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# LiFePO<sub>4</sub> – MPLhP 51.2V 55Ah Battery System

## Installation Manual



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

**Retain these instructions for reference.**

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Table 11-1 History of Version Upgrade

<b>Version</b>	<b>Date</b>	<b>Change</b>
V 1.0	25/09/2020	First edition
V1.1	08/10/2020	Updates on HMI, Tools, BMS Configuration
V3.0	03/10/2021	Updates to Cabinet, BMS, and Wiring
V4.0	05/26/2021	Added Rack Lifting Instructions
V4.3	08/17/2021	Updated instructions, rack images and lifting instructions
V4.4	09/15/2021	Updated torque specs
V4.5	11/22/2021	Updated part numbers
V4.7	03/22/2022	Updated to reflect SPI communication changes
V4.8	10/24/2022	Updated images, instructions and dry contacts
V4.9	01/24/2023	Updated images, format

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## 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 LFP lithium 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 machines. 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 technical operators should be able to access the system.

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

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### **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 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, qualified, trained personnel, following proper Lockout/Tag out procedures prior to beginning electrical work.



### **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.

Do not dismantle batteries, it contains electrolyte which is a hazardous material that can harm 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!

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Use only insulated tools with minimum rating of 1000V to avoid accidental short circuits!

Disconnect charging through opening of disconnect. Ensure load is Open 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.)!

Avoid direct sunlight on the battery rack, exposure to water or rain or high humidity!

Batteries must be handled, transported, and recycled or discarded in accordance with federal, state, and local regulations!



### **Installation Precautions**

Before installation and Inspection, all required personal protection equipment (PPE) for supervising and installation shall be in place.

Before installation, the installation personnel should fully understand the installation procedures outlined in the manual.

All power cables shall be considered energized unless proper measures have been taken to de-energize.

Before installation, be sure to cut off the UPS power and make sure the battery Control Box is switched off by turning main power switch to off position on each string.

All battery racks must be grounded.

The tightening torque for the Busbar is 25 Nm using a M10 hex head screws. The BMS and cabinet disconnect control box power connections torque is 25 Nm using a M10 hex head screws.

Before electrical commissioning, ensure the following connections are properly torqued.

- Busbar connection between modules
- Control Box Power Terminals
- Ground Terminals
- Mounting Screws for Modules

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

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Please pay attention to the following safety cautionary markings and warning signs during installation.

### Warning Signs Table

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

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## 1. Scope

This manual stipulates system specifications and detailed steps and attentions during installation of Narada NESP 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 51.2NESP55 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 Pcs of 51.2NESP55 modules) in rated voltage and 55 Ah in rated capacity.
- 2.4 Cabinet:** The rack enclosure that contains the battery system components (Modules and Control box).
- 2.5 Control box:** The control box 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.

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**2.10 BAU:** Battery Administration Unit.

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

### 3. Product Description

**3.1 The following acronyms and abbreviations are used in this manual.**

<b>Abbreviations</b>	<b>Full Name</b>
BMS	Battery Management System
BMU	Battery Management Unit (Module level)
BCU	Battery Cluster Management Unit (String level)
BAMS	Battery Administration Management System (BAU and HMI)
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

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### 3.2 Introduction

NESP Series 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.

### 3.3 Features

- 3.3.1 **Modular design:** The battery module and BMS designed to have uniform standard modular design. Flexible configuration allows for different quantities of battery modules in series providing multiple battery voltage options to match your UPS. Modular design makes the system easy to assemble, maintain and install.
- 3.3.2 **High safety:** The grouping structure, ventilation and thermal management design ensures the temperature consistency of each cell in each battery module during operation. Redundant protection system ensures the unit safety.
- 3.3.3 **Long-life design:** Long-life and high-quality cells are automatically selected during production, thus the consistency of the cells in grouping is ensured. The combination of passive and active balancing of the battery modules ensures the consistency of each cell during system operation, leading to extended battery life and improved system safety and reliability.
- 3.3.4 **Smart BMS:** System data is collected and managed in a systematic manner, through data interaction between BMS and monitoring system, enabling rapid response. The BMS ensures the battery is always running properly through real time monitoring, automatically balancing, automatically scanning protection and power data requests.

### 3.4 Specifications

	<b>512NESP55</b>		<b>5125528</b>	
	<b>Module</b>		<b>System</b>	
Rated Voltage / Capacity	V / Ah	51.2 / 55	Configuration	160S1P
Weight	Kg/lbs	35 / 77	Modules /String	10
Charge / Discharge Current (Max)	A	55 / 425	Nominal Voltage(V)	512
Charge / End Voltage	V	57.6 / 43.2	Module (Ah)	55
Discharge Voltage	V	43.2	Charge Voltage(V)	584
Module Dimensions	Width, mm/in	392 / 15.5	Cutoff Voltage(V)	448
	Depth, mm/in	435 / 17.2	Max Discharge (A)	425
	Height, mm/in	165 / 6.5		
Recommended Temperature Range	Charge	0°C to 55°C	Rack Width(mm/in)	500 / 19.7
	Discharge	-20°C to 55°C	Rack Depth(mm/in)	710 / 28.0
	Storage	0°C to 40°C	Rack Height(mm/in)	2048 / 80.7
	Operating	15°C to 35°C	System Weight (kg/lbs.)	540 / 1188

Fig 3-1 51.2NESP55 Rack Specifications

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### 3.5 Components

3.5.1 The major components of NESP rack are:

3.4.1.1 Battery Module

3.4.1.2 Control Box

3.4.1.3 Cabinet

3.4.1.4 BMS – Based on a 3-level architecture and is composed of

3.4.1.4.1 BMU - Preinstalled in Battery Module

3.4.1.4.2 BCU - Preinstalled in the Control Box

3.4.1.4.3 HMI - Preinstalled in cabinet.

3.4.1.4.4 BAU – Preinstalled in cabinet.

Table 3-1 Location of BMS Components

Unit Level	Unit Name	Location	Function
Level 1, Module Level	BMU	In Battery Module	Monitor cell information; Active balancing
Level 2, Rack Level	BCU	In Control Box	Data collection, analysis, and decision; Rack Level Protection; Communication with BAMS;
Level 3, System Level	BAU + HMI	On Cabinet door	Communication with BCU and UPS, etc.

Table 3-2 Main Components of NESP Rack

No.	Components	Description	Appearance
1	Batteries	High Rate LFP Battery Modules	
2	Connectors	Copper Bus Bars	
3	BMS	BMU 1P16S	
		Control Box (BCU)	
		HMI	
		BAU	
4	Cabinet	Cabinet for battery and BMS	

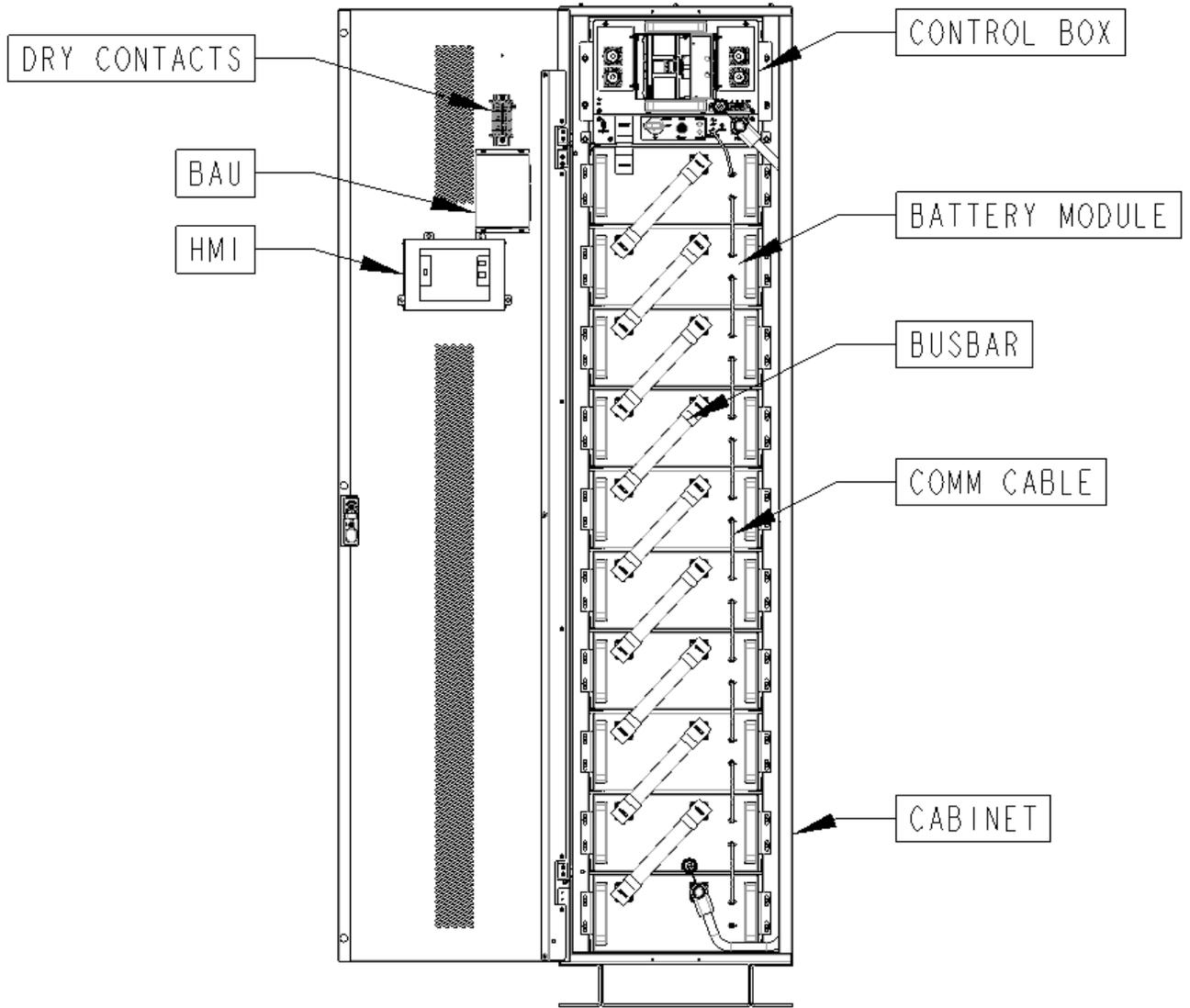


Fig 3-2 Major Components of 5C Rack

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### 3.6 Battery Module

3.4.2.1 The battery module consists of battery cells in an 1P16S configuration. Below are front and isometric views the module.

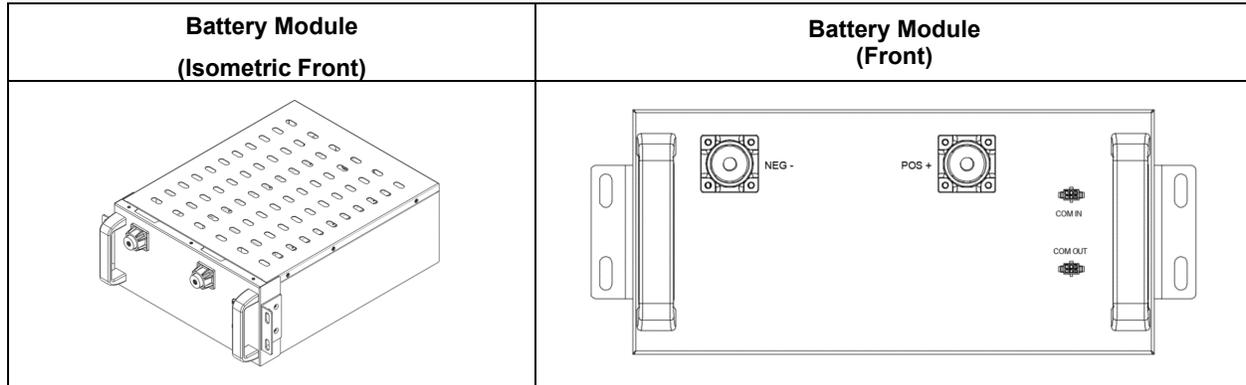


Fig 3-3 Front and Isometric Views of the Battery Modules

### 3.7 Control Box

3.4.2.1 The Control Box consists of a protection circuit and a BCU.

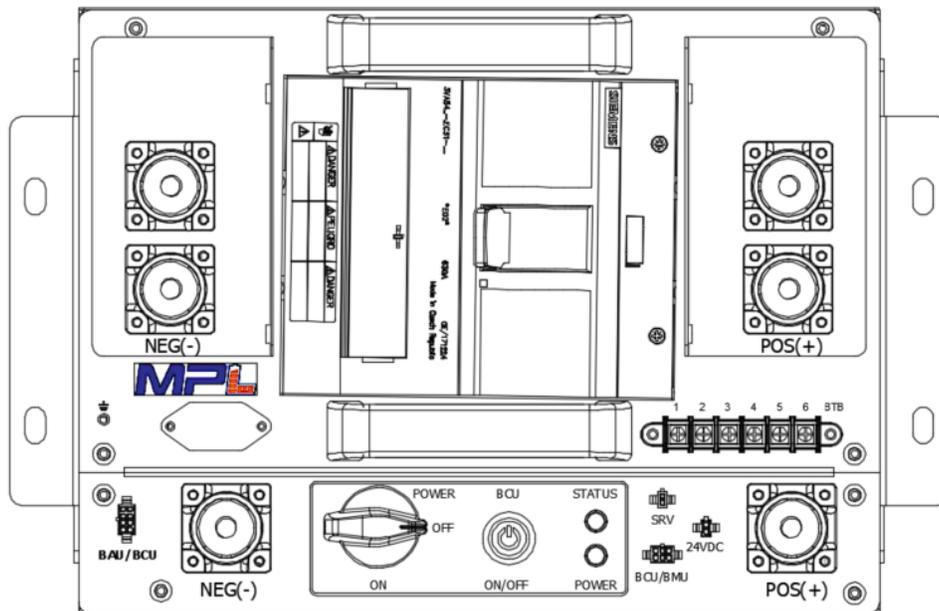


Fig 3-5 Control Box

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## 4. Cabinet

### 4.1 Cabinet

4.1.1 The Cabinet houses Modules, Control Box and integrated BAMS assembly. It facilitates grounding the installed components.

4.1.2 For the Rack composed of ten 51.2V 55Ah modules (Model #5125528), the specification is as below:

Weight: 540KG

Dimension (LxWxH): 500mm x 741mm x 2138mm

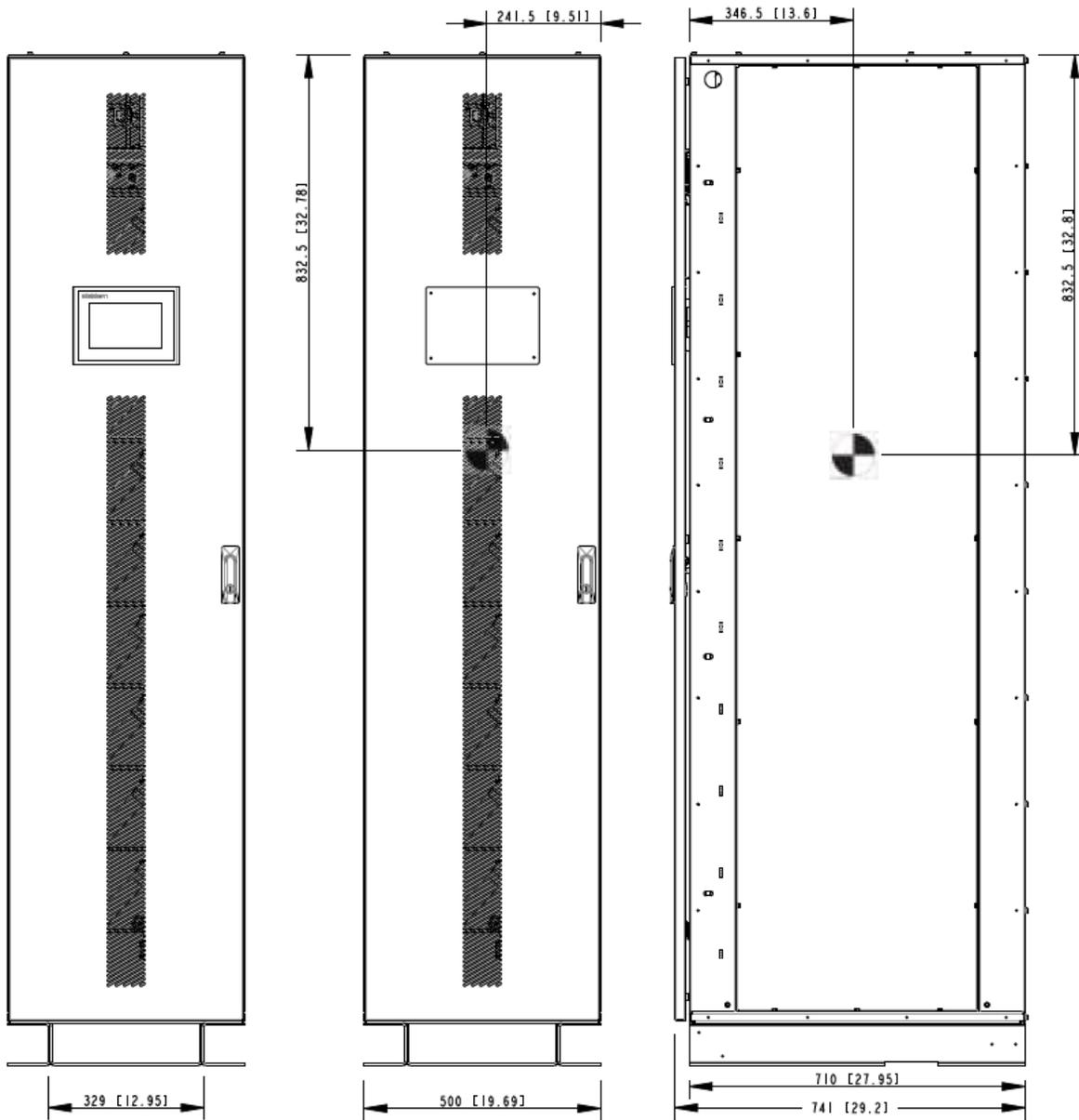


Fig 4-1 Front and Side Views of the Standard 10-Module Rack

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## 4.2 BMS

For the Rack composed of ten 51.2NESP55 modules (Model #5125528), the specification is as below:

Table 4-1 Specifications of BMS Components

Unit Level	Unit Name	Specifications
Module Level	BMU	<ul style="list-style-type: none"> <li>Battery type: High Rate LFP</li> <li>Voltage detection range: 0.5-5.0V</li> <li>Voltage acquisition of cells in strings: 16</li> <li>Voltage sampling accuracy: 0.1% or <math>\leq 5\text{mV}</math></li> <li>Temperature sampling accuracy: <math>\pm 2^\circ\text{C}</math></li> <li>Balance type: Active balance</li> <li>Balance current: <math>\leq 2.5\text{A}</math></li> <li>Communication interface: SPI</li> <li>Supply voltage: 20-28Vdc (typical 24Vdc)</li> </ul>
Rack Level	BCU	<ul style="list-style-type: none"> <li>Max BMU number: 10</li> <li>Current sampling accuracy: <math>\pm(1\%\text{FS} + 1\%\text{RD})</math></li> <li>Voltage sampling interval: 100ms</li> <li>Communication interface: RS 485*0, CAN*3</li> <li>Supply voltage: 20-28Vdc (typical 24Vdc)</li> <li>High voltage detection: 0-900 Vdc, Accuracy: 0.5%</li> <li>Insulation resistance detection: 100K-5M<math>\Omega</math>, Accuracy <math>\leq 10\%</math></li> </ul>
System Level	BAU	<ul style="list-style-type: none"> <li>Communication interface: RS 485*3, SPI, Ethernet*1</li> <li>Supply voltage: 20-28Vdc (typical 24Vdc)</li> </ul>

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

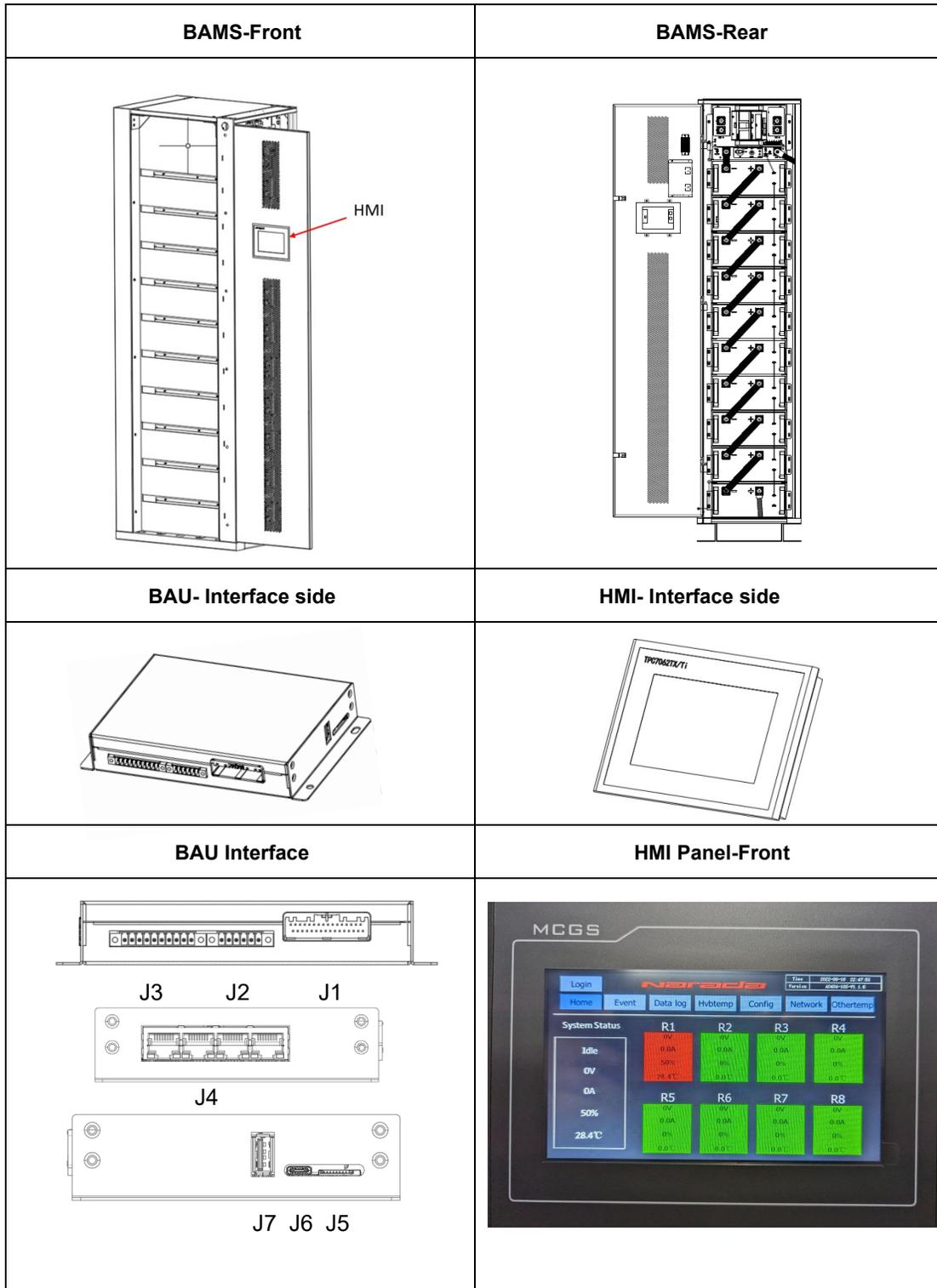


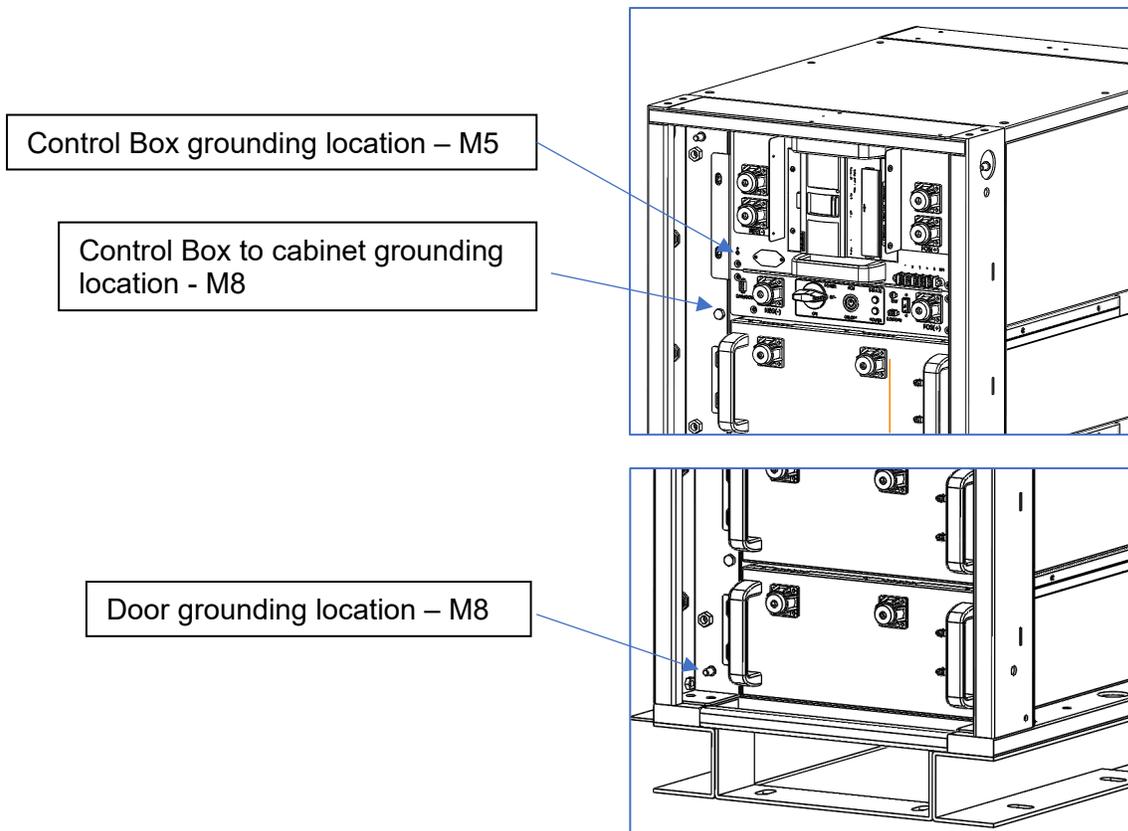
Fig 4-2 Front and Rear Views of the Cabinet Integrated BAMS

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4.2.2.1 There are a number of 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.

4.2.2.2 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.

### 4.3 Grounding Wires



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- 4.3.1 Grounding the system is required to reduce and eliminate electrical noise in the system and prevent shock hazards.
- The control box should be grounded to the rack frame using the supplied green/yellow cable.
  - The door should be grounded to the rack frame using the supplied green/yellow coiled cable.
  - The rack should be grounded to a site/system ground with customer supplied cable
- 4.3.2 Grounding connections and requirements will vary based on specific project and system configurations. All grounding methods should comply with NEC Article 250.
- 4.3.3 Ground wire should be at least 16mm<sup>2</sup> (#5 AWG) with M8 ring terminals.

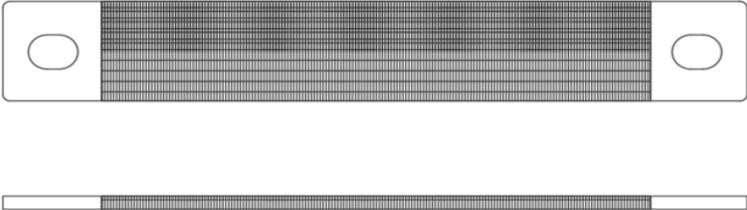
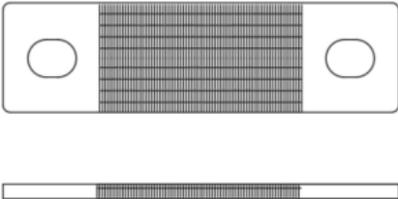
Table 4-5 Rack Fastener Hardware

Fastener Location	Size	Hardness	Thread Pitch	Material
Wire Fasteners	M8*14L	HRC32 Grade 8.8	1.25mm (0.05 in)	SS304
Rack Fasteners (Floor Anchors)	M10*30L M12*200mm (min) (seismic)	HRC32 Grade 8.8	1.5 mm (0.06 in)	SS304
Multi Rack Fasteners	M8*25L (Side)	HRC32 Grade 8.8	1.5 mm (0.06 in)	SS304

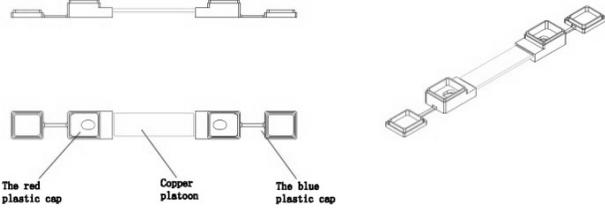
#### 4.4 Accessories

- 4.4.1 Bus bars are supplied for connecting the modules together in series to form a full string connected to the Control Box.

Table 4-1 Specifications of Accessories

Types	Descriptions of Accessories
1	<p>Copper bus bar for connecting modules diagonally within a cabinet. Part Number BB-4030263M10</p> 
2	<p>Copper bus bar for connecting the control box to the first module. Part Number BB-4030109M10</p> 

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3	<p>Busbar Terminal Covers</p>  <p>The diagram illustrates the assembly of busbar terminal covers. It shows a top view of a busbar with two covers being placed on it. A detailed view below shows the components: a red plastic cap on the left, a copper platoon in the middle, and a blue plastic cap on the right. A perspective view on the right shows the covers being slid onto the busbar.</p>
4	M10 x 25mm SS bolt with Flat washer and Lock Washer
5	Cable Lug Terminal cover Black
6	4/0 UL 94V-0 High Flex Cable - Last Module Positive to Control Box Positive Input

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## 5. Preparation Requirement

### 5.1 Required Personnel

- 5.1.1 All personnel performing these installation activities shall be trained and experienced with the Narada High Rate LFP Battery system. Individuals shall meet all the training prerequisites and must have completed the system training. Required Personnel include:
- 5.1.2 Authorized and trained service personnel to perform any installation work that falls within owner's scope of effort as identified in this document.
- 5.1.3 Authorized and trained owner representative to perform any installation work that falls within owner's scope of effort as identified in this document.

### 5.2 PPEs and Tools

	<b>WARNING</b>
	<ul style="list-style-type: none"> <li>▪ Do not wear watches, rings, jewelry, or any other metal objects.</li> <li>▪ Wear helmet before entering construction site to protect your head.</li> <li>▪ Wear electrically insulated gloves and safety shoes.</li> <li>▪ Use properly insulated tools to prevent accidental electric shock or short circuits!</li> <li>▪ Wear FR clothing.</li> </ul>

***Service Engineer should prepare the needed items such as Personal Protection Equipment (PPEs) and Tools before the operation and installation starts. Service Engineer must check condition of PPE and verify it is suitable prior to performing any installation activities.***

***Recommended tools and equipment are shown in the following table. Verify that all equipment is calibrated via approved calibration procedures, and that the calibration is not expired.***

Table 5-1 Recommended Tools and Instruments

No.	Items	Appearance
1	Insulated Phillips Screwdriver	
2	Utility Knife	
3	Insulated Torque Wrench	
4	Insulated Sockets (10 mm, 13mm, 18mm and 19mm)	
5	Insulated Extension for Socket	
6	Level	

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7	1000V Digital Multimeter	
8	Insulated wrench & box wrenches	
9	Measuring tape	
10	Conductance, Battery Tester	
11	Module Loading Stroller (300lb load Maximum)	

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### 5.3 Documentation

5.3.1 Before installation, all related documents such as Contracts, Technical Agreement, Shipping List, Installation Drawing shall be collected and confirmed they are of the final version. Technical service personnel should make sure all required preparation in place before installation and fill in checklist for battery system installation step by step as shown below.

### 5.4 Unpacking

5.4.1 Check the following parts during unpacking. The Quantities are based on parts for 1 HMI cabinet with 10 modules.

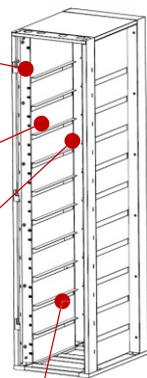
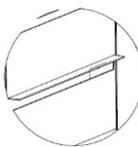
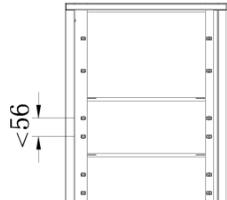
Table 5-3 Parts for Single Rack with 10 modules (5125528)

BILL OF MATERIALS			
Item	Part Number	Description	Qty
1	MPLHP-5125528-11	MPLHP-5125528 Cabinet Black, 10 Modules, with HMI-BAU	1
2	MPLHPCB-10000	MPLHP-51255 Control Box with SPI-BCU	1
3	BREAKER	Siemens Breaker See Control Box Details for Details	1
4	NLHP51255	Narada Module, 51.2V 55Ah, SPI	10
5	LHP-DINTB5WB1RB	MPLHP Terminal Block Kit	1
6	-	M4 FLANGE NUTS	2
7	LHP-BAU001	MPLHP, BAU-B20, System Control BMS, SPI	1
8	LHP-HMI7K	MPLHP Interface Screen, 7"	1
9	BB-4030109M10	NHPL-51255 Module to HVCB Busbar	1
10	BB-4030263M10	NHPL-51255 Module Diagonal Busbar	9
11	HDW-M1025SS-30	M10x25mm Hardware Kit (30 Sets)	1
12	LHP-BBTC-BLK	Busbar Terminal Covers Black	20
13	LHP-CBL-402070M10	MPLHP-51255, 10 Module, Control Box Cable, 4/0, M10M10	1
14	LHP-CBLTC-BLK	Cable Terminal Cover Black	2
15	HDW-M620ZP-50	M6 Hardware Kit 20mm 50 Sets	1
16	MPLHP-51255-11D	Cabinet Door, Black, 10 Module with HMI Cutout	1
17	LHP-CCOM-AC01	MPL Com Cable SPI BAU-BCU	1
18	LHP-CCOM-CT01	MPL Com Cable SPI BCU Terminator	1
19	LHP-CCOM-J1J3	MPL Com Cable SPI BAU-J1-DRY-TB-HMI, BAU-J3-DRY-TB	1
20	LHP-CCOM-MC01	MPL Com Cable SPI BMU-BCU	1
21	LHP-CCOM-MM01	MPL Com Cable SPI BMU-BMU	9
22	LHP-GC5-120-M8M5	5Ga 120mm Ground cable Yellow/Green,	1
23	LHP-GC5-300-M8M8	5Ga Ground cable Yellow/Green - Enclosure to Door	1
24	HDW-HHCSZP-M825	M8x25 Hex Head Cap Screw, Grade 8.8 Zinc Plated	2
25	HDW-HHFNYZ-M8	Cabinet Grouding M8 Nut & Washer	1
26	MPLHP-HVCB-TSM4-6	MPLHP Control Box Terminal Cover Thumb Screw	4
27	LHP-TPCVRBL	Terminal Protective Covers, Black Control Box Pair, POS/NEG	1

## 5.5 Inspections

5.5.1 Installation personnel should make a record after unpacking according to the checking list. After unpacking, the following items should be inspected and then fill up the Receipt of the Goods and sign it by customer (representative of customer) and installation personnel together. If any defects are found during the inspection, contact technical customer service department to address the problem.

Table 5-5 Inspection of NESP Rack Components

Component	Inspection items		
Module	<ul style="list-style-type: none"> <li>Voltage and internal impedance using a battery tester</li> <li>Damage to the exterior</li> <li>Missing or protruding screws</li> <li>Peeling paint</li> </ul>		
Control Box	<ul style="list-style-type: none"> <li>Damage to the exterior</li> <li>Missing or protruding screws</li> <li>Peeling paint</li> </ul>		
BAMS	<ul style="list-style-type: none"> <li>Damage to the exterior</li> <li>Missing or protruding screws</li> <li>Peeling paint</li> </ul>		
Accessories	<ul style="list-style-type: none"> <li>Quantity</li> <li>Specifications</li> </ul>		
Cabinet	<ul style="list-style-type: none"> <li>Structural Damage</li> <li>Peeling paint</li> <li>Screw damage</li> </ul>	<p>Missing Cage Nuts</p> 	
		<p>Deformed Guide Rail</p>  <p>Wrong size</p> 	

## 6. General Guidelines

### 6.1 Installation Steps

Table 6-1 Installation Steps of Rack with 10 Modules

No.	Step	
1	Unpacking	
2	Inspection	
3	Cabinet Positioning	
4	Rack Installation	Battery Modules
		Control Box
		BAMS Assembly
		Busbars
		Communication Cables
		Power and Control Cables
		BMS Configuration

### 6.2 Clearance Distance

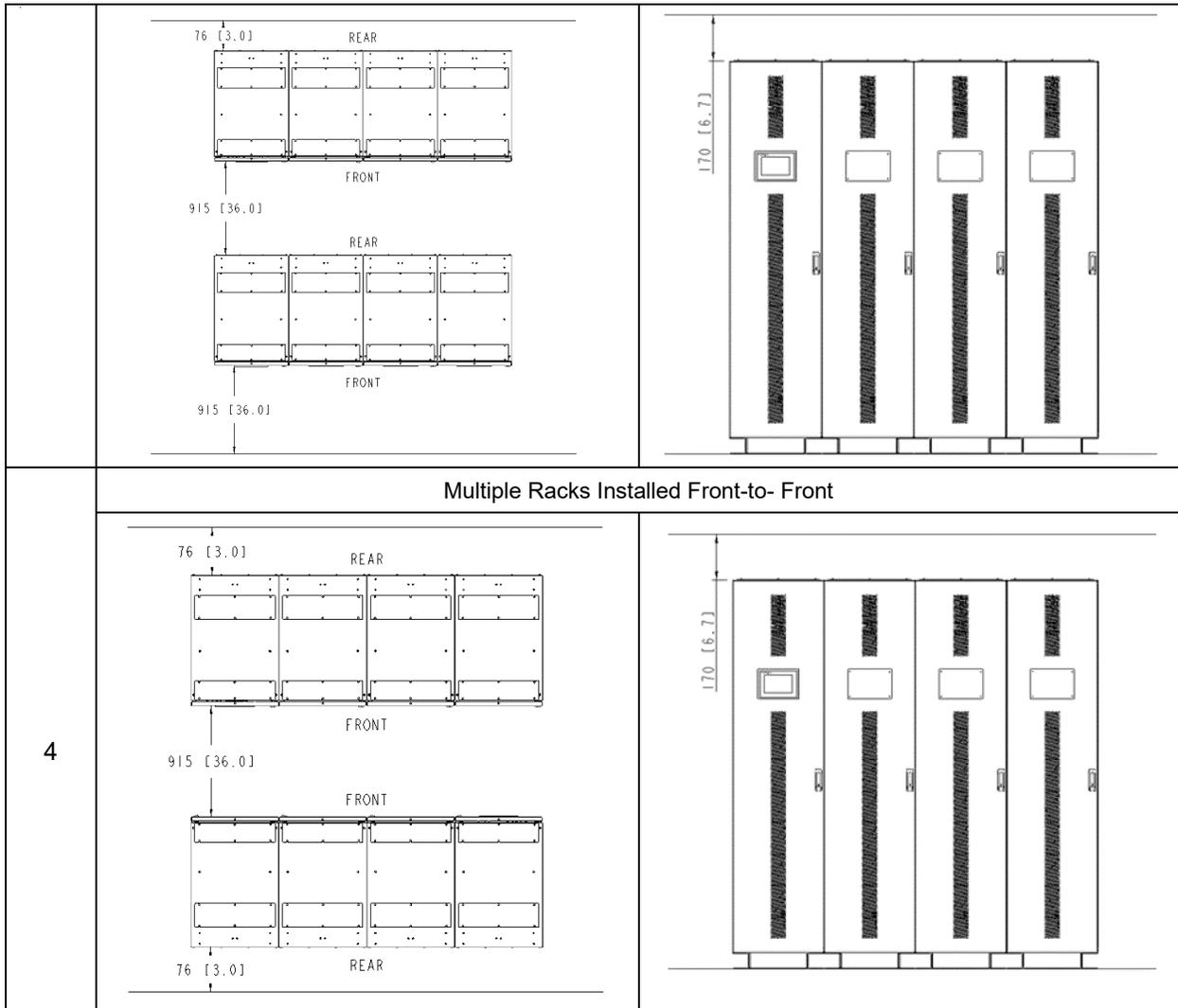
	<b>WARNING</b>
	<ul style="list-style-type: none"> <li>▪ Lift the rack from the front when using a forklift. Please see Section 11 for lifting instructions.</li> <li>▪ Use lock washers on all anchoring bolts.</li> <li>▪ Be sure rack is installed plumb and level.</li> <li>▪ Do not distort the rack by installing on a non-level or non-flat surface.</li> <li>▪ Distorting the rack will cause problems connecting racks together and opening/closing the doors.</li> <li>▪ Adhere to the clearance distances as required.</li> </ul>

6.2.1 The clearance distances should be kept according to the figures shown below for the purpose of proper ventilation and cooling of the battery, and for the ease of installation and maintenance.

Table 6-2 Rack Installation Clearance Distances

Types	Clearance Distance	
1	Single Rack	
	<p>Diagram showing a single rack with a clearance distance of 915 [36.0] from the front to the rear.</p>	<p>Diagram showing a single rack with a clearance distance of 170 [6.7] from the top to the bottom.</p>
2	Multiple Racks	
	<p>Diagram showing four multiple racks with a clearance distance of 915 [36.0] from the front to the rear.</p>	<p>Diagram showing four multiple racks with a clearance distance of 170 [6.7] from the top to the bottom.</p>
3	Multiple Racks Installed Rear-to-Rear	
	<p>Diagram showing four multiple racks installed rear-to-rear with a clearance distance of 915 [36.0] from the front to the rear.</p>	<p>Diagram showing four multiple racks installed rear-to-rear with a clearance distance of 170 [6.7] from the top to the bottom.</p>

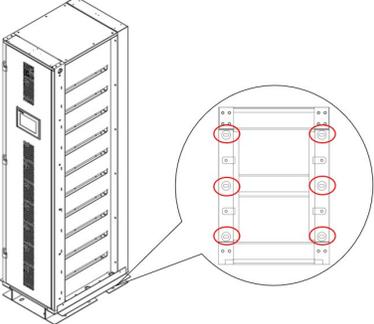
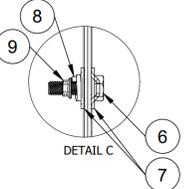
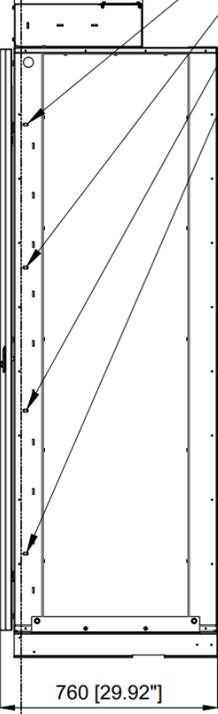
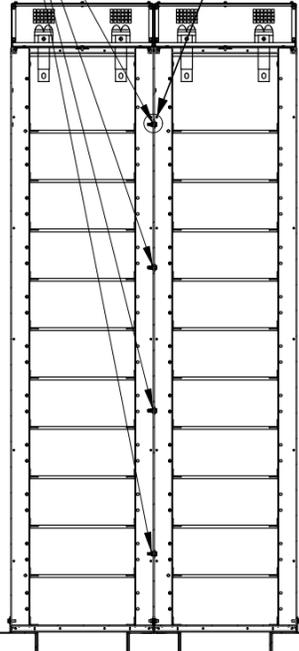
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### 6.3 Cabinet Positioning

- 6.3.1 After the cabinet is unpacked and transported to its installation location, (Please see Section 11 for lifting instructions) confirming the pre-drilled holes in the bottom and sides are aligned for positioning and mounting and remove the side and rear panels from the rack.
- 6.3.2 The cabinet positioning steps are as follows.

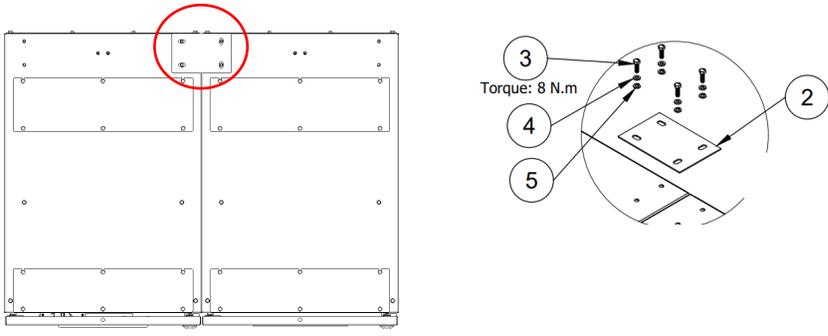
Table 6-3 The Steps for Cabinet Positioning

Steps													
1	<p>Mount cabinet to the floor.</p> 												
2	<p>Connect adjacent racks together using screws, nuts, washers.</p> <table border="1" data-bbox="386 751 1377 886"> <tr> <td>6</td> <td>HDW-HHCSZP-M825</td> <td>M8x25 Hex Head Cap Screw, Grade 8.8 Zinc Plated</td> </tr> <tr> <td>7</td> <td>HDW-FWZP-M8</td> <td>M8 Flat Washer Grade 8.8 Zinc Plated</td> </tr> <tr> <td>8</td> <td>HDW-LWZP-M8</td> <td>M8 Lock Washer Grade 8.8 Zinc Plated</td> </tr> <tr> <td>9</td> <td>HDW-NZP-M8</td> <td>M8 Nut Grade 8.8 Zinc Plated</td> </tr> </table>    <p style="text-align: center;">SECTION A-A (ONLY SHOWING 2 CABINETS)</p>	6	HDW-HHCSZP-M825	M8x25 Hex Head Cap Screw, Grade 8.8 Zinc Plated	7	HDW-FWZP-M8	M8 Flat Washer Grade 8.8 Zinc Plated	8	HDW-LWZP-M8	M8 Lock Washer Grade 8.8 Zinc Plated	9	HDW-NZP-M8	M8 Nut Grade 8.8 Zinc Plated
6	HDW-HHCSZP-M825	M8x25 Hex Head Cap Screw, Grade 8.8 Zinc Plated											
7	HDW-FWZP-M8	M8 Flat Washer Grade 8.8 Zinc Plated											
8	HDW-LWZP-M8	M8 Lock Washer Grade 8.8 Zinc Plated											
9	HDW-NZP-M8	M8 Nut Grade 8.8 Zinc Plated											

3

Connect the adjacent racks together on the top of the cabinet using connecting plate and M6 hardware.

2	HWR-PLT20150100	MPLHP-51255 Multi-Rack Connecting Plate
3	HDW-HHCSZP-M620	M6x20 Hex Head Cap Screw, Grade 8.8 Zinc Plated
4	HDW-FWZP-M6	M6 Flat Washer Grade 8.8 Zinc Plated
5	HDW-LWZP-M6	M6 Lock Washer Grade 8.8 Zinc Plated



## 6.4 Installation Principles

- 6.4.1 The general installation sequences are as below.
- The Control box is always at the top of the rack.
  - Narada recommends installing Battery Modules from the bottom up.
  - A systematic illustration is provided to offer a complete understanding of the materials to be installed.

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Fig 6-1 Systematic Illustration of Installed Materials

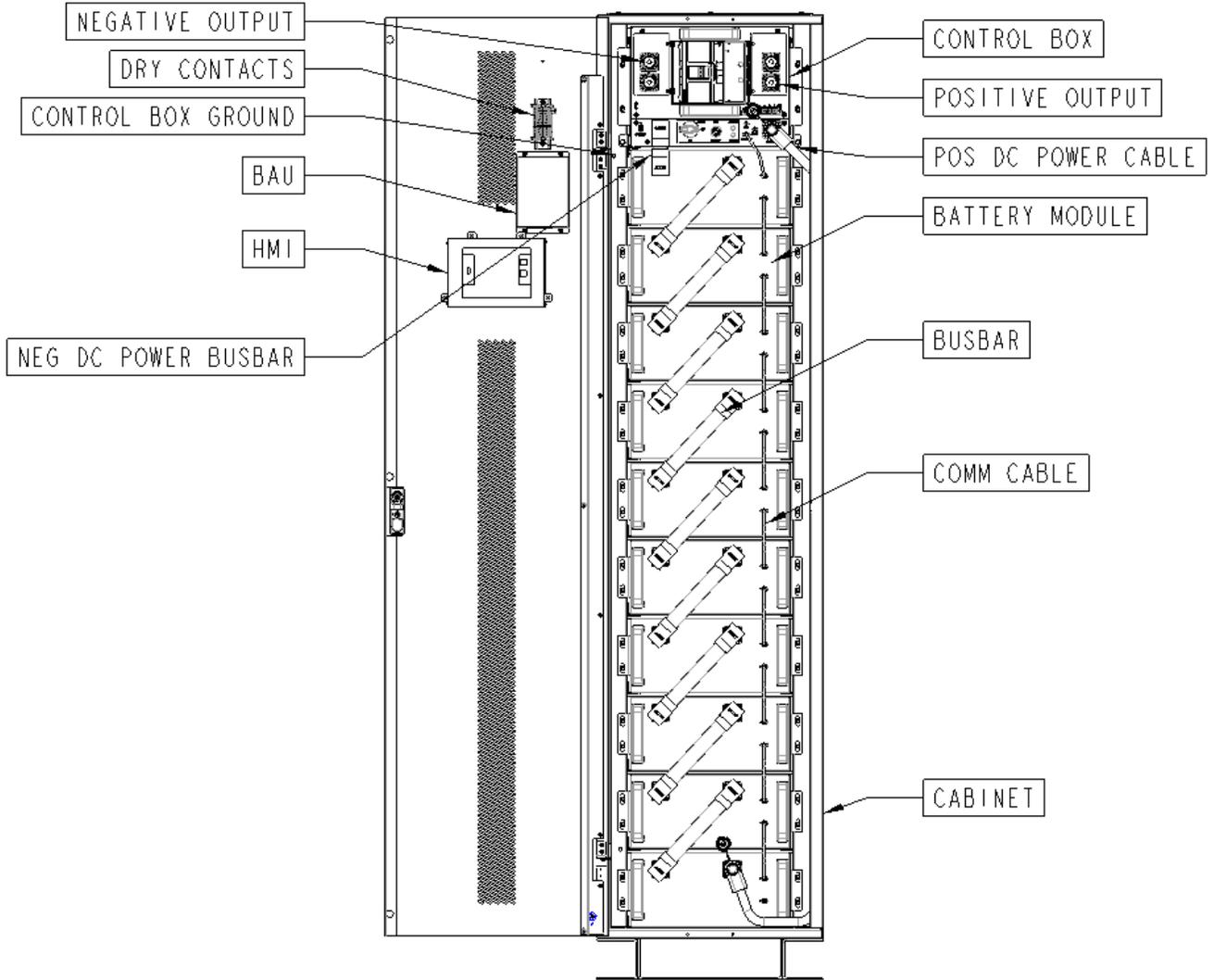
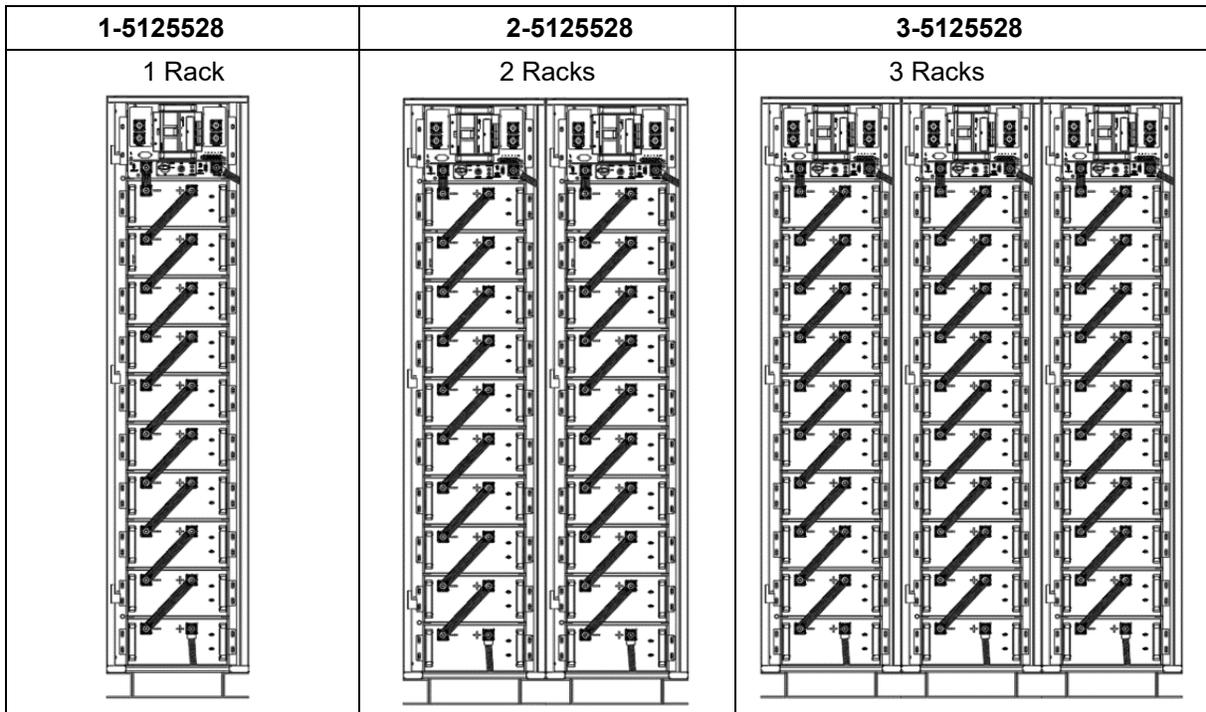


Table 6-4 Layout of Different Configuration



6.1.1 For a standard 10-module rack, the bottom module (#10) shall be place first.

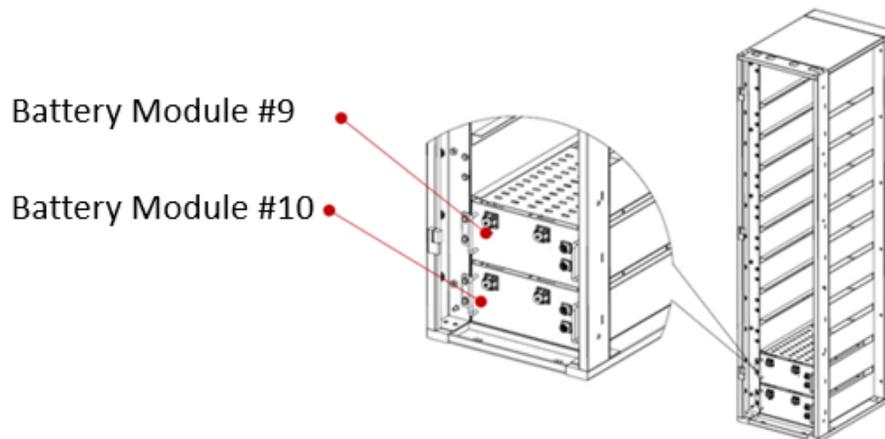


Fig 6-2 Battery Module Arrangement from the Bottom

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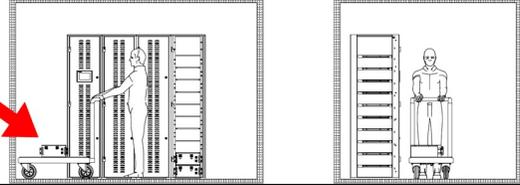
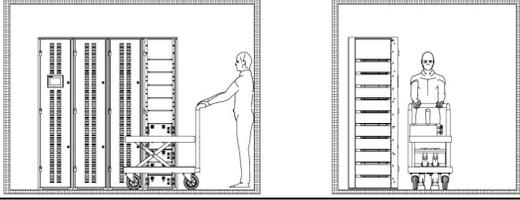
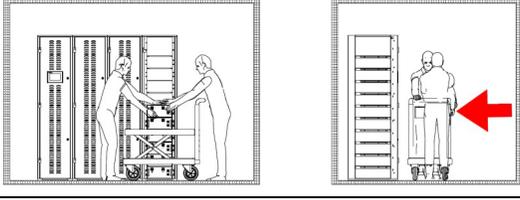
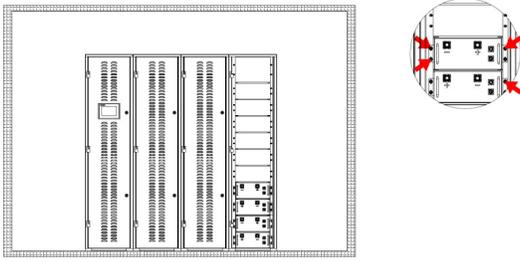
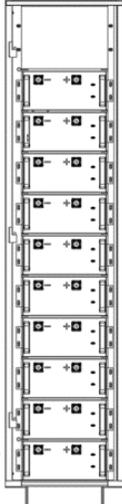
## 6.5 Module Placing

	<b>WARNING</b>
	<ul style="list-style-type: none"> <li><input type="checkbox"/> Only insulated tools should be used.</li> <li><input type="checkbox"/> A battery lift is recommended due to the weight of the modules.</li> <li><input type="checkbox"/> Pay attention to the GROUP Number on the package boxes and on module cases!</li> <li><input type="checkbox"/> Do not mix modules of different GROUP Number!</li> <li><input type="checkbox"/> Modules of same GROUP Number should be placed and installed in the same rack!</li> </ul>

- 6.5.1 Modules of the same rank in terms of initial charge and discharge characteristics are identified by same GROUP Number. GROUP Number marks are pasted on the packaging boxes and module cases as well.
- 6.5.2 Before module lifting and placing, pay attention to the GROUP Number! Make sure battery modules of the same GROUP Number are placed and installed in the same rack.
- 6.5.3 Modules of the same Group Number should be placed and installed in the same rack.
- 6.5.4 Transport battery modules to the installation location and then lifting and placing of the battery modules according to the installation diagram.

<b>PLEASE PAY ATTENTION TO THE GROUP NUMBER!</b>	
	
Group Number mark on the package box	Group Number mark on the module case
	

Table 6-5 The Steps for Module Placing in Internal Access Enclosure

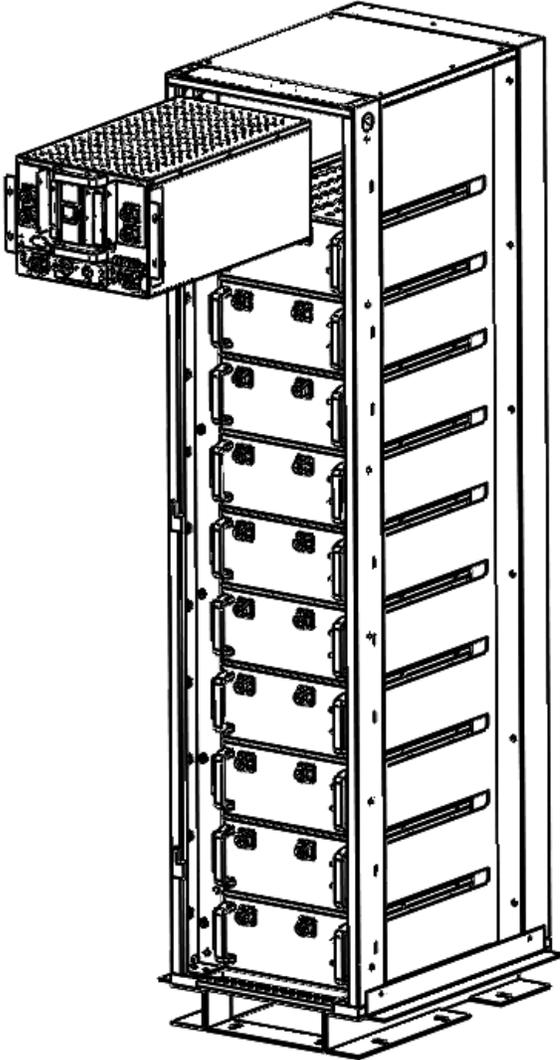
Steps	Module Placing
1	<p>Place the module on the lift car</p> 
2	<p>Pull the lift car to the front of the rack</p> 
3	<p>Push the battery into the rack with a force perpendicular to the rack</p> 
4	<p>Attach each to the rack with four M6 x 15L bolts After the module is inserted in the rack (Torque: 9 Nm)</p> 
5	<p>Repeat steps 1 to 5 until all battery modules are populated into the rack</p> 

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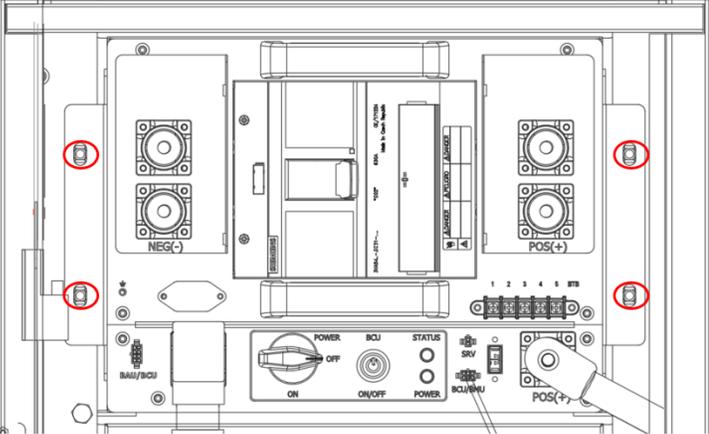
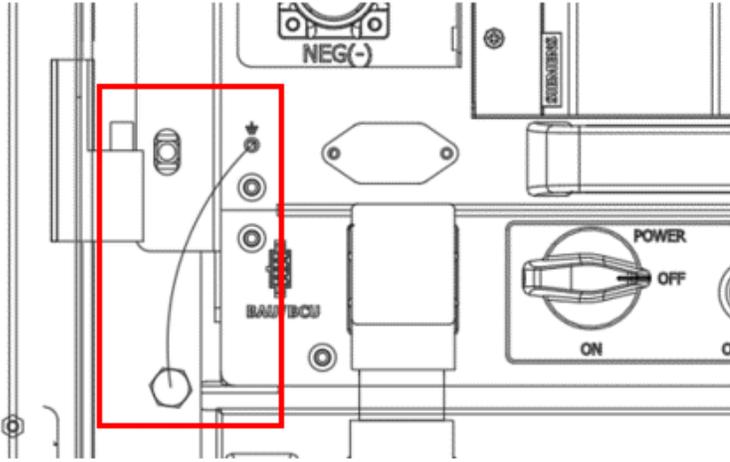
## 6.6 Control Box Placing

	<b>WARNING</b>
	<ul style="list-style-type: none"> <li>▪ The Isolation switch in the Control Box should be in the —<b>OFF</b> position during installation.</li> <li>▪ Attach each Control Box to its cabinet with four M6 x 25L screws with torque of 9 Nm.</li> </ul>

Table 6-6 The Steps for Control Box Placing

Steps	Control Box Placing
1	<p>Install the control box in the upper left position of the rack using the same steps as installing the battery modules.</p> 

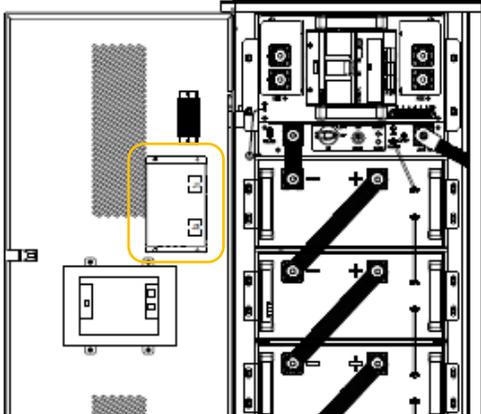
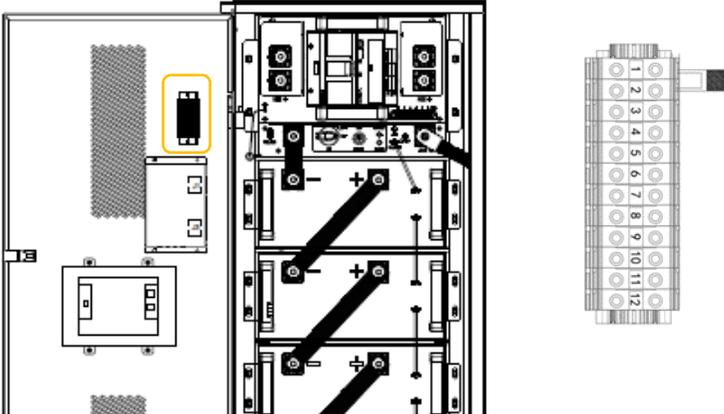
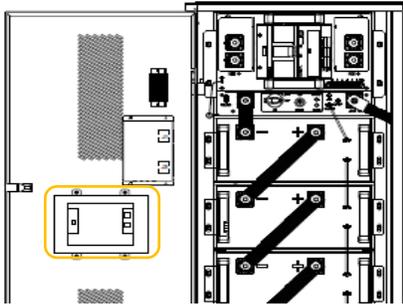
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2	<p>Secure the control box in the rack using the four M6 bolts. Fastening torque is 9 Nm.</p> 
3	<p>Once the control box is inserted and secured in the rack, connect the ground cable to the control box using M5 bolt. Fastening torque is 7 Nm. Connect the other end of the cable to the cabinet using M8 Nut.</p> 

### 6.7 BAMS Placing

	<b>WARNING</b>
	<ul style="list-style-type: none"> <li>▪ Attach the inserted BAUAssemblies to the DOOR by fastening each with four M4 screws with torque of 2.8 Nm</li> <li>▪ Attach the inserted HMI to the DOOR by fastening each with four M5 screws with Torque 5 Nm</li> </ul>

Table 6-6 The Steps for BAMS Placing

Steps	BAMS Placing
1	<p>Install the BAU component of the BMS in the designated position on the door using 4x M4 Nuts. Torque to 2.8Nm</p> 
2	<p>Attach the Dry Contacts terminal Block to the Door using 2x M4 nuts. Torque to 2.8Nm.</p> 
3	<p>Install the HMI in the designated position on the door of the rack. Attach HMI to the Door using supplied hardware kit. Torque to 2.8Nm</p> 

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## 6.8 Busbar Connection

	<b>WARNING</b>
	<ul style="list-style-type: none"> <li>▪ Exercise extreme caution to prevent short circuits between the positive and negative terminal of a single battery module.</li> <li>▪ Exercise extreme caution to prevent positive and negative terminals from contacting anything other than their intended mounting points.</li> <li>▪ Only remove module terminal covers when installing bus bars.</li> <li>▪ Immediately re-install module terminal covers when bus bar installation is complete for each module.</li> <li>▪ Ensure control box disconnect is in the OFF position.</li> <li>▪ Fastening torque for the M10 screw at the control box is 25 Nm.</li> <li>▪ Fastening torque for the M6 screws on the battery module are 9 Nm</li> </ul>

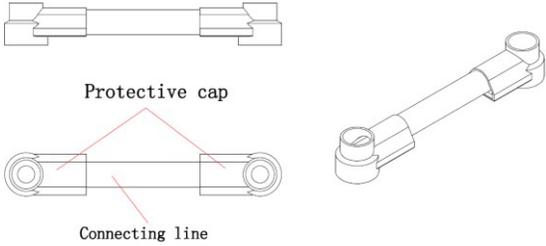
6.5.5 Busbar Connection After all the modules and control box have been installed and secured, connect the bus bars to the battery modules.

6.5.6 Tightening Torque Specification

Screw size	Location	Torque
M6	Module Mounting	9 N-m
M6	Option Ground (top of cabinet)	9 N-m
M8	Ground wires	12 N-m
M8	Cabinet to Cabinet	18 N-m
M10	Busbars, Input/Output terminals	25 N-m

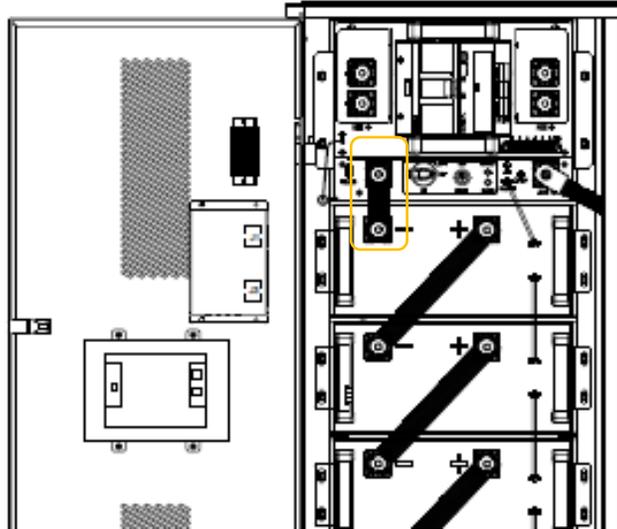
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Table 6-8 The Steps for Busbar Connection

Steps	Busbar Connection
1	<p>Busbars (9) for module to module and control box negative terminal to module connections will have with black silicone insulating cover on both sides</p> 
2	<p>The connecting line of control box positive terminal and negative pole connecting line (Brass terminal protective cap)</p>  <p>1: Red protective cap at both ends of positive pole; 2: Blue protective cap at both ends of negative pole</p>

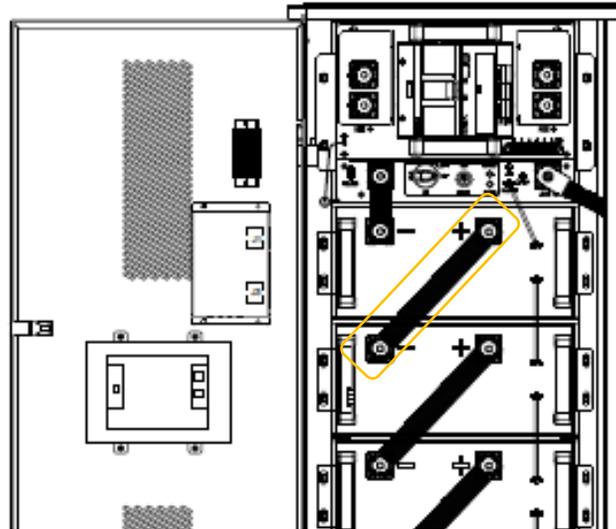
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Control Box Input - and Module #1 Neg terminal is connected using an M10 screw.



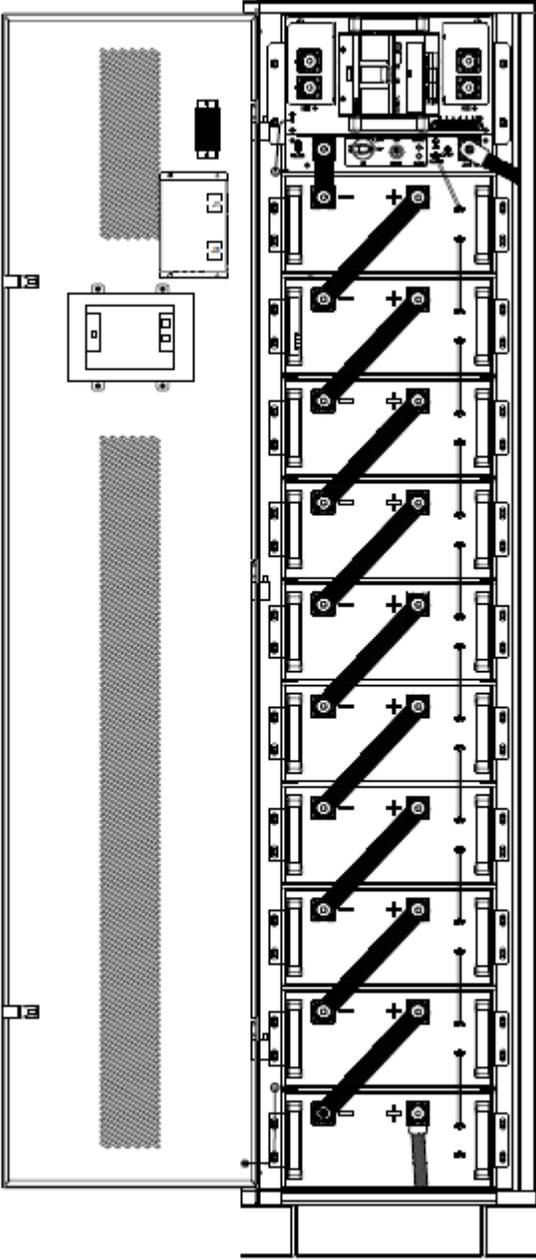
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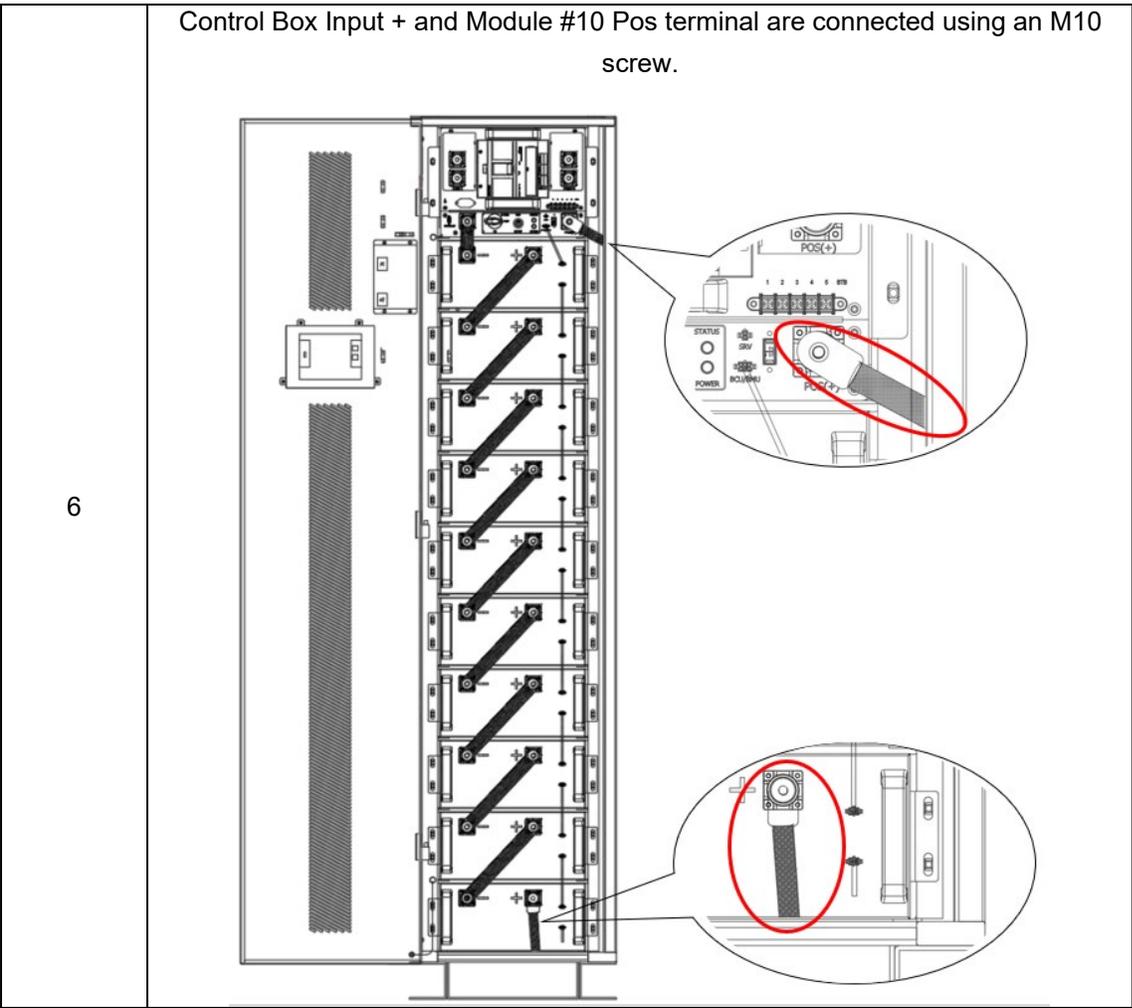
Connect Battery Module #1 Pos and Module #2 Neg using a flexible busbar and an M10 screw. Then close the terminal cover.



Continue with steps 3 and 4 until you have connected the 10 battery modules.

5





## 7. Communication Cable Connection

### 7.1 Control Box and Module

	<b>WARNING</b>
	<ul style="list-style-type: none"> <li>Use the proper signal cables as specified by the specifications below.</li> <li>Do not insert both ends of the signal cable into the same Battery Module.</li> </ul>

The specifications of communication cables to connect control box to battery modules is included in the following table.

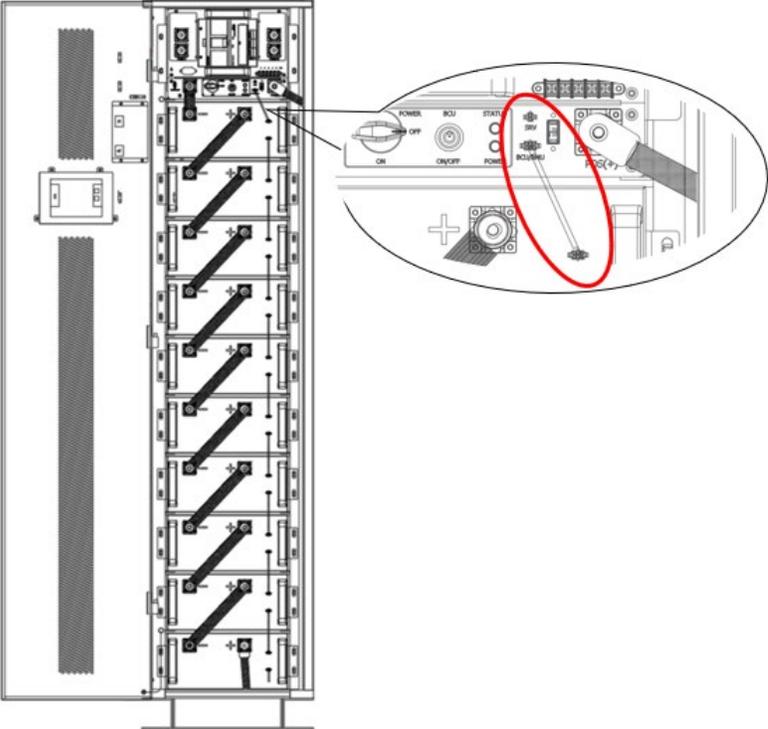
Table 7-1 The Specification of Communication Cable Between BCU and BMU

*Note that below two cables look similar, but pinouts are different!*

Types	Communication Cable
BCU-BMU Cable	<p>1 of these are needed for communication between modules to modules and between first module to control box. Part number: LHP-CCOM-MC01</p> 
BMU-BMU Cable	<p>9 of these are needed for communication between modules to modules and between first module to control box. Part number: LHP-CCOM-MM01</p> 

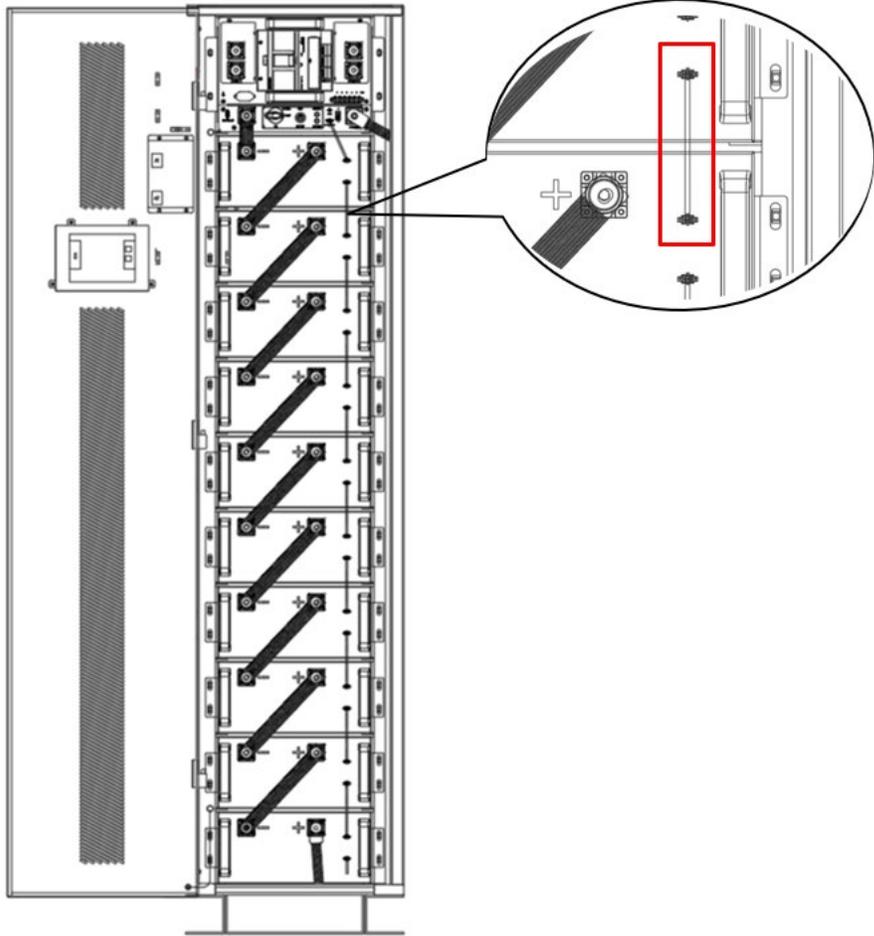
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Table 7-2 The Steps for Communication Connection Between Control Box and Module

Steps	Communication Connection Between Control Box and Module
1	<p>Connect the communication cable between the BMU COM port of Control Box and Module #1 top COM port.</p> 

Connect the signal cable from Module #1 Into Module #2 Out and proceed down until all Com cables are installed between Modules

2

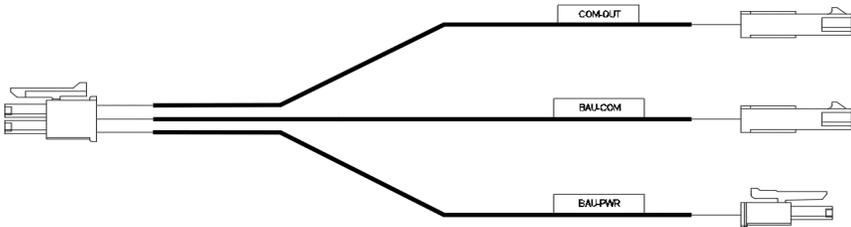
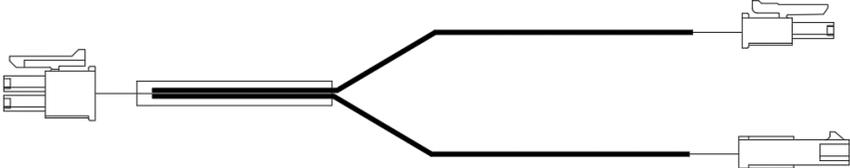
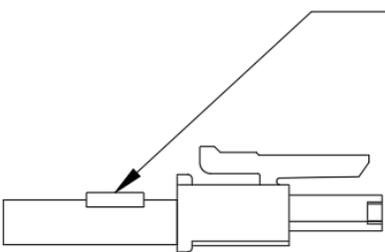


## 7.2 Control Box and BAMS

	<b>WARNING</b>
	<ul style="list-style-type: none"> <li>Use the proper signal cables as specified by the specifications below.</li> </ul>

The specifications of signal cables to connect control box to BAMS is included in the following table.

Table 7-3 The Specification of Signal Cable Between BCU and BAMS

BMS	Communication Cable
Cabinet 1 BAU-BCU Cable "LHP-CCOM-AC01"	
Non Cabinet 1 (without HMI) BCU-BCU Cable "LHP-CCOM-CC01"	
Connects to last cabinet's BCU cable. BCU Termination Cable "LHP-CCOM-CT01"	<div style="text-align: right;">120 Ohm resistor</div>  <p style="text-align: center;">See relevant drawings for pin out</p>

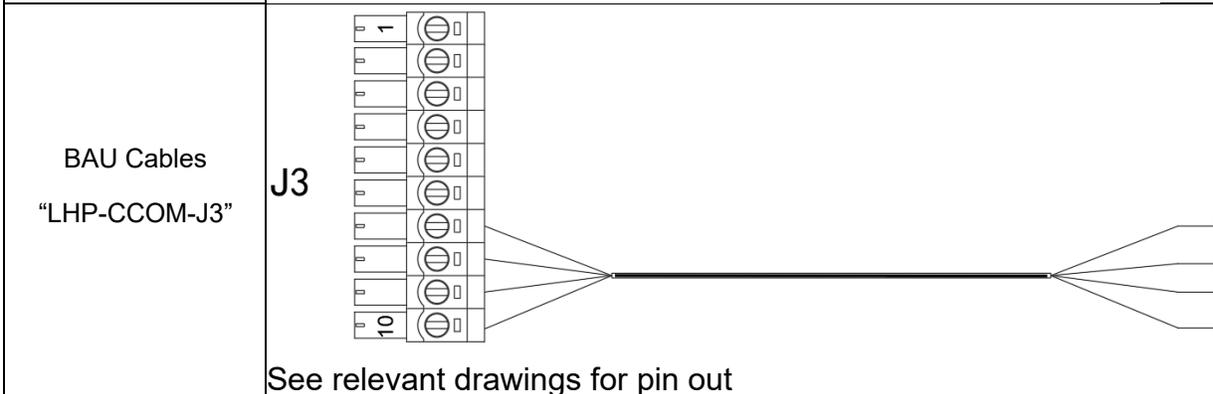
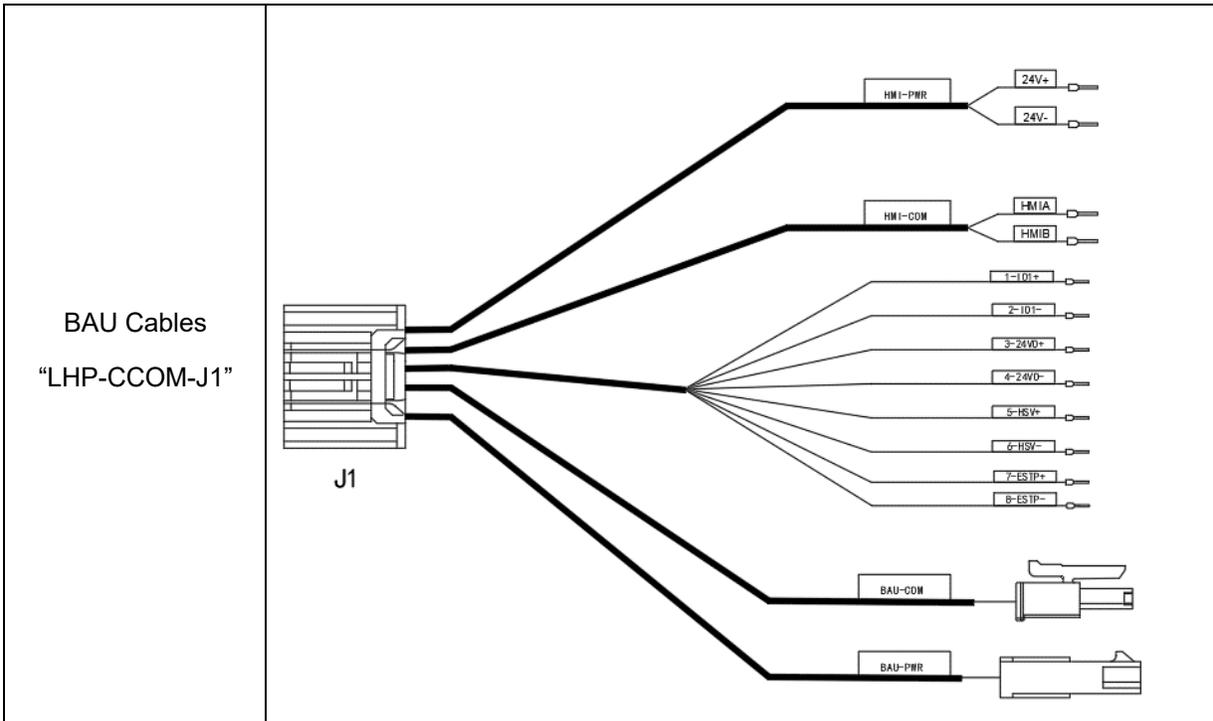
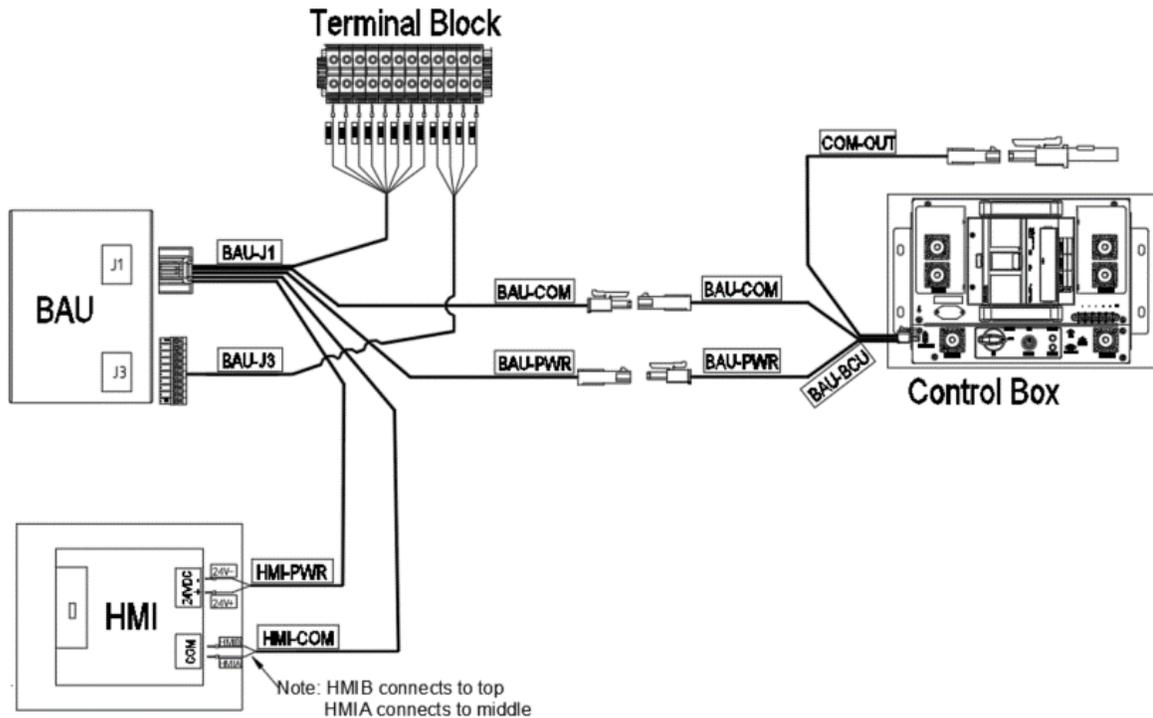


Table 7-4 The Steps for Communication Connection Between Control Box and BAMS

Steps	Communication Connection Between Control Box and BAMS
1	Connect the BAU-BCU cable (LHP-CCOM-AC01) to control box BAU/BCU COM port.
2	Connect the BAU-J1 (LHP-CCOM-J1), BAU-J3 (LHP-CCOM-J3) cables to BAU and connect its lead to HMI, control box and terminal blocks as shown in diagram below. <b>For more details, refer to relevant drawings.</b>
3	Connect BCU terminator cable (LHP-CCOM-CT01) to COM-OUT lead of the BAU-BCU (LHP-CCOM-AC01) cable. If there are more than one cabinet in a system, BCU terminator cable goes to last cabinet's BCU-BCU (LHP-CCOM-CC01) cable.

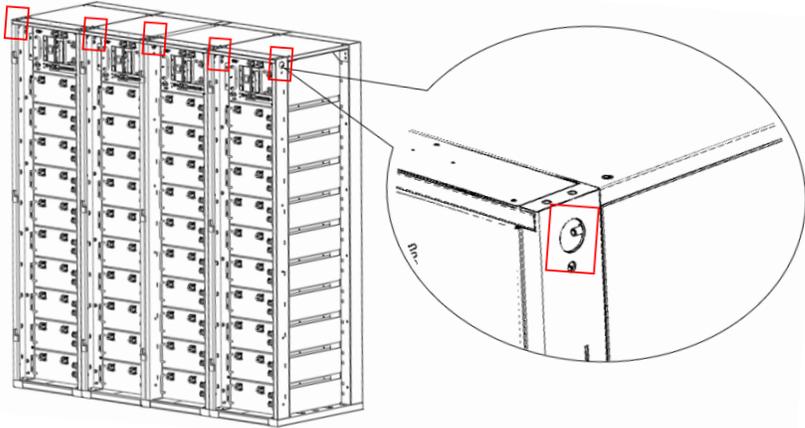
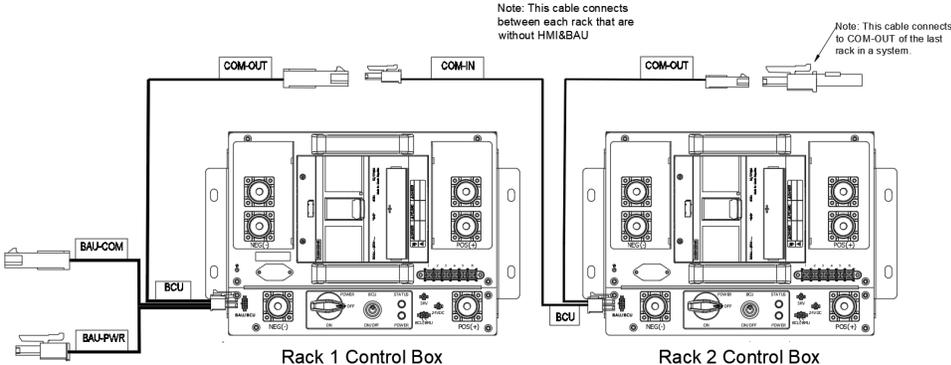


### 7.3 Multiple Cabinets

	<b>WARNING</b>
	<ul style="list-style-type: none"> <li>Use the proper signal cables as specified by the specifications below.</li> </ul>

The specifications of signal cables to connect control box to another control box is included in the following table.

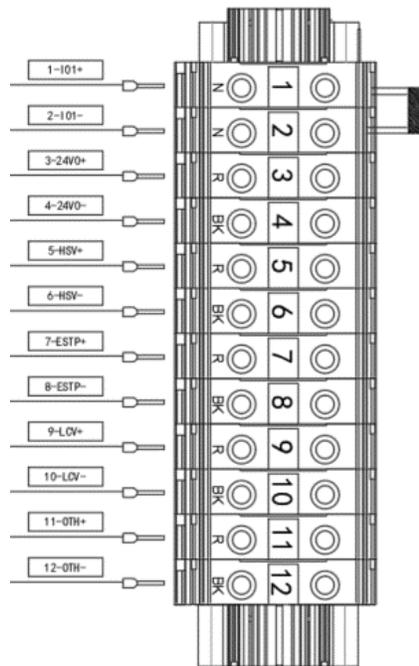
Table 7-5 The Steps for Communication Connection Between Multiple Control Boxes

Steps	Communication Connection Between Multiple Control Boxes
1	<p>For multi-rack systems, signal lines are connected between the control boxes of each rack. The cable passes through the opening at the top of the side column of the cabinet.</p> 
2	<p>Connect the BCU signal cable to another BCU signal cable one by one.</p> <p style="text-align: center;"> <small>Note: This cable connects between each rack that are without HMI&amp;BAU</small> </p>  <p style="text-align: center;"> <small>Note: This cable connects to COM-OUT of the last rack in a system.</small> </p> <p style="text-align: center;">Rack 1 Control Box                      Rack 2 Control Box</p>

## 8. Dry Contacts and E-Stop

E-Stop feature can be utilized by USP or external device to turn battery power off to the system. I01+ and I01- of BAU-J1 cable can be shorted to clear alarm for testing purposes (shown below). Please refer to the relevant drawings for more details.

Dry Contact #	Alarm List	Alarm level	Alarm Description	Configuration	Dry Contact Description
1 and 2	None	Critical	Emergency Stop	Normally Closed	Emergency Stop
3 and 4	None	Unspecified	Unspecified	24V Relay	Unspecified Relay
5 and 6	<b>High String Voltage</b>	Alarm	String over voltage Alarm	Normally Closed	HSV - High String Voltage
7 and 8	Any	Critical	Any Critical alarm	Normally Closed	ANY Critical Alarm
9 and 10	<b>Low String Voltage</b>	Alarm	String under-voltage Alarm	Normally Closed	LSV - Low String Voltage
11 and 12	Over Temperature	Warning	Over temperature, charge or discharge	Normally Closed	OTA - Over Temp Alarm



## 9. BMS Configuration

### 9.1 BMS Architectures

BAUs do not communicate with each other and should be treated as an independent sub-system. BAUs can be identified by different IP address. Sample architectures are shown below.

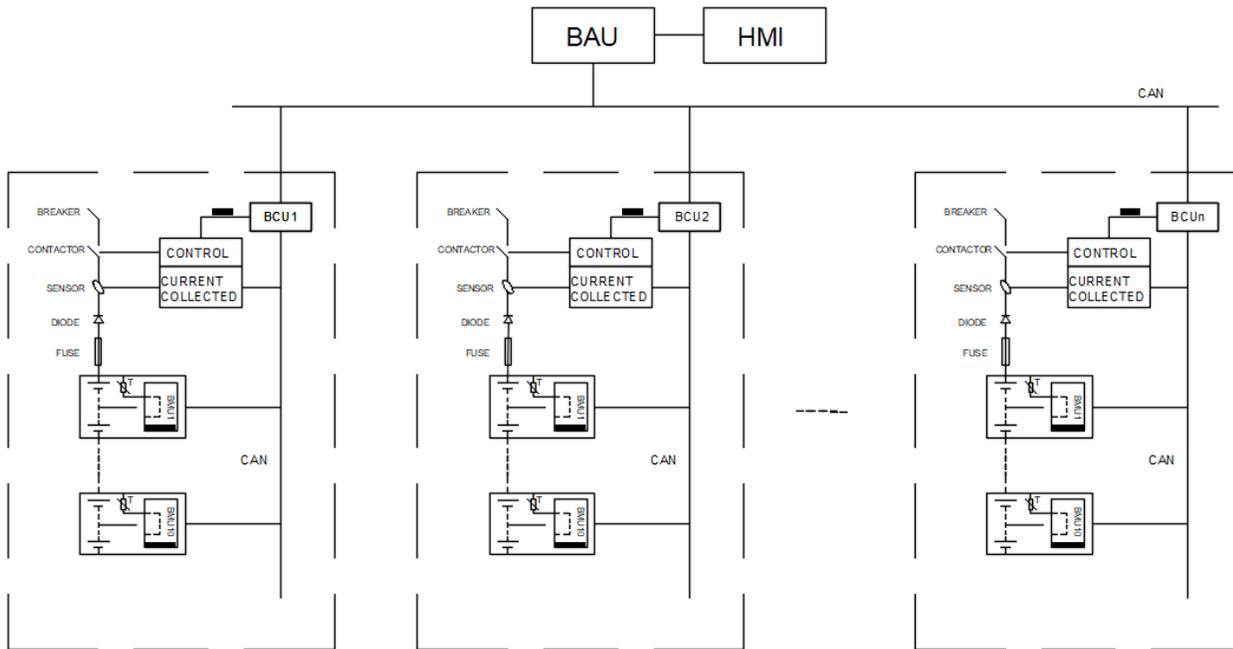


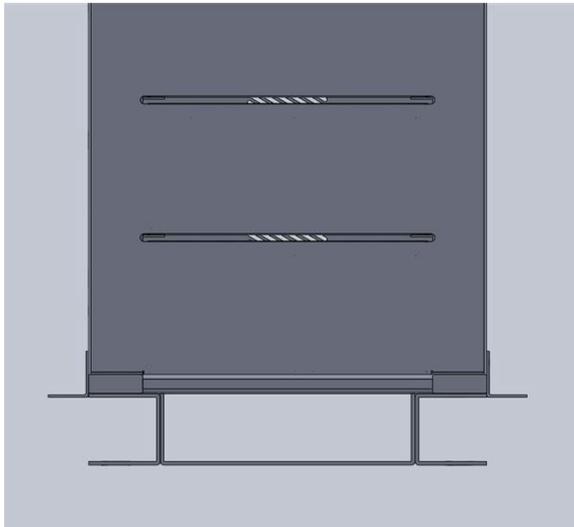
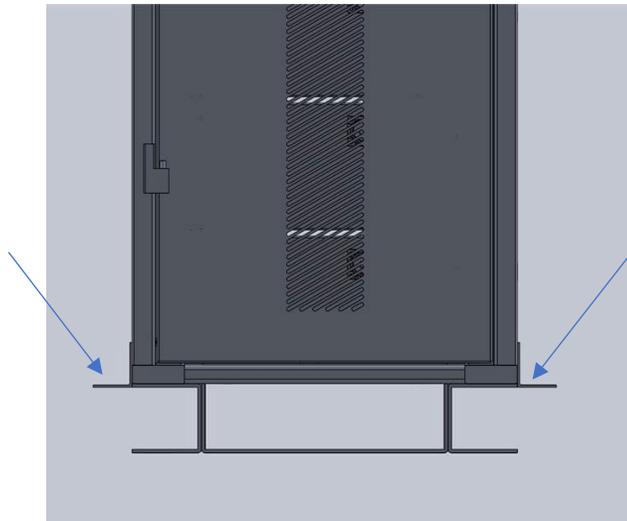
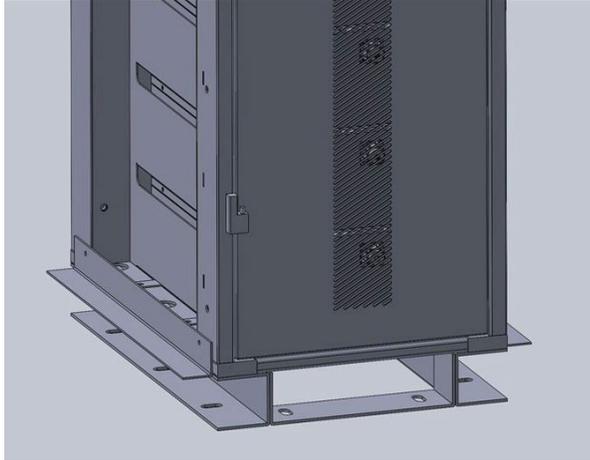
Fig 10-1 System with a single BAU

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## 10. Rack Lifting Instructions

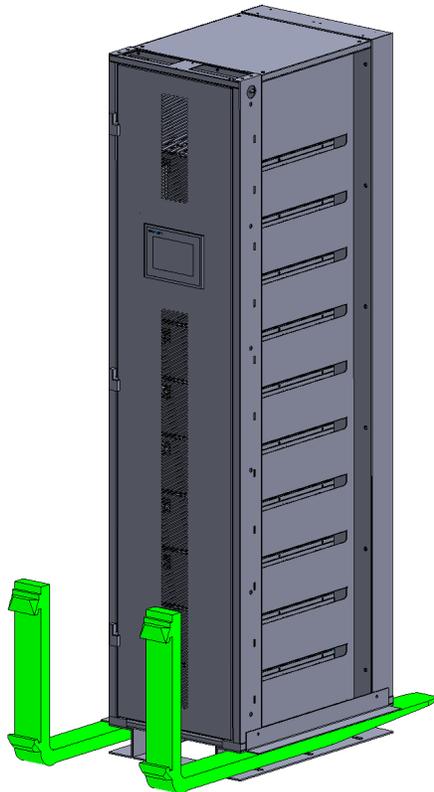
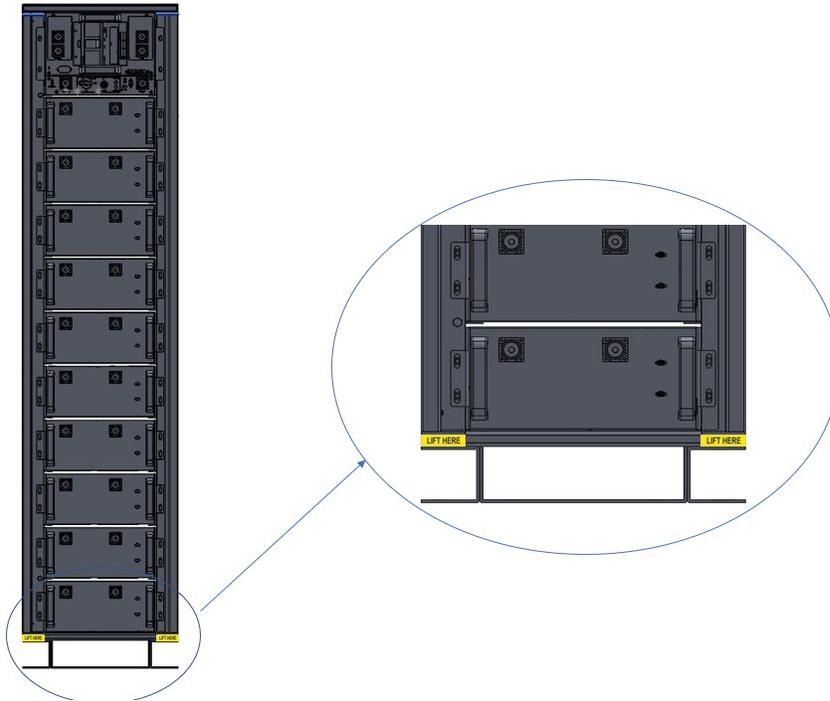
### 10.1 Lifting Instructions

Install angle brackets on the bottom left-side and right-side of the cabinet. (If not already installed)



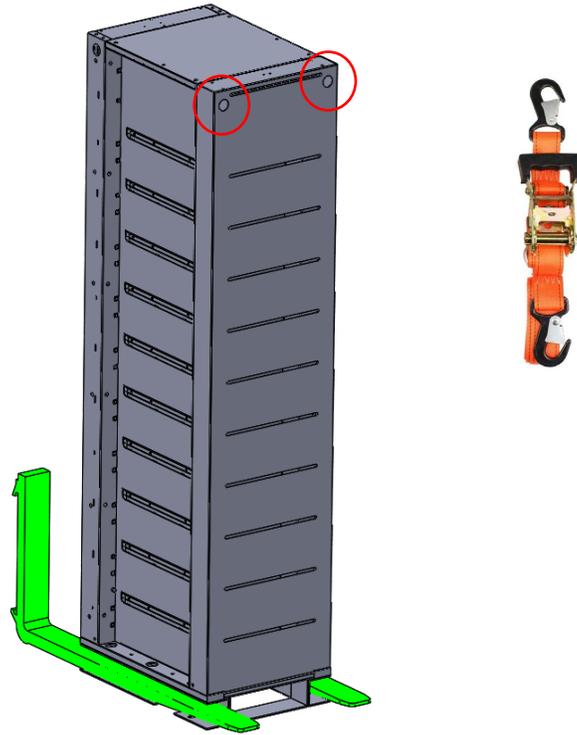
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- Insert forklift under the verticals. There are stickers at lifting points.
- Forklift inside width shall be about 350mm (13.8 in)
- 21-in wide pallet jacks shall work as well.

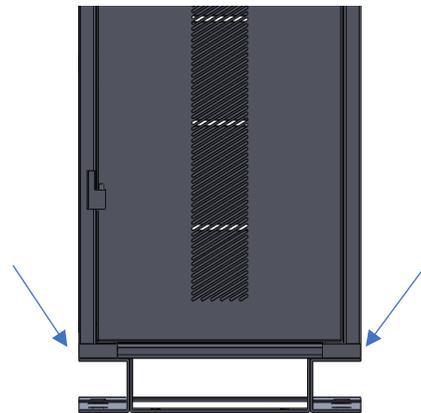


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To ensure stability of the rack during transportation it is recommended that the top of the rack is strapped to the frame of the forklift using a ratchet strap. Below image shows the locations where the strap can be attached.

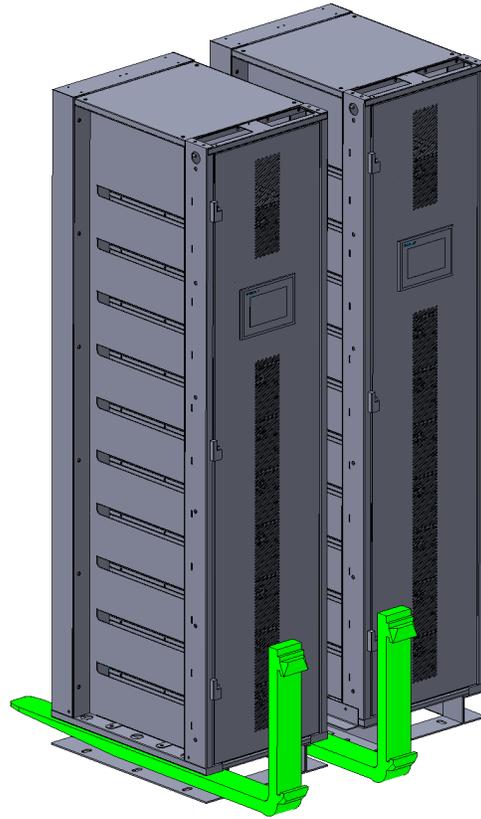


Position the first rack in place.  
Remove the angle brackets from both sides.

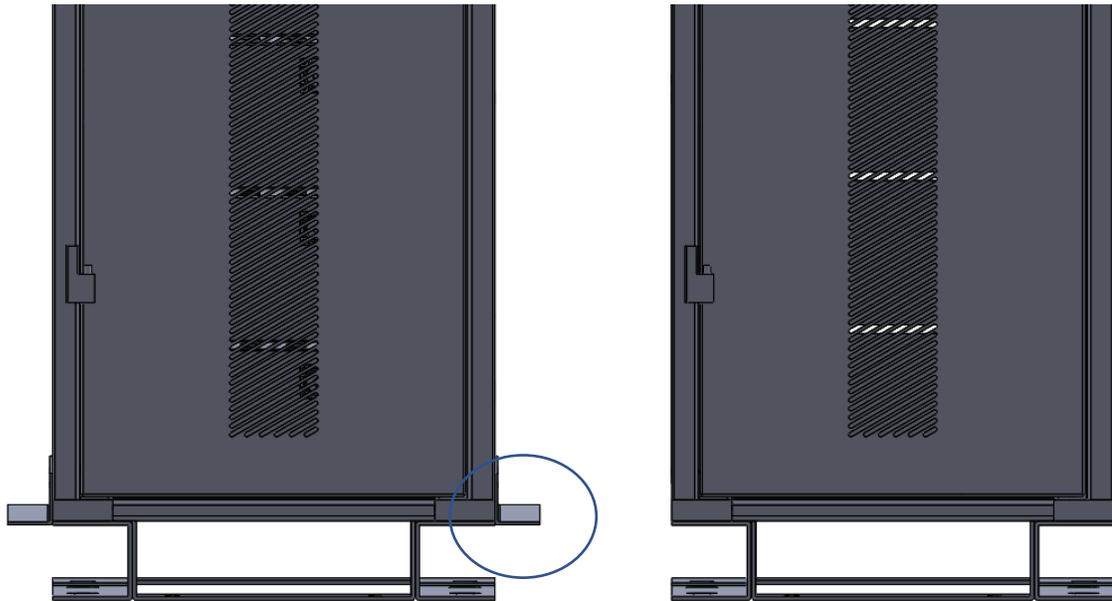


Secure the rack with the anchoring bolts to the floor.  
Place the second rack beside the first one that is already in place. Leave about 8-10" in between to be able to remove angle brackets,

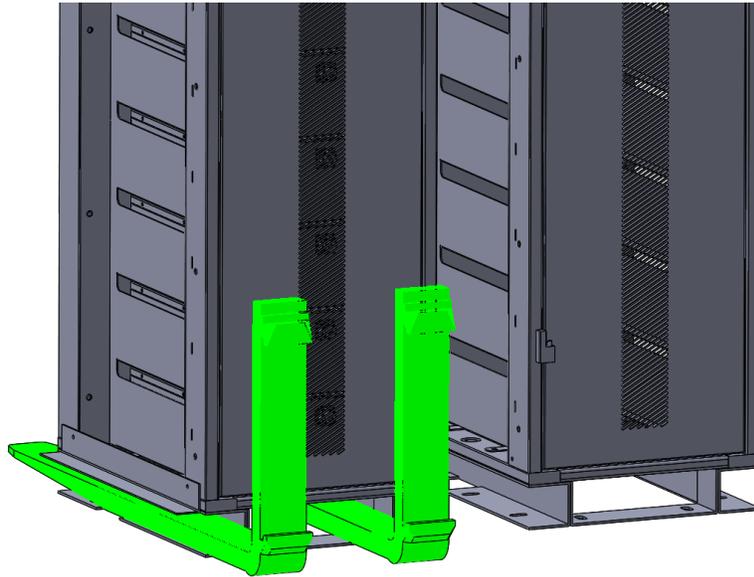
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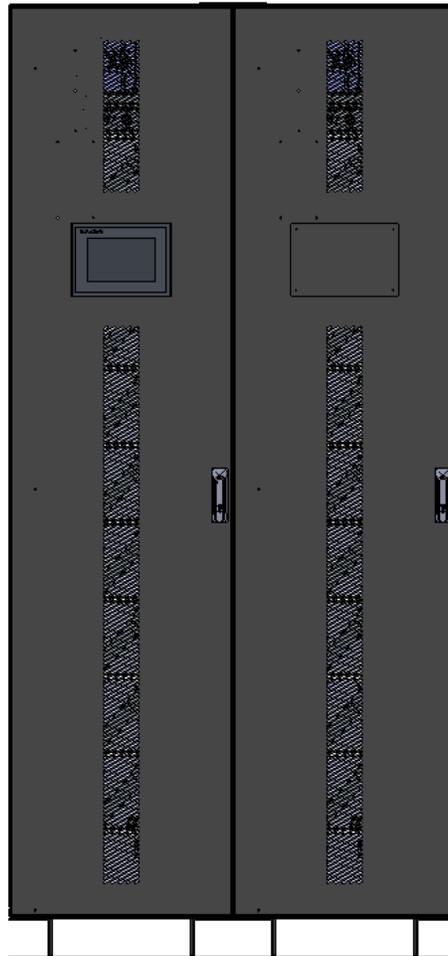
Uninstall right-side angle bracket from the 2<sup>nd</sup> rack.



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Slightly lift the rack and reposition it adjacent to the one already in place.  
Remove the angle bracket on the left side of the second rack and anchor it to the floor.  
Anchor 2<sup>nd</sup> rack to the floor

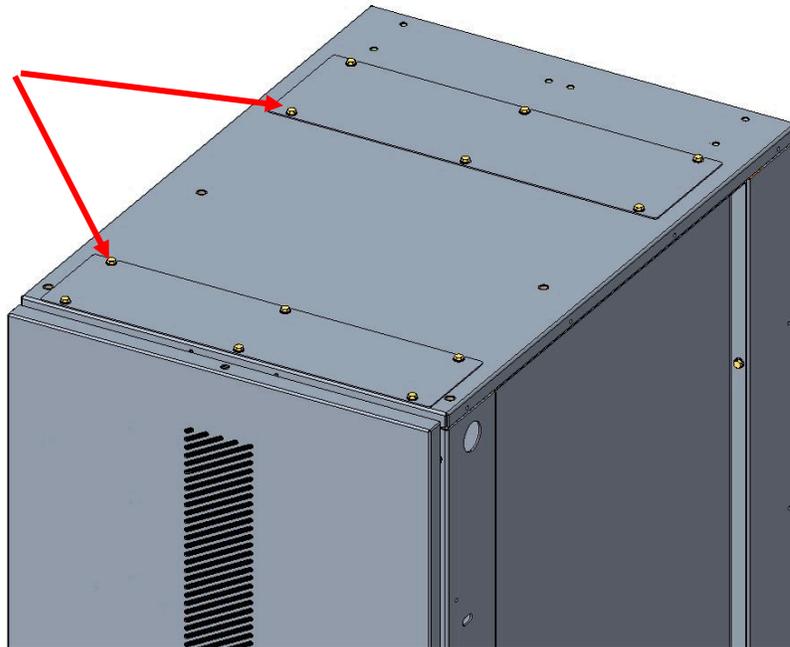


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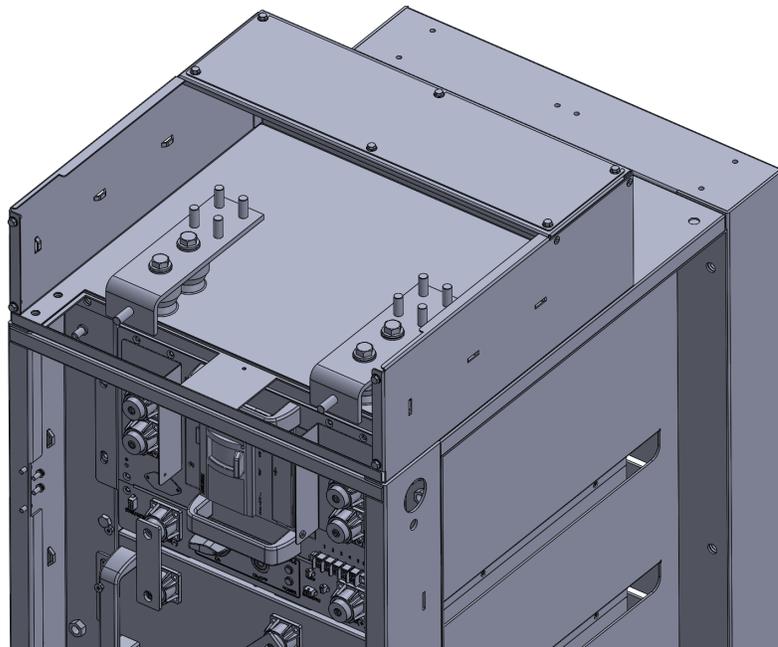
## 11. Conduit Landing box installation

It is recommended to install all conduit landing boxes after all the cabinets have been set in place, tied together, and anchored to the floor.

Remove 2 plates on the top of the cabinet by unscrewing 2 sets of 6 M6 bolts.

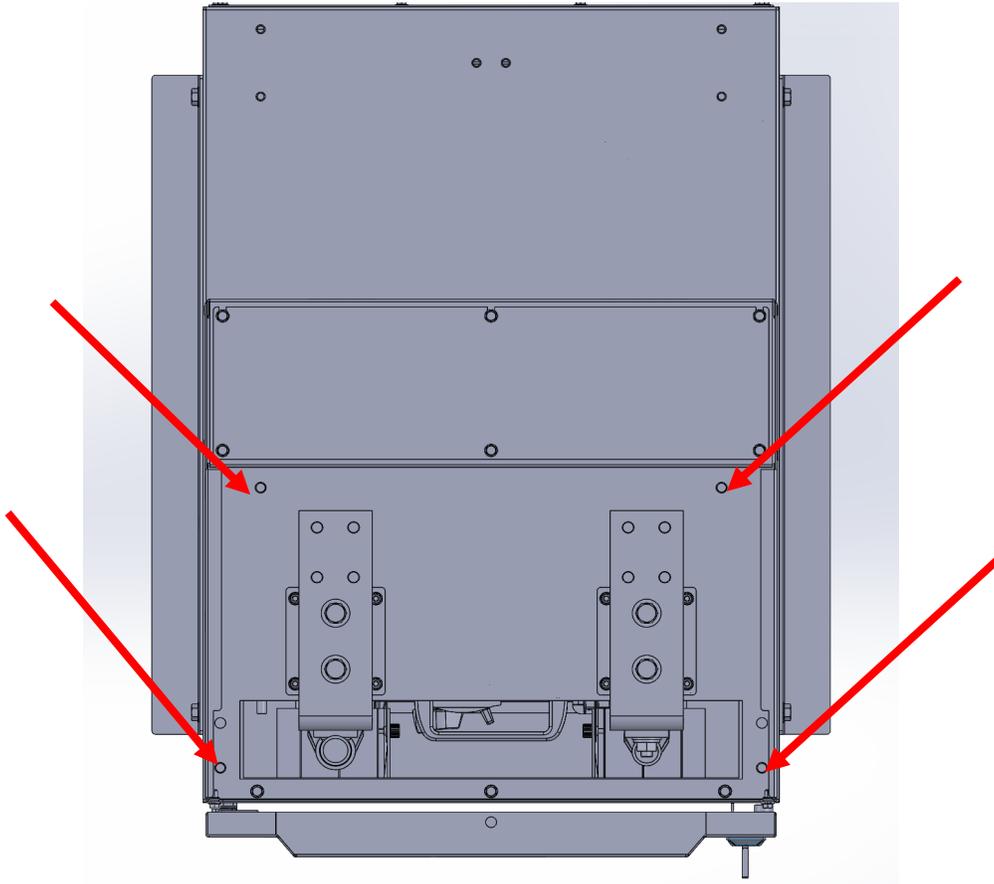


Remove the front cover from the CLB and Place the box on top of the cabinet and ensure the mounting holes are aligned.

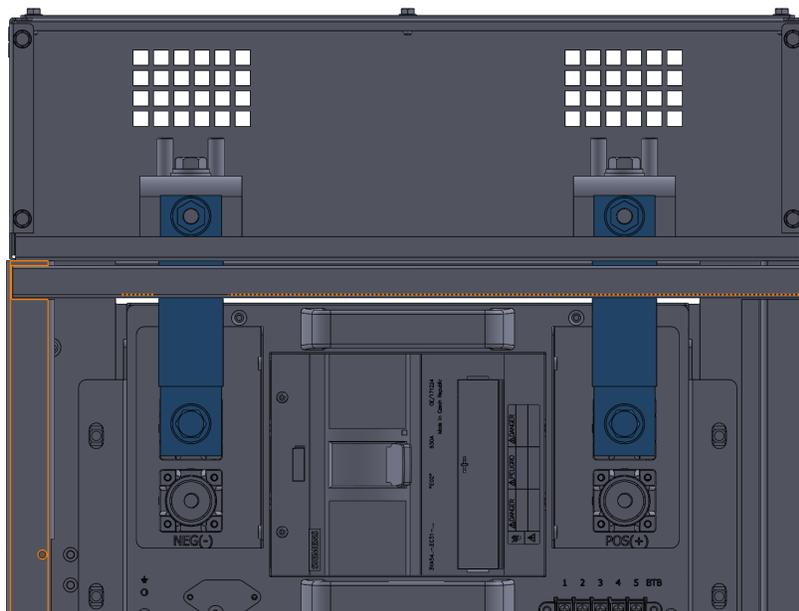


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Secure the box to the top hat using (4) M8 bolts. Tighten these bolts to 12Nm.

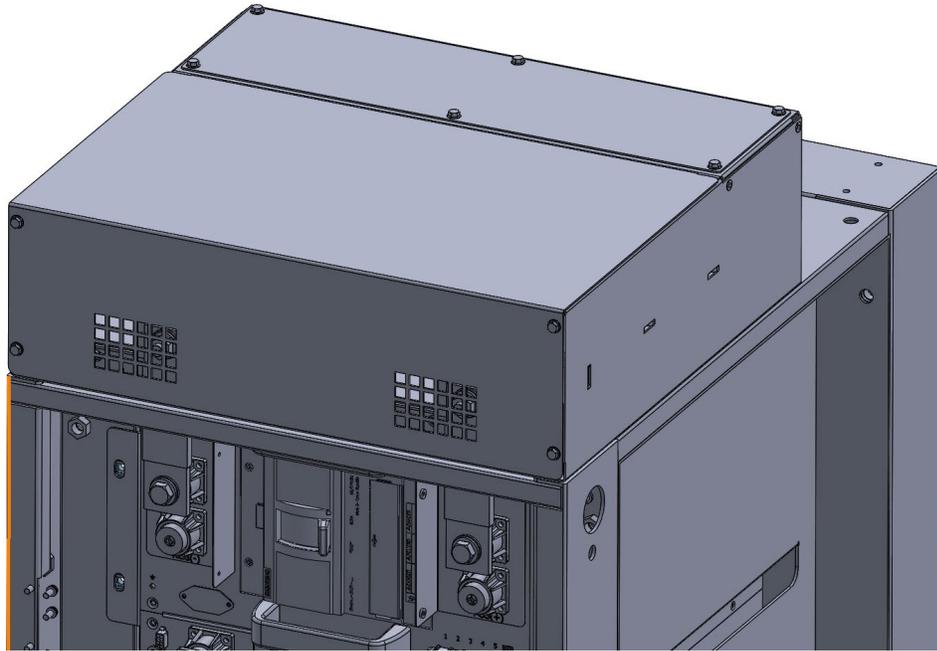


Connect the busbars to the control box output terminals using provided hardware. Tighten the Bolts and Nuts to 25Nm torque.



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After the power output terminals have been connected to the busbars reinstall the cover.



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