	Closed	Closed	green
		Alarm	3750	3450	3s	3s	Open	Closed	green
		Critical	3900	3700	1s	3s	Open	Open	Red
3	Total Voltage Low	Warning	404	432	3s	3s	Closed	Closed	green
		Alarm	396	432	3s	3s	Closed	Closed	green
		Critical	389	432	3s	3s	Open	Open	Red
4	Cell Voltage Low	Warning	2500	2800	3s	3s	Closed	Closed	green
		Alarm	2400	2800	3s	3s	Closed	Closed	green
		Critical	2300	2800	3s	3s	Open	Open	Red
5	Discharge Temperature High	Warning	55	50	3s	3s	Closed	Closed	green
		Alarm	60	55	3s	3s	Closed	Closed	green
		Critical	65	60	3s	3s	Open	Open	Red
6	Discharge Temperature Low	Warning	0	5	3s	3s	Closed	Closed	green
		Alarm	-5	0	3s	3s	Closed	Closed	green
		Critical	-10	-5	3s	3s	Open	Open	Red
7	Charge Temperature High	Warning	55	50	3s	3s	Closed	Closed	green
		Alarm	60	55	3s	3s	Open	Closed	green
		Critical	65	60	3s	3s	Open	Open	Red
8	Charge Temperature Low	Warning	10	15	3s	3s	Closed	Closed	green
		Alarm	5	10	3s	3s	Open	Closed	green
		Critical	0	5	3s	3s	Open	Open	Red
9	Charge Current High	Warning	100	55	3s	10s	Closed	Closed	green
		Alarm	140	100	3s	10s	Open	Closed	green
		Critical	165	110	3s	10s	Open	Open	Red
10	Discharge Current High	Warning	380	300	3s	10s	Closed	Closed	green
		Alarm	400	300	3s	10s	Closed	Closed	green
		Critical	460	400	3s	10s	Open	Open	Red
11	Insulation Low	Critical	80	300	1s	1s	Open	Open	Red
12	Control Box Temperature High	Warning	80	70	3s	3s	Closed	Closed	green
		Alarm	90	80	3s	3s	Closed	Closed	green
		Critical	100	90	3s	3s	Open	Open	Red

5.5 *Login for Administrator Operation

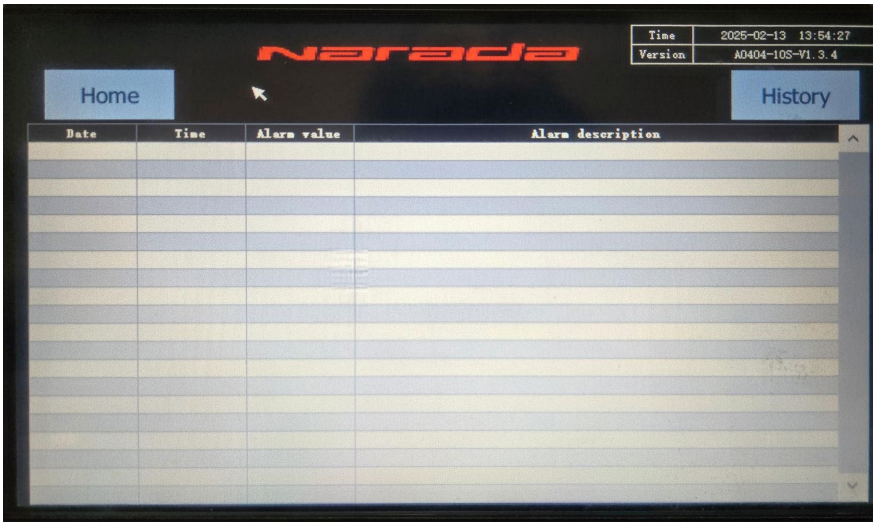
On the main page, Touch the login button in the upper left corner of the screen to enter the Admin login interface. Then enter the username and password to execute the administrator operation. **Only Authorized MPINarada technicians should login. Any changes to any settings can VOID the system warranty.**



5.6 Alarm Data Display

Touch the Alarm button in the main interface to enter the alarm information page to check current and historical alarm information. The current alarm information page is shown as below.

Then Touch the History button to check the historical alarm information as shown in the following figure.



5.7 Manual Storage Interface

5.7.1 Obtain the administrator authority first by logging in and then Touch the Data Log button in the main interface to enter the manual storage page. In this page, you can determine the status of the USB, check storage and operation, and manually force the data logs to save to the USB.

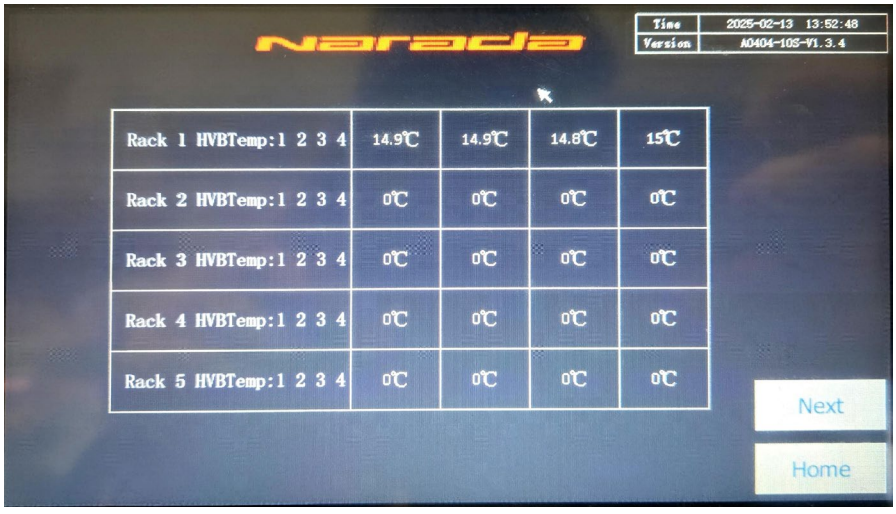
5.7.2 "Normal" button in green means that the contact is normal. If "Normal" is in red, please check the contact of the USB flash drive. Data storage process can be performed when the contact is normal. Touch the "Refresh" button to store the data. "Data Log Completed" means that the storage is successful. Once Completed, the USB can be removed to transfer the data to a laptop.

5.7.3 The data stored are Excel files organized within a folder on the USB which can be transferred to a laptop to download data files as needed. The files are organized by "Alarm", "Total State" and "Cluster" number (string number) and then within those folders by date and time in 24-hour segments. Please remember to reinstall the USB after copying files.

Note: ***Please do not remove the USB flash drive Data Logging process, it may cause damage or data loss. Please wait for the screen to show "Data Log Completed".***

5.8 Temperature Interface

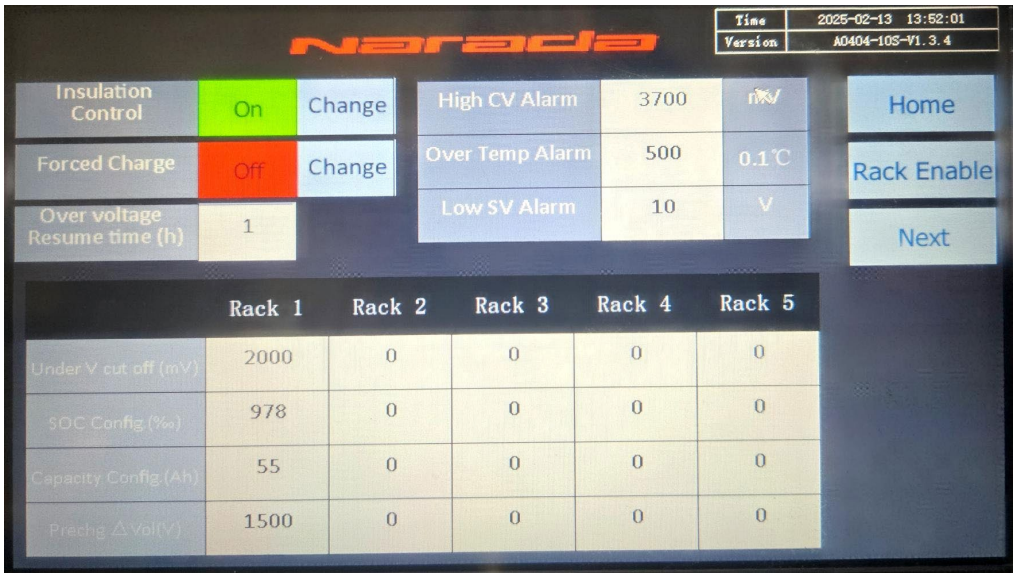
The interface displays the temperature values collected by control box. Touch the Hvbtemp button in the main interface to enter the temperature interface page.



5.9 Configuration Interface

The maximum charge and discharge current are the recommended values by the current system. The “SOC Config” is generally not used. The “Delta voltage between Pre-charge and final” means that when the difference between the total voltage and the pre-charge voltage at the end of the grid connection is greater than this value, grid connection will fail.

The “Recharge” button is used to reconnect the racks after a full discharge has taken place and racks have been automatically disconnected due to low voltage. This is utilized as a worst-case scenario option when a discharge has completed to the point where the cabinet disconnects itself from the system. Under normal operation the UPS will be utilized to prevent the battery system from over-discharging and this button will not be needed.

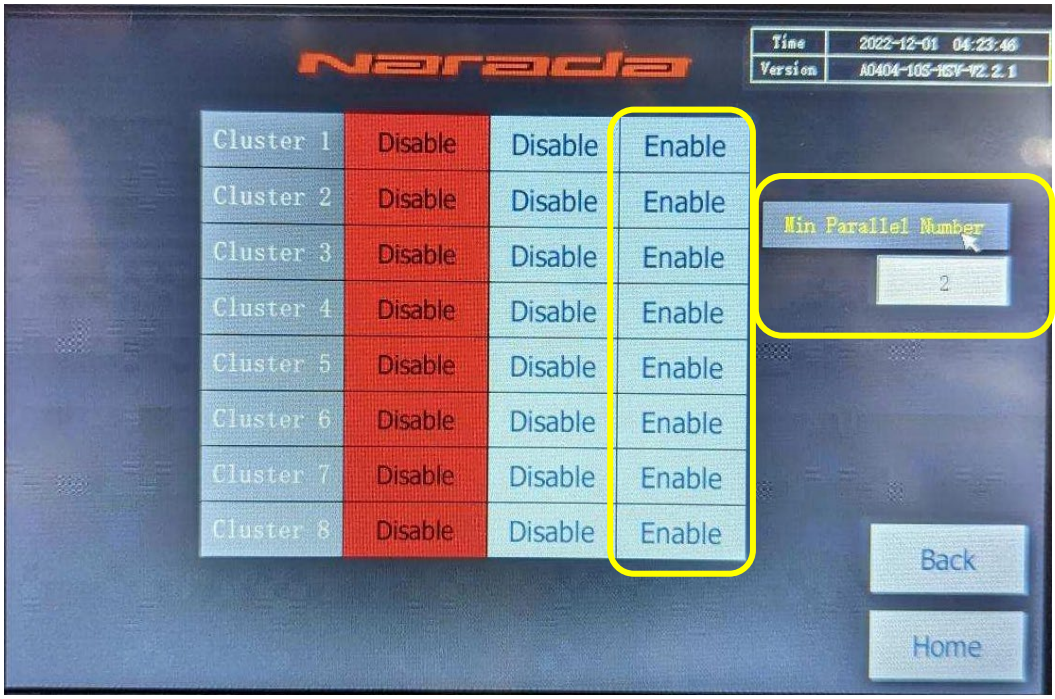


5.10 Rack Enable

5.10.1 Each rack needs to be enabled prior to operation. By default, the racks are disabled as indicated on the screen below and both charge and discharge contactors are open as indicated by Red LED Status light on the front of the Control Box. Each Rack must be enabled by pressing the “Enable” buttons. Once the buttons are pressed contactors will make Touching sounds and will close if there are no active alarms. The Status LED will turn Green. This will indicate that the system is ready to operate.

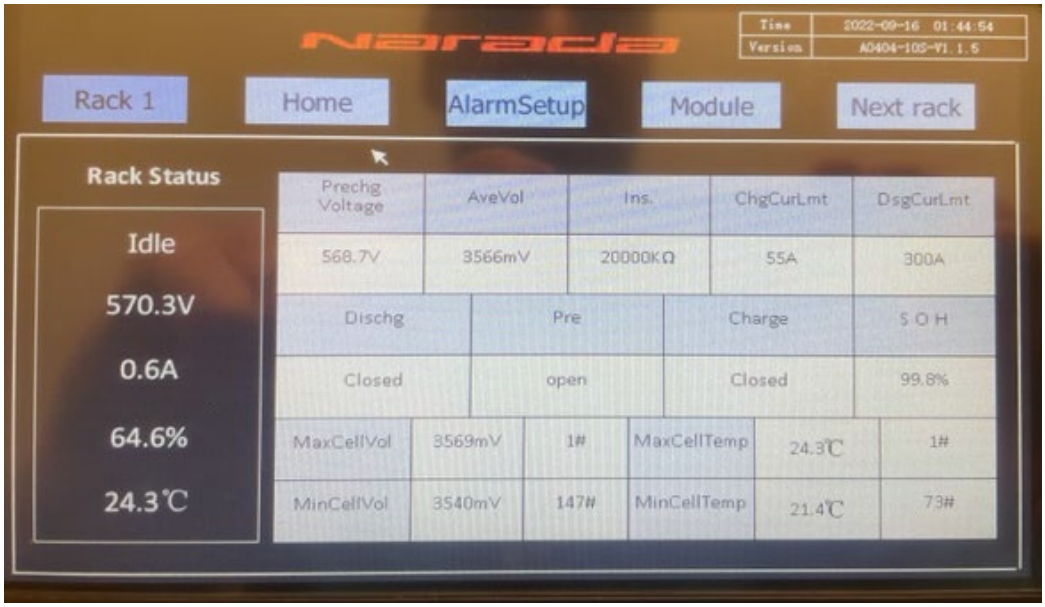
5.10.2 After the system has been fully configured and enabled, be sure to press ‘logout’ from the Home screen to avoid inadvertent setting changes by unqualified personnel.

5.10.3 The **Minimum Parallel Number** setting represents a minimum number of racks needed to support the total load during discharge. By default, it is set to N-1 of total number of racks in the system.



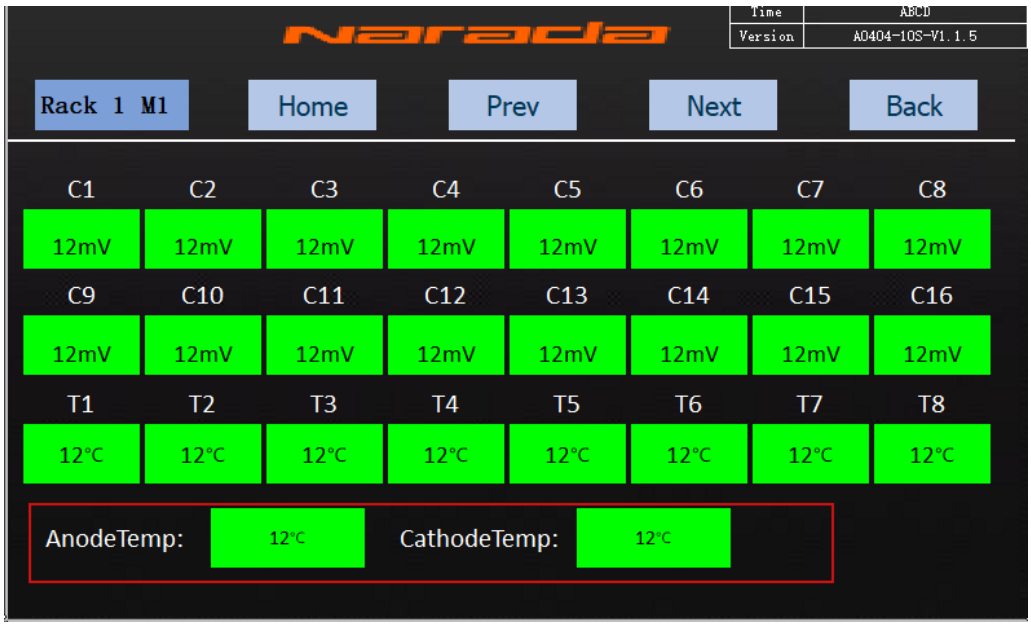
5.11 Single Rack Data Page

R1 to R8 represents Rack 1 to Rack 8, and the data is displayed for the actual number of racks connected. For example: the RACK 1, Touch the R1 button to enter the data interface of Rack 1 and check the specific data. This interface contains the sampling information of the specific rack, including the max cell voltage, the min cell voltage, the charge and discharge status, SOC, SOH, max/min temperature and other information.



Touch the Module button to enter the BMU information collection interface, which contains the cell voltage and temperature information collected by the BMU. RACK1 M1 shows the

information collected by the first BMU, and RACK1 M2 is the information collected by the second BMU, so on and so forth.



5.12 BMS Automatic SOC Calibration

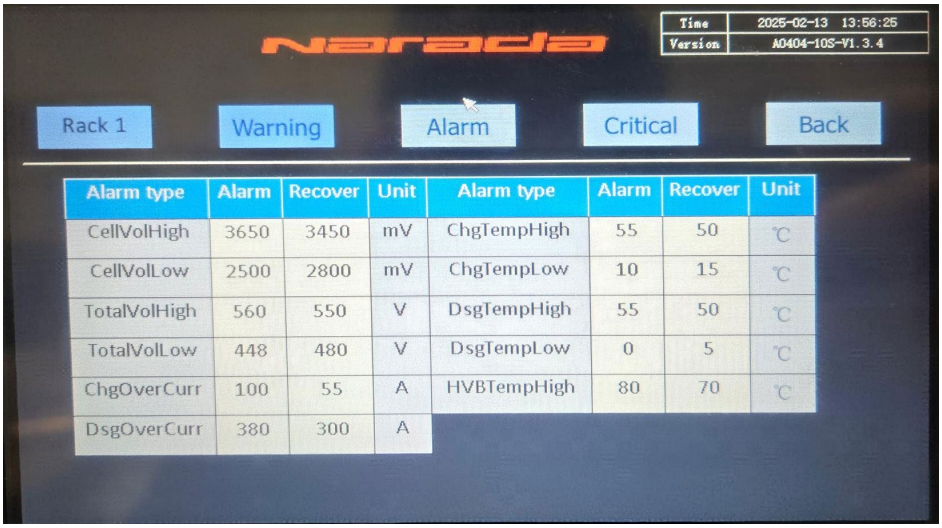
The battery system SOC is calibrated during a full charge and discharge cycle. The calibration process is automatic.

5.13 Threshold Parameter Setting

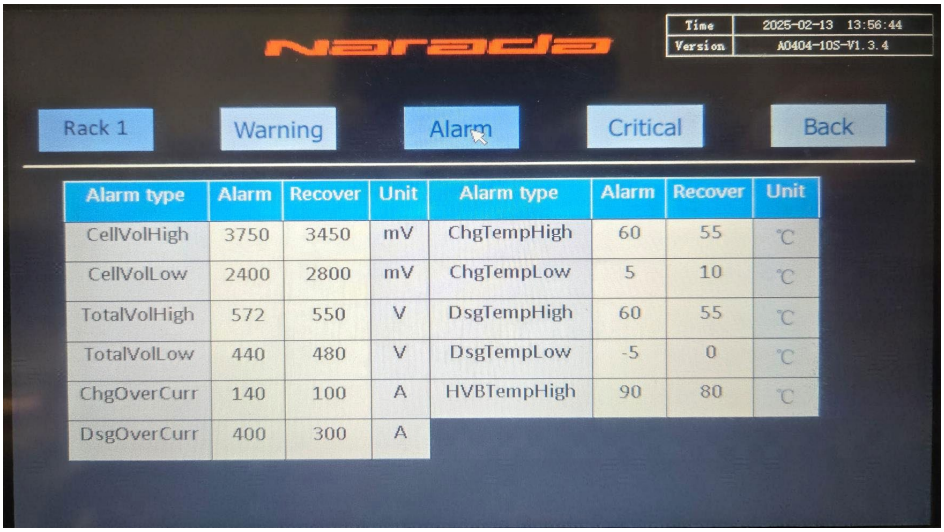
5.13.1 Touch the AlarmSetup button to enter the threshold parameter setting page. On this page, you can set the first-level “Warning” threshold, the second-level “Alarm” threshold, and the third-level “Critical” threshold.

5.13.2 On the parameter setting page, you can Touch the screen to set the relevant parameters of the three level of alarm and recover thresholds. After entering the value, Touch the OK button. When the value in the dialog box changes to the set value, it proves that the setting has been successful.

5.13.3 The first-level warning thresholds in terms of cell over-voltage, under-voltage, high temperature, and other parameters can be set. When the parameters of a rack reach the alarm threshold, the alarm interface will report the alarm information. When the system parameter reaches the recovery threshold, the rack will automatically recover. The same is true for the second and third-level threshold settings. In case the third level “Critical” threshold is reached, the system protection mechanism will be triggered. When the third level alarm is recovered, the system needs to be powered on again, and the system operation will return to normal.



Alarm type	Alarm	Recover	Unit	Alarm type	Alarm	Recover	Unit
CellVolHigh	3650	3450	mV	ChgTempHigh	55	50	℃
CellVolLow	2500	2800	mV	ChgTempLow	10	15	℃
TotalVolHigh	560	550	V	DsgTempHigh	55	50	℃
TotalVolLow	448	480	V	DsgTempLow	0	5	℃
ChgOverCurr	100	55	A	HVBTempHigh	80	70	℃
DsgOverCurr	380	300	A				

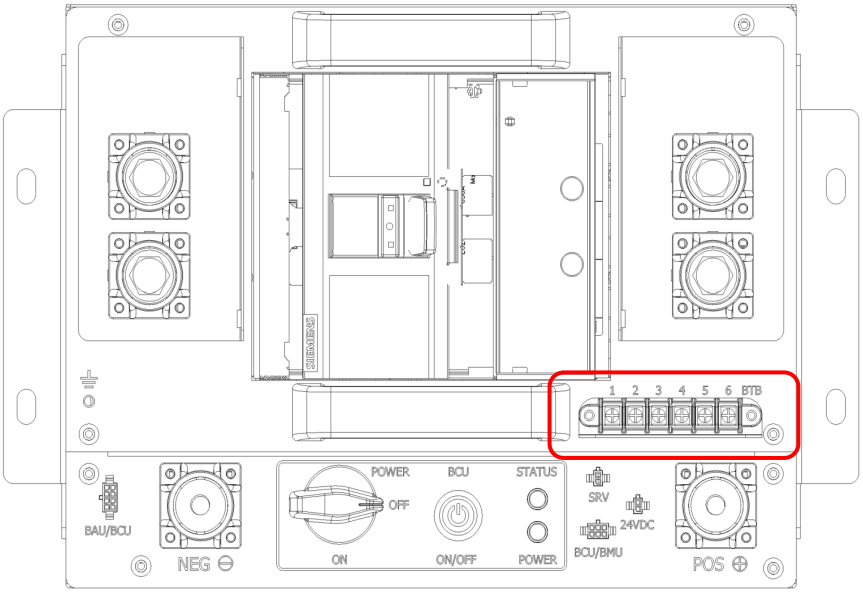


Alarm type	Alarm	Recover	Unit	Alarm type	Alarm	Recover	Unit
CellVolHigh	3750	3450	mV	ChgTempHigh	60	55	℃
CellVolLow	2400	2800	mV	ChgTempLow	5	10	℃
TotalVolHigh	572	550	V	DsgTempHigh	60	55	℃
TotalVolLow	440	480	V	DsgTempLow	-5	0	℃
ChgOverCurr	140	100	A	HVBTempHigh	90	80	℃
DsgOverCurr	400	300	A				

Alarm type	Alarm	Recover	Unit	Alarm type	Alarm	Recover	Unit
CellVolHigh	3900	3700	mV	ChgTempHigh	65	60	℃
CellVolLow	2300	2800	mV	ChgTempLow	0	5	℃
TotalVolHigh	578	550	V	DsgTempHigh	65	60	℃
TotalVolLow	432	480	V	DsgTempLow	-10	-5	℃
ChgOverCurr	165	110	A	HVBTempHigh	100	90	℃
DsgOverCurr	460	400	A				

5.14 Circuit Breaker Accessories

Circuit Breaker Accessories are used to check on the status of the system and to be able to remotely take the system offline by opening a breaker.



5.14.1 **Aux Contact** is used to check if the Circuit Breaker is in Open or Closed position.

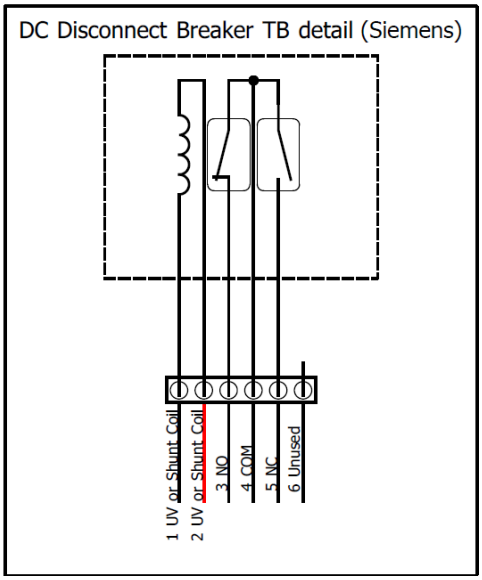
5.14.2 **UVR** – Under Voltage Release. UVR requires DC voltage (24V or 48V) to be constantly supplied to keep the breaker in the closed position. Once the Voltage is removed the UVR will open the breaker.

5.14.3 **Shunt Trip –** Woks opposite of UVR. Shunt trip mechanism does not require voltage to keep the breaker closed. When the voltage (24V or 48V) is supplied to the accessory the mechanism will open the breaker.

Note: It is typically a customer choice which accessory to use. Some customers may choose not to install any accessories.

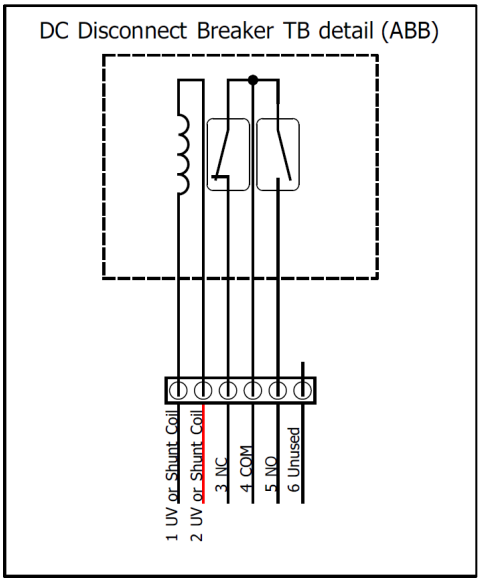
5.14.4 Accessories Pinout (Siemens Breaker)

- Pin 1 - UVR or Shunt trip
- Pin 2 - UVR or Shunt trip
- Pin 3 – Aux Contact **Normally Open**
- Pin 4 – Aux Contact **Common**
- Pin 5 **–** Aux Contact **Normally Closed**

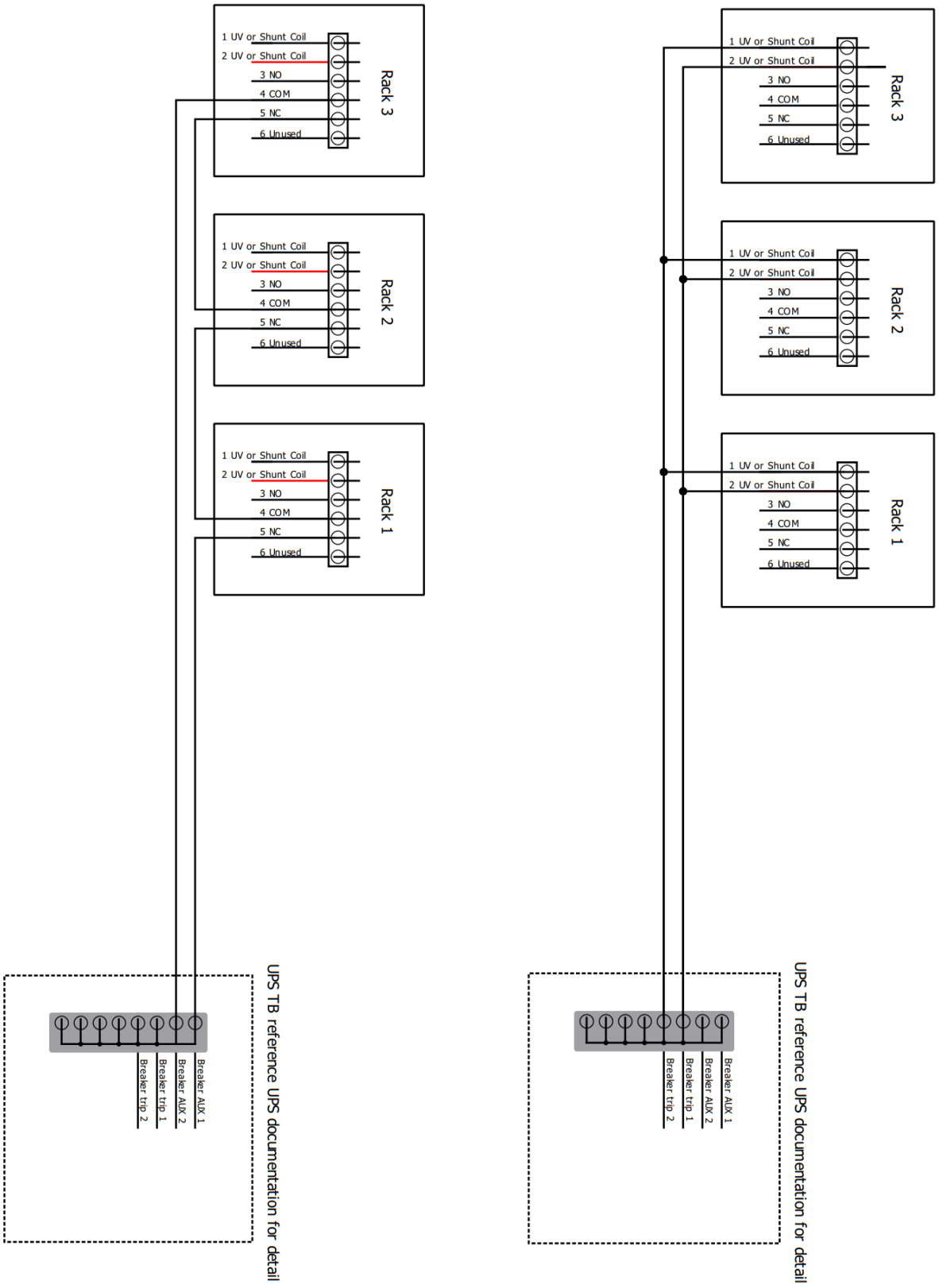


5.14.5 Accessories Pinout (ABB Breaker)

- Pin 1 - UVR or Shunt trip
- Pin 2 - UVR or Shunt trip
- Pin 3 – Aux Contact **Normally Closed**
- Pin 4 – Aux Contact **Common**
- Pin 5 **–** Aux Contact **Normally Open**

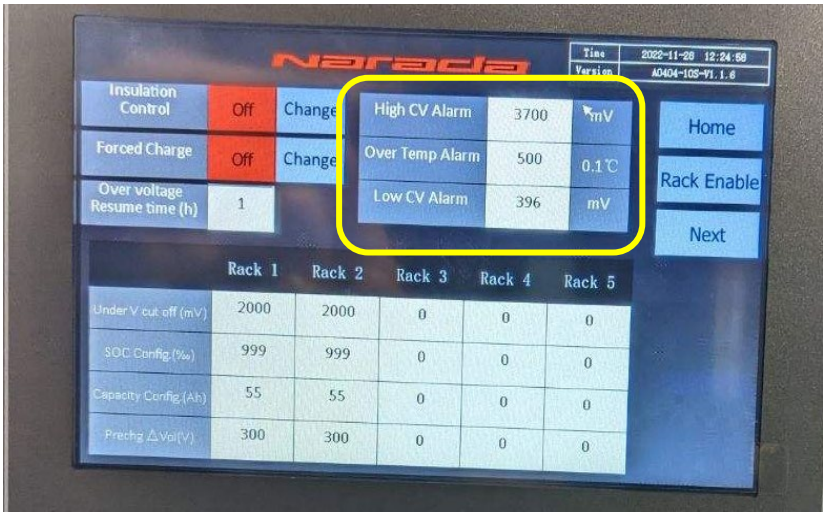


5.14.6 Accessories Muli-Rack Wiring (Siemens Breaker).

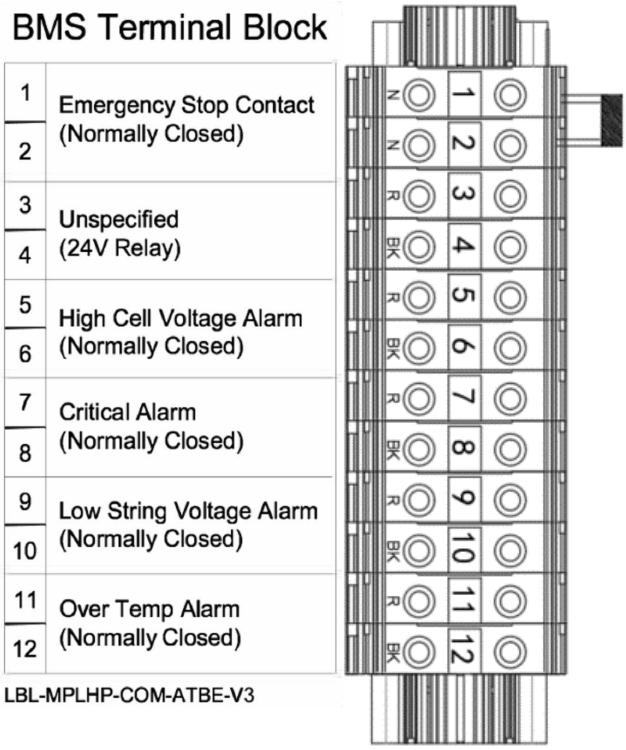


5.15 Dry Contacts and E-Stop

5.15.1 Dry contacts allow Battery System to communicate with outside devices including the UPS and enable the UPS to stop Charge and or Discharge before Battery System BMS automatically stops the charging or discharging of the Battery System. Refer to the Installation Manual for more information. High Voltage, High Temperature and Low Cell Voltage alarm values are shown on the page displayed below.



5.15.2 Dry Contacts Wiring



6. Storage

The MPLHP51255 Battery System can remain in storage prior to installation for an extended period. During extended storage periods, the batteries should be monitored and maintained as per the guidelines in this document.

6.1 Definition of Storage

6.1.1 Battery modules are considered stored when in an open circuit state and disconnected from a charging source by means of the breaker or physical disconnection.

6.1.2 Stored Batteries, kept under specific conditions detailed in this document, retain the ability to perform their designed function.

6.2 When batteries should be placed in storage post-installation

6.2.1 Batteries should be stored any time the charger is expected to be in the off state for greater than 48 Hours.

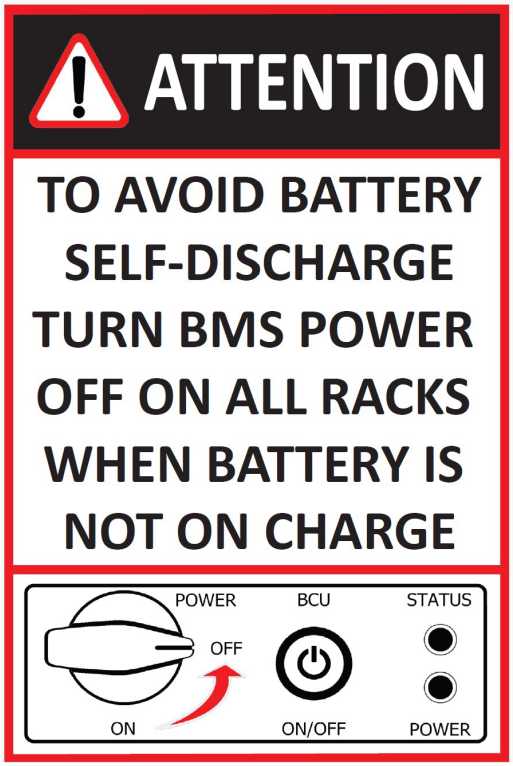
6.2.2 The following conditions should be observed when storing batteries that have been installed and started/commissioned.

6.2.1.1 Batteries should be stored at 100% Charge

6.2.1.2 Control and logic Power should be secured to prevent battery discharge.

WARNING

Failure to place the power switch and BCU on/off PB in the OFF position when there is no active battery charging, the breaker is tripped or disconnected from the UPS will result in battery self-discharge and permanent damage to the battery modules should power not be restored within ONE day and loss of warranty coverage.



6.3 Temperature Range

6.3.1 Acceptable Storage temperature range: -10℃ to 40℃, recommended storage temperature range: 15℃ to 30℃.

6.3.2 Battery modules can be kept at -10℃ minimum condition without damage but must be heated up to 15℃ before charge & discharge operation.

6.4 Relative Humidity

6.4.1 The relative humidity shall not be higher than 95%

6.5 Storage Preinstallation Condition

6.5.1 Recharge is required to recover capacity loss due to self-discharge during storage and transportation before operation.

6.5.2 During long-term storage, which means the storage period is beyond the recharge intervals stated in the table below, recharge should be conducted within the stated recharge interval according to the recharge program. After recharge, the SOC of the battery should be increased to 100% prior to any discharge testing.

6.6 Storage Post-Installation Condition

6.6.1 The charger should be secured.

6.6.2 Battery Breaker should be open on all racks.

6.6.3 BCU On/Off Push Button should be in the OFF position, and the main Power switch should be OFF.

6.6.4 Before returning to service or discharge testing, the system shall be recharged to 100% SOC.

6.7 Inspection Interval and Recharge Program Table

<table>
<tr><th>Storage Temperature</th><th>Inspection Interval</th><th>Recharge Program</th></tr>
<tr><td>-10C – 0C</td><td>Every 6 Months</td><td rowspan="2">The modules must be heated up to at least 15℃ before charge & discharge operation;</td></tr>
<tr><td>0C – 24C</td><td>Every 6 Months</td></tr>
<tr><td>25C – 30C</td><td>Every 4 Months</td><td rowspan="3">Refer to the Charge Procedure in the following section</td></tr>
<tr><td>31C – 35C</td><td>Every 3 Months</td></tr>
<tr><td>36C – 40C</td><td>Every 2 Months</td></tr>
<tr><td colspan="3">Notes:

If, during inspection, a module voltage is measured below 52.0V, this module needs to be recharged.

Reinspect after 6 months.

Modules measuring above 52.0V during initial inspection should be inspected in 2-month increments.

Relative Humidity must be ≤45%
SOC must be between 5-% and 80%</td></tr>
</table>

6.8 Stored battery Charge Procedure

6.8.1 Every 6 months modules should be charged during storage if the module voltage measures 52V or below.

6.8.2 For installed systems, the UPS/Charger should be used where possible. If the UPS is not available and if the system has not been installed, module level charging can be performed as follows.

6.8.2.1 Tools needed

- 60v power supply
- Multimeter
- Cables

6.8.2.2 Power Supply Voltage Setting – **56V** or per recommendation from MPI Engineering.

6.8.2.3 Current Limit Setting – **11A.**

6.8.2.4 Connect the battery to the Power Supply

6.8.2.5 Turn ON the Power Supply

6.8.2.6 Charging is complete when the current is <2.0A.

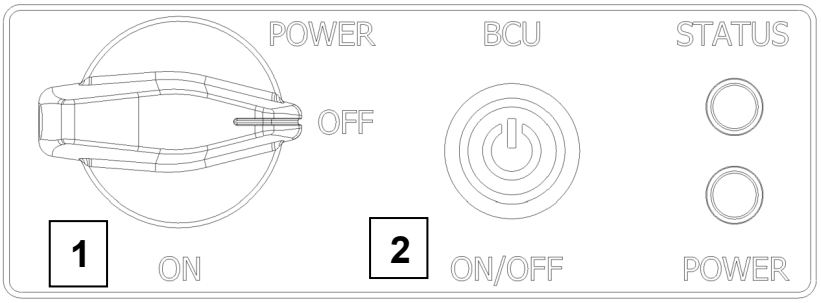
7. Startup procedure and Load Testing.

7.1 Control Box Power Disconnect Switch

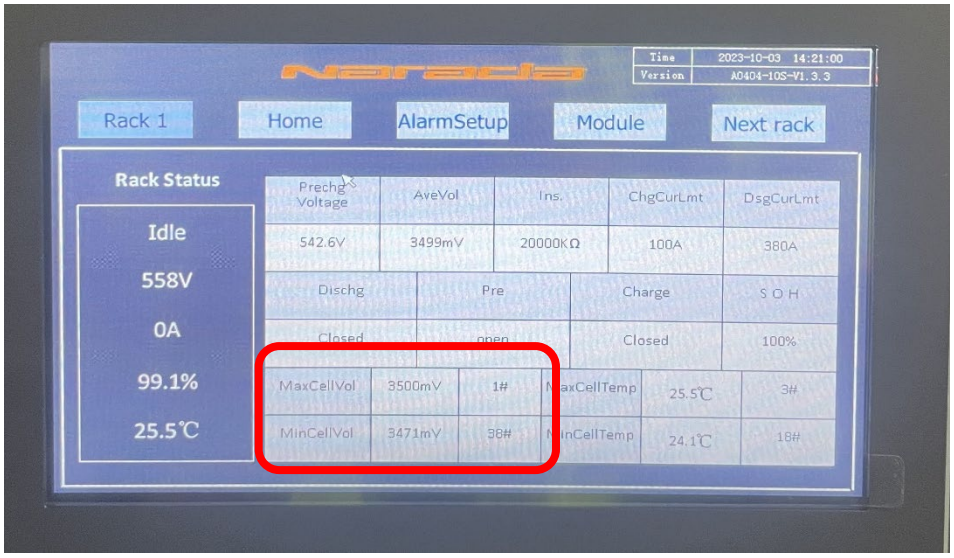
7.1.1 This switch can be found on the front of the control box on each string in the system. The black knob, shown in image below, controls main string level power. When in the “Off” position all BCU/BAU power will be disconnected, and both the “Status” light and “Power” will be off.

7.1.2 When the switch (1) is turned to the “On” the BCU of that string will now be getting the required voltage. However, the BAU and HMI screen will not be powered up during this step. Completion of this step will give you a Green light for “Power” no light for “Status” signifying the system is powered on but not online.

7.1.3 To power the BAU and HMI, String 1 in the system will need to have the On/Off switch shown as #2 in image below depressed. Once pushed, the “Status” light will light up Red and “Power” light will remain green. This signifies a properly powered up system. You will hear a beep from the HMI and it will illuminate. Follow this procedure for all strings in the system to allow all BCU’s to communicate to the BAU/HMI.



7.2 Ensure all communication cables and bus bars are installed.
7.3 Turn the system on.
7.4 Verify the status of each rack by checking the Events tab on the HMI screen. Note all active alarms.
7.5 For 10 module systems, set the UPS float voltage to 550V and keep it on charge until the minimum and maximum cell voltages are within 0.030V. Change the UPS float voltage to 560V. Set UPS Cut Off Voltage to 420V and Charge Current to 100A/system.
7.6 For 9 module systems, set the UPS float voltage to 395V and keep it on charge until the minimum and maximum cell voltages are within 0.030V. Change the UPS float voltage to 504V. Set UPS Cut Off Voltage to 380V and Charge Current to 100A/system.
7.7 Once the strings are enabled via the HMI (see Section 5.12), the contactors will close on each string, followed by the “Status” light turning green.
7.8 Check modules for any low cell voltages.
7.8.1 Review system settings Review high and low cell voltage values. They should be +/- 0.030V
7.8.2 If the deviation is greater, exit to the main screen, select each rack and then each module to identify the module with a low cell voltage.
7.8.3 If all cells are low, then the module needs to be recharged.
7.8.4 If all modules are low, then the rack needs to be recharged.

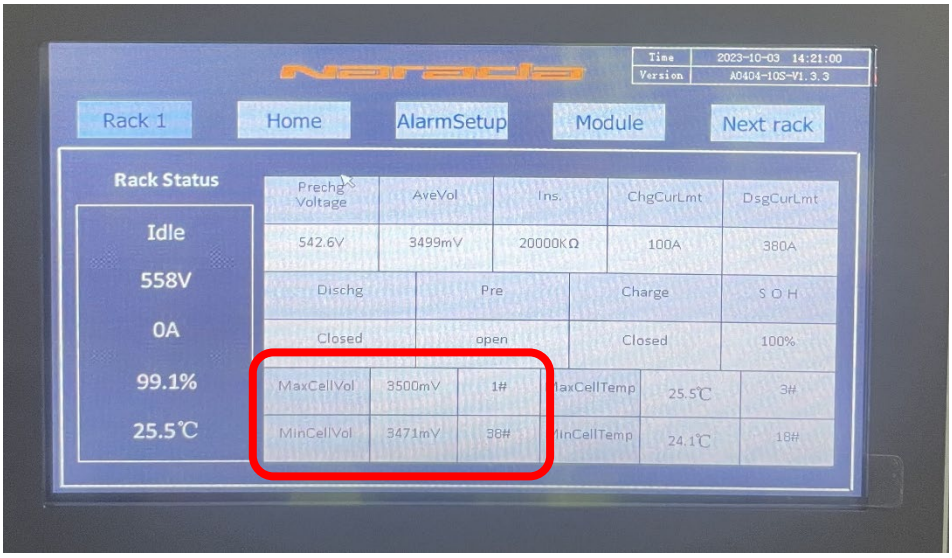


7.9 Check BAU BCU and HMI software versions. Use configuration manual MPITD-MAN-CNF-5125528.
7.10 Update BAU, BCU and HMI software if needed following instructions in the configuration manual.
7.11 Set Minimum number of racks to N-1. For 6 rack system set Minimum # of racks to 5.
7.12 Verify the status of each rack by checking the Events tab on the HMI screen. Note all active alarms.
7.13 Close Circuit Breakers on all Racks.
7.14 If there are no Active alarms Enable all racks. Check the Status LED lights on the control box. The light should be Green.
7.15 Check the status of contactors for R1-R6 on the HMI screen by Touching on R1, R2….., R6. Both Charge and Discharge contactors should be closed.
7.16 The Racks should start charging.

7.17 Keep the racks on Float Charge for 2-3 days. The racks will need to be balanced prior to performing any discharge testing. Monitor active alarms and cell voltages. There should be no discharge while there are active alarms or while the cells are balancing.

7.18 A “High Cell Voltage” alarm is common towards the end of charge upon initial startup. Over time, the racks will balance out, and the alarm will disappear.

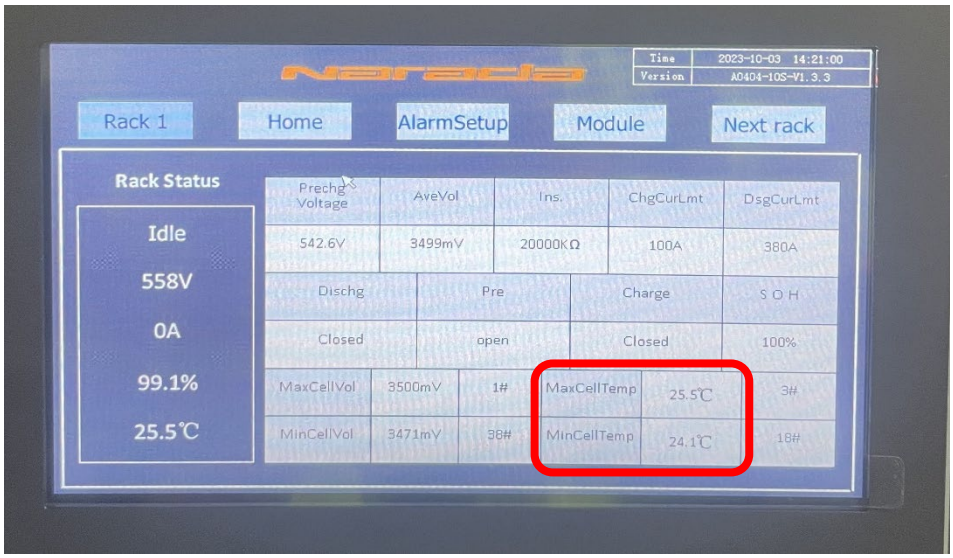
7.19 Check Min and Max cell voltages in each Rack. All modules are balanced when the Min and Max cell voltage is within 0.030V.



7.20 After a couple of days on charge all racks should reach ~560V +/- 3V, Once the racks stabilize at 560V and all modules have balanced they are ready for a discharge test.

7.20.1 If any of the racks in a system have not reached 560V, further investigation is needed to determine the cause. There should be no discharge testing performed on the system.

7.21 Check Min and Max Temperature of the Cells as well as Temperature of the room. Note: A full power load test should only be performed when the temperature of the cells is between 22- and 30-degrees C.



7.22 For the batteries that have been in storage for over 6 months, it is recommended to run a 50% power discharge prior to performing a full power load test:

7.22.1 Ensure the batteries have reached a full charge and are floating at around 560V.

7.22.2 Minimum and Maximum Cell Voltages are around 3.5V, and the difference between min and max does not exceed 0.030V.

7.22.3 Room temperature and battery minimum cell temperature are above 22C.Lower temperature will impact the voltage drop during a discharge. It is advisable to set the low voltage cut off to 420V for a 10 Module system and 380V for a 9 Module system.

7.23 Run a discharge test at 1C Rate for 5 minutes. Recharge the batteries. Allow the batteries to cool down to a temperate range of 22-30 degrees C.

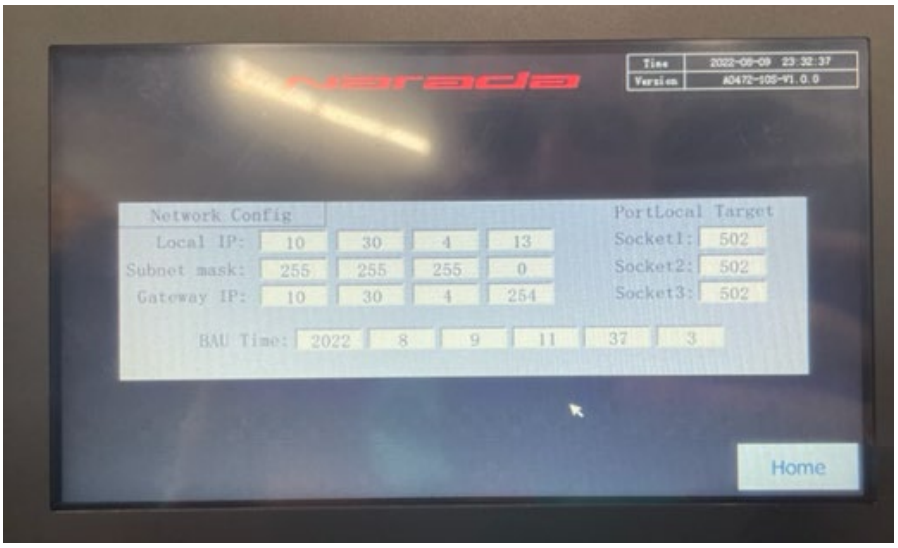
7.24 After the batteries have cooled down, a full power load test can be performed.

WARNING

Ensure the batteries continue to be connected to the UPS and are recharged after the test. Failure to do so will result in permanent damage to the battery modules and a loss of warranty coverage. If UPS power is not available, the system must be turned off. If the battery breaker trips during the discharge, ensure it is reconnected as soon as possible. Failure to close the breaker will cause the battery to self-discharge.

8. Ethernet Communication

8.1 After installation, wiring, and configuration are completed, check the communication status by connecting the Ethernet cable to the BAU to communicate via MODBUS to see whether the System BMS provides the data correctly. Press the Network Tab from the home screen to set the IP address.



8.2 The default IP address is:192.168.1.199 (May vary based on system – Part of startup procedure for commissioning) Port number 502 .

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