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LiFePO₄ – 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

| Version | Date | Change |
|---------|------------|--|
| 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 |
| V5.0 | 12/19/2023 | Updated specification table |
| V6.0 | 2/28/2024 | Updated Installation images, Added TB wiring, Output connections |
| V6.1 | 3/6/2024 | Updated installation details pertaining to side panels |
| V7.0 | 6/6/2024 | Updated Aux Contacts for ABB breaker |
| V8.0 | 1/31/2025 | Updated storage guidelines, Self discharge warning |

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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 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 Pcs of NLHP51255 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 level 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 level 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.
- 2.11 **HMI:** Human Machine Interface, enabling data reading and parameter setting.

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3. Product Description

3.1 Acronyms and abbreviations

| 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 (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 Cabinet

- 3.2.1 Each Cabinet houses Modules, a Control Box and integrated BMS components. The cabinet facilitates grounding of the installed components.
- 3.2.2 The cabinet or rack is composed of ten 51.2V 55Ah modules (Model #5125528), Weight and dimensions of the cabinet are:
- Weight: 540KG (1190.5lbs)
 - Dimensions: (LxWxH) 500mm x 741mm x 2138mm. (19.68" x 29.17" x 84.17)

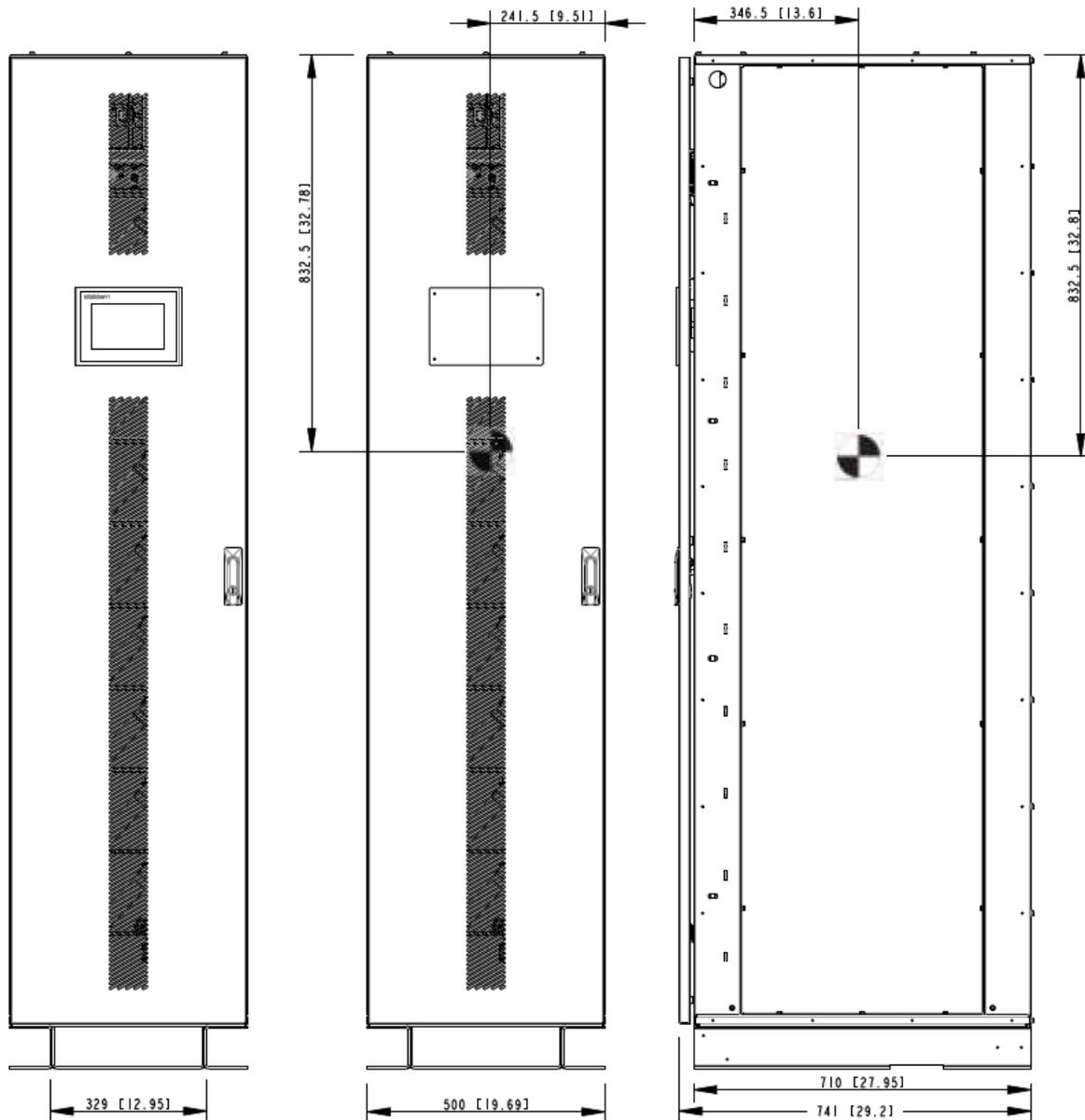
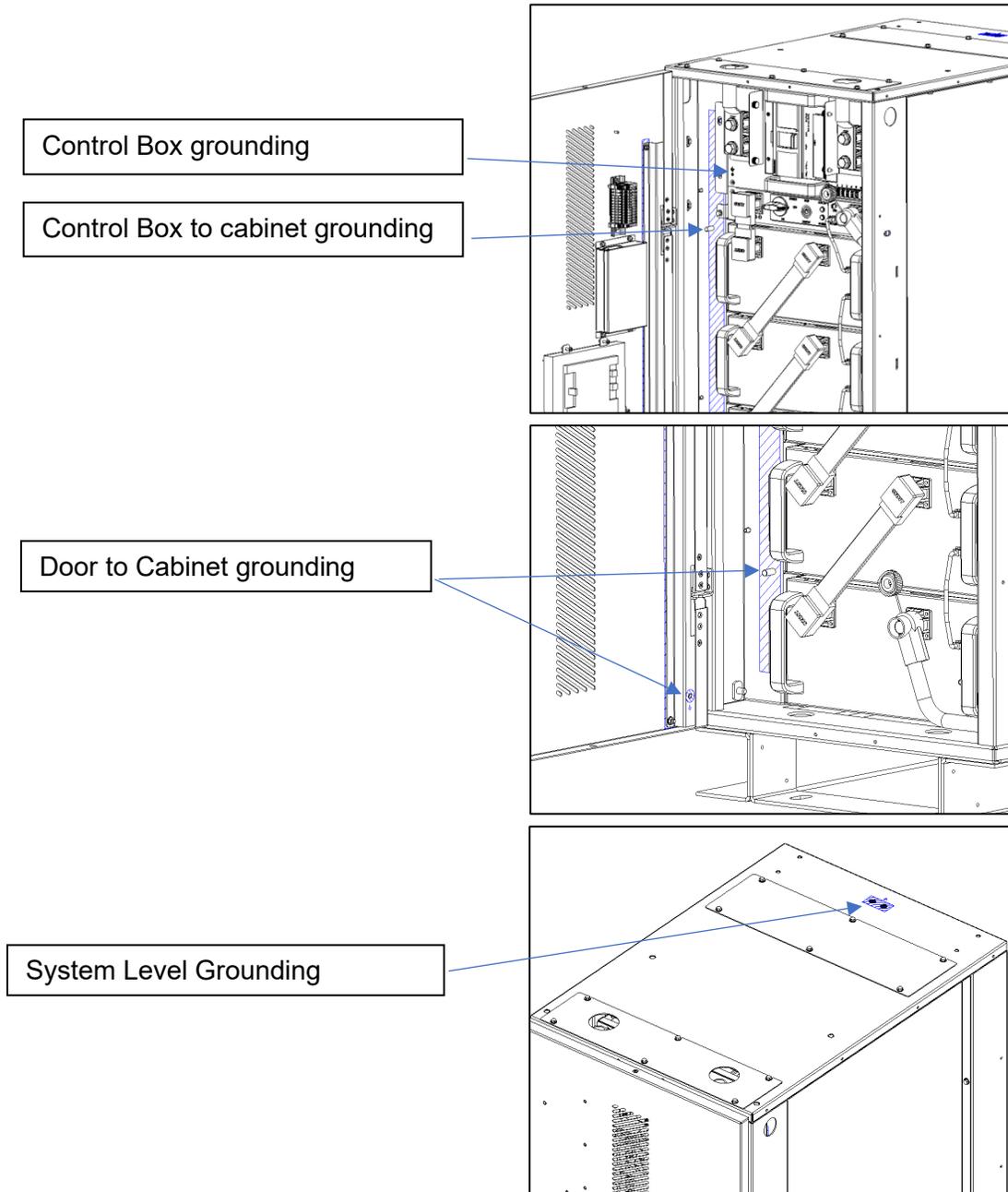


Fig 4-1 Front and Side Views of the Standard 10-Module Rack

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3.2.3 Grounding Wire locations (pre-installed)

Preinstalled grounding wires can be found in the following locations.



3.2.4 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 cable.**

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- The door should be grounded to the rack frame using the supplied green/yellow cable.
- The rack should be grounded to a site/system ground with customer supplied cable.

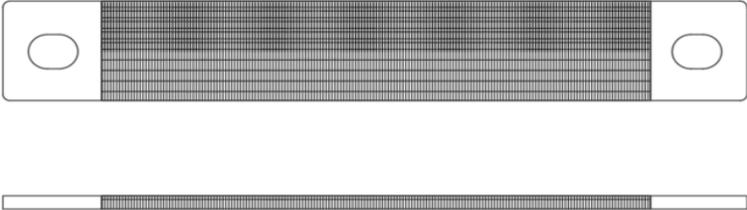
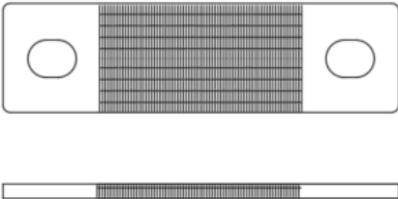
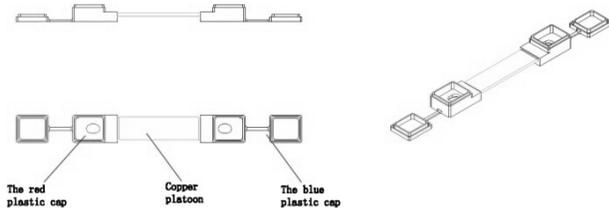
3.2.5 Grounding connections and requirements will vary based on specific project and system configurations. All grounding methods should comply with NEC Article 250.

3.2.6 Ground wire should be at least 16mm² (#5 AWG) with M8 ring terminals.

3.3 Accessories

3.3.1 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>  |
| 3 | <p>Busbar Terminal Covers</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 |
| 7 | MPLHP-51255-MCIK – Mult cabinet installation kit |

3.4 BMS

3.4.1 Each 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"> 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 $\leq 5\text{mV}$ Temperature sampling accuracy: $\pm 2^\circ\text{C}$ Balance type: Active balance Balance current: $\leq 2.5\text{A}$ Communication interface: SPI Supply voltage: 20-28Vdc (typical 24Vdc) |
| Rack Level | BCU | <ul style="list-style-type: none"> Max BMU number: 10 Current sampling accuracy: $\pm(1\%\text{FS} + 1\%\text{RD})$ Voltage sampling interval: 100ms Communication interface: RS 485*0, CAN*3 Supply voltage: 20-28Vdc (typical 24Vdc) High voltage detection: 0-900 Vdc, Accuracy: 0.5% Insulation resistance detection: 100K-5MΩ, Accuracy $\leq 10\%$ |
| System Level | BAU | <ul style="list-style-type: none"> Communication interface: RS 485*3, SPI, Ethernet*1 Supply voltage: 20-28Vdc (typical 24Vdc) |

3.4.2 BMS Configuration

The individual BAUs do not communicate with each other and should be treated as independent sub-systems. BAUs can be identified by different IP addresses. Sample architectures are shown below.

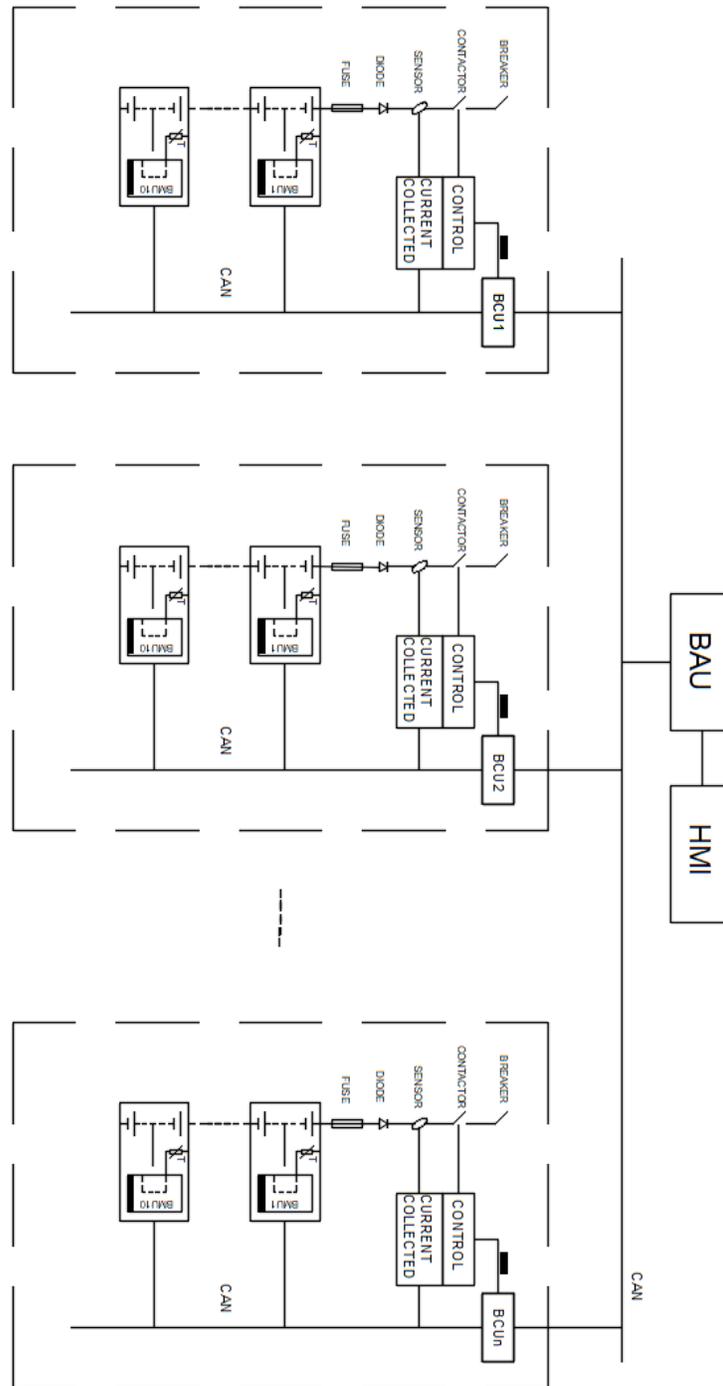
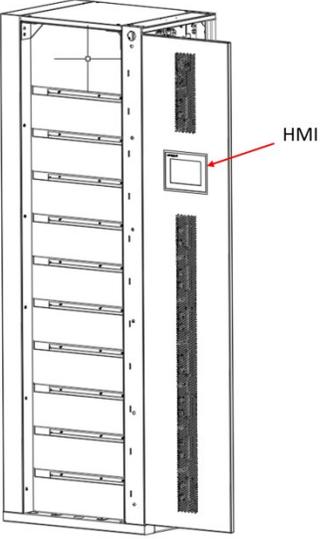
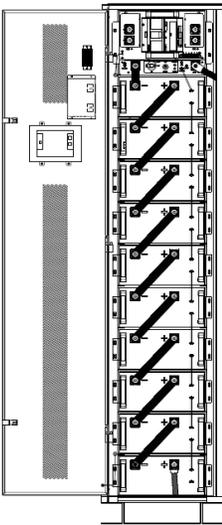
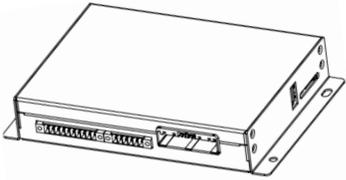
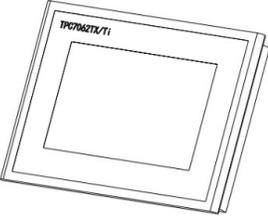
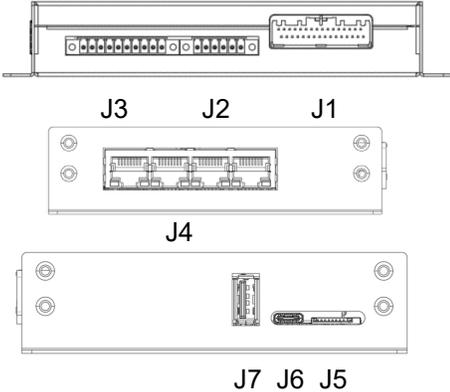


Fig 10-1 System with a single BAU

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

| | |
|---|---|
| <p style="text-align: center;">BAMS-Front</p>  | <p style="text-align: center;">BAMS-Rear</p>  |
| <p style="text-align: center;">BAU- Interface side</p>  | <p style="text-align: center;">HMI- Interface side</p>  |
| <p style="text-align: center;">BAU Interface</p> | <p style="text-align: center;">HMI Panel-Front</p> |
|  |  |

3.4.4 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.

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3.4.5 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. Installation

| | |
|---|---|
|  | <p><i>Service Engineer should prepare needed items such as Personal Protection Equipment (PPEs) and Tools before the installation starts. The Service Engineer must check condition of PPE and verify it is suitable prior to performing any installation activities.</i></p> <p><i>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.</i></p> |
|---|---|

4.1 Required Personnel

4.1.1 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:

- Authorized and trained service personnel to perform any installation work that falls within owner's scope of effort as identified in this document.
- Authorized and trained owner representative to perform any installation work that falls within owner's scope of effort as identified in this document.

4.2 PPEs and Tools

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

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, 16mm, 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 / Resistance Battery Tester |  |
| 11 | Module Loading Lift (300lb load Maximum) | |
| | | |

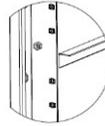
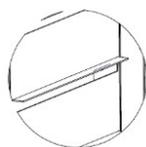
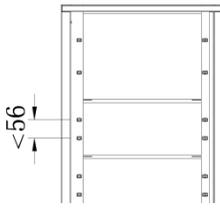
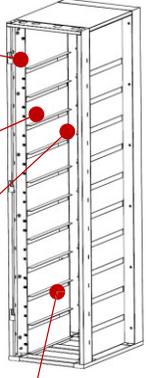
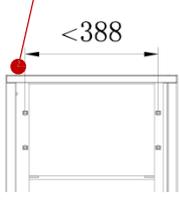
4.3 Documentation

- 4.3.1 Before installation, all related documents such as Contracts, Technical Agreement, Shipping List, and Installation Drawings should be collected and confirmed they are of the correct version. Technical service personnel should make sure all required preparations are in place before installation.

4.4 Inspection

- 4.4.1 Installation personnel should make a record after unpacking according to the check 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"> • Voltage and internal impedance using a battery tester • Damage to the exterior • Missing or protruding screws • Peeling paint | | |
| Control Box | <ul style="list-style-type: none"> • Damage to the exterior • Missing or protruding screws • Peeling paint | | |
| BAMS | <ul style="list-style-type: none"> • Damage to the exterior • Missing or protruding screws • Peeling paint | | |
| Accessories | <ul style="list-style-type: none"> • Quantity • Specifications | | |
| Cabinet | <ul style="list-style-type: none"> • Structural Damage • Peeling paint • Screw damage | <p>Missing Cage Nuts</p>  <p>Deformed Guide Rail</p>  <p>Wrong size</p>  |   |

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5. Rack Installation Instructions

| | |
|---|---|
|  | IMPORTANT |
| | <p>Ensure the power switch is in OFF position before starting the installation steps. After installation, verify switch is in OFF position and the indicator lights are NOT illuminated.</p> <p>NOTE: A magnetic warning label is placed on the door next to HMI as reminder to turn the BMS power OFF when system is not being charged by UPS. The label can be placed inside the cabinet after the system has been put in service</p> |



ATTENTION

TO AVOID BATTERY SELF-DISCHARGE TURN BMS POWER OFF ON ALL RACKS WHEN BATTERY IS NOT ON CHARGE

| | | |
|--|--|--|
|  <p style="margin: 0;">POWER</p> <p style="margin: 0;">ON</p> |  <p style="margin: 0;">BCU</p> <p style="margin: 0;">ON/OFF</p> |  <p style="margin: 0;">STATUS</p> <p style="margin: 0;">POWER</p> |
|--|--|--|

5.1 Installation Steps

Table 5-1 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* |
| | | Power and Control Cables |
| | | Communication Cables |
| | | Busbars |
| | | BMS Configuration |

*IF not already installed

5.2 Rack Positioning Clearance Distance

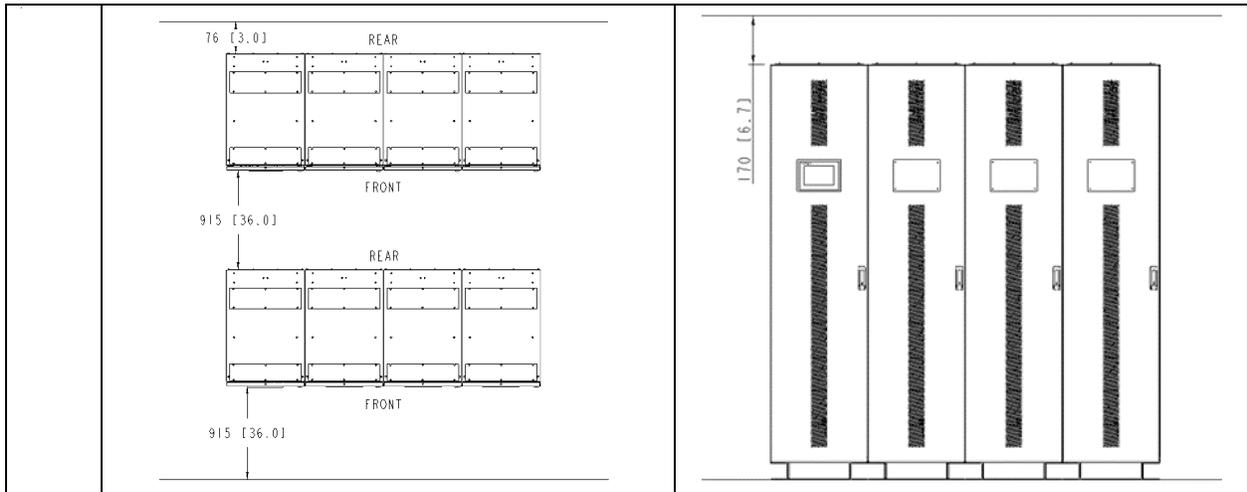
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|---|--|
|  | WARNING |
| | <ul style="list-style-type: none"> ▪ Lift the rack from the front when using a forklift. Please see Section 6.3 for lifting instructions. ▪ Use lock washers on all anchoring bolts. ▪ Be sure the rack is installed plumb and level. ▪ Do not distort the rack by installing it on a non-level or non-flat surface. ▪ Distorting the rack will cause problems connecting racks together and opening/closing the doors. ▪ Adhere to the clearance distances as required. |

5.2.1 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.

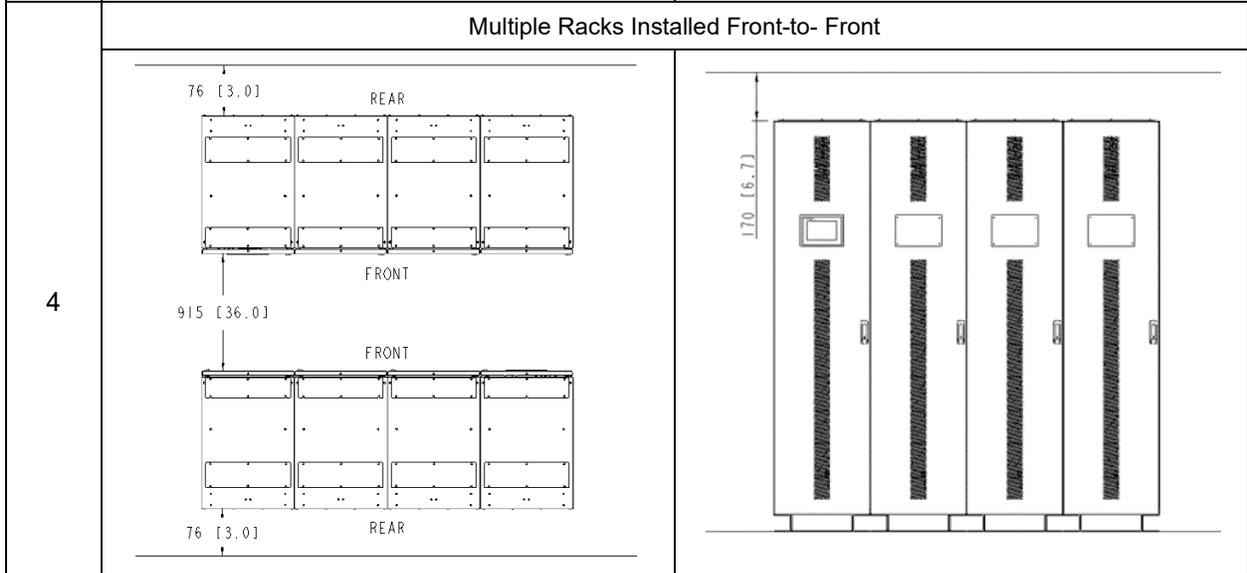
Table 5-2 Rack Installation Clearance Distances

| Types | Clearance Distance | |
|-------|---|--|
| 1 | Single Rack | |
| | <p style="text-align: center;">REAR</p> <p style="text-align: center;">FRONT</p> <p style="text-align: center;">915 [36.0]</p> | <p style="text-align: center;">170 [6.7]</p> |
| 2 | Multiple Racks | |
| | <p style="text-align: center;">REAR</p> <p style="text-align: center;">FRONT</p> <p style="text-align: center;">915 [36.0]</p> | <p style="text-align: center;">170 [6.7]</p> |
| 3 | Multiple Racks Installed Rear-to-Rear | |
| | <p style="text-align: center;">FRONT</p> <p style="text-align: center;">FRONT</p> <p style="text-align: center;">915 [36.0]</p> <p style="text-align: center;">915 [36.0]</p> | <p style="text-align: center;">170 [6.7]</p> |

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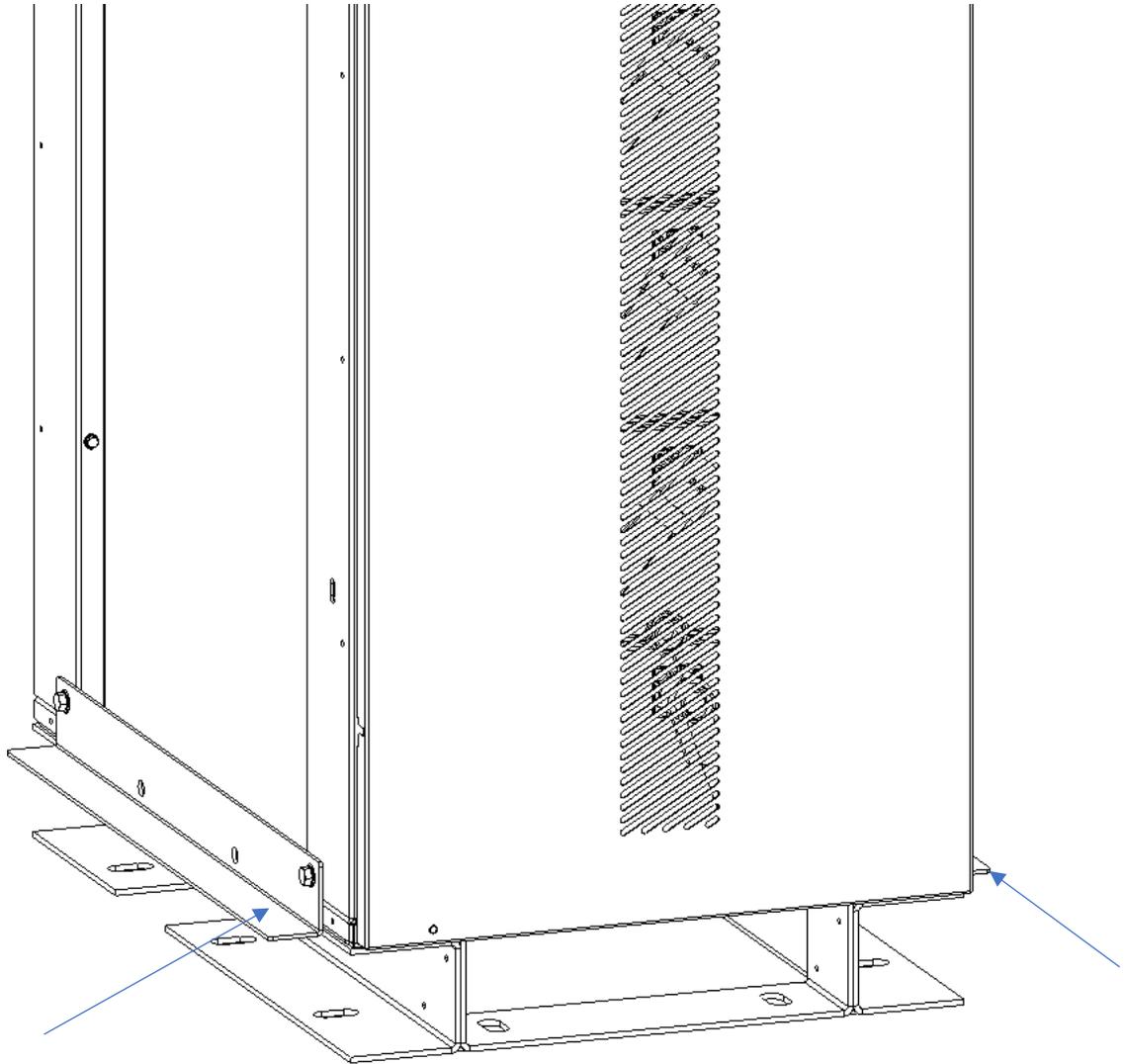
Multiple Racks Installed Front-to- Front



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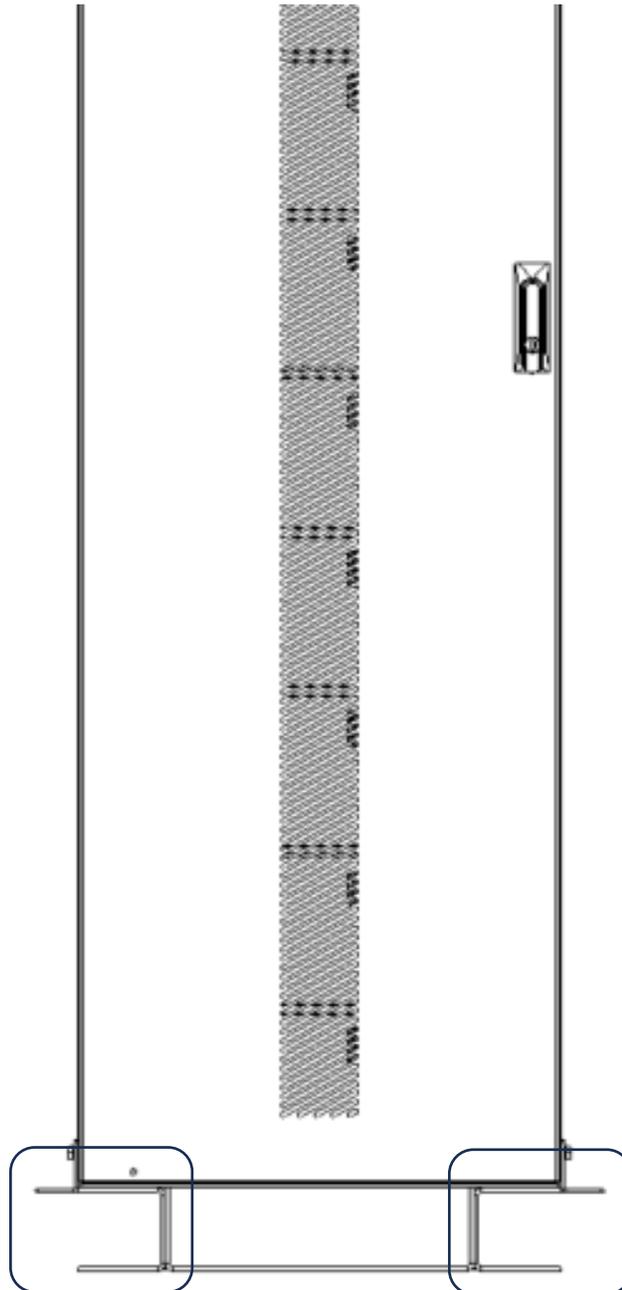
5.3 Lifting and positioning instructions

- 5.3.1 After the cabinet is unpacked and transported to its installation location, confirm the pre-drilled holes in the bottom and sides are aligned for positioning and mounting.
- 5.3.2 Install angle brackets on the bottom left-side and right-side of the cabinet. (If not already installed)



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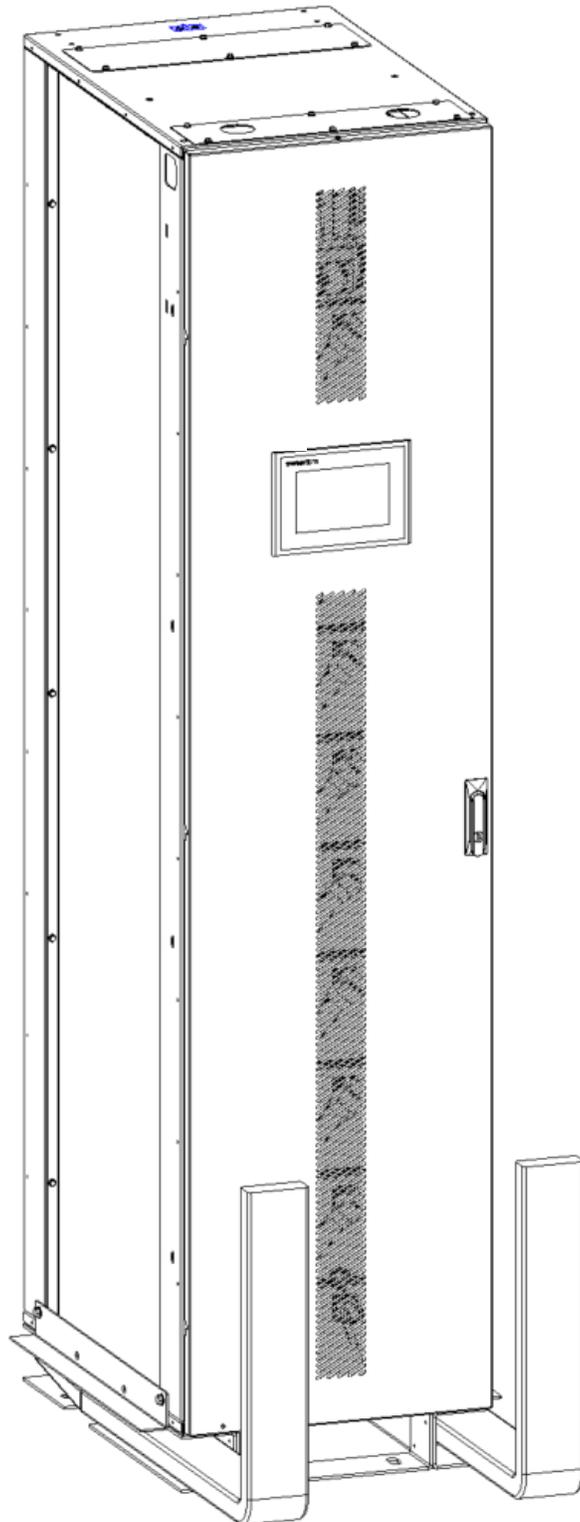
- 5.3.3 Insert forklift under the verticals.
- 5.3.4 Forklift inside width shall be about 350mm (13.8 in)
- 5.3.5 21-in wide pallet jacks shall work as well.





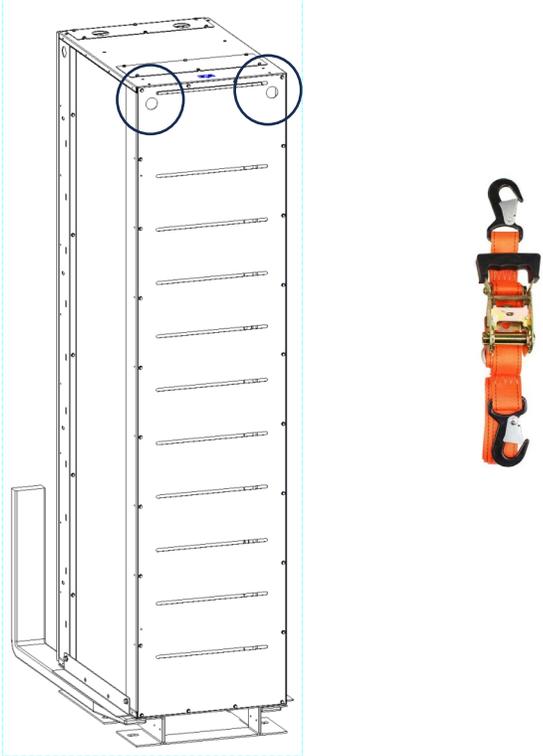
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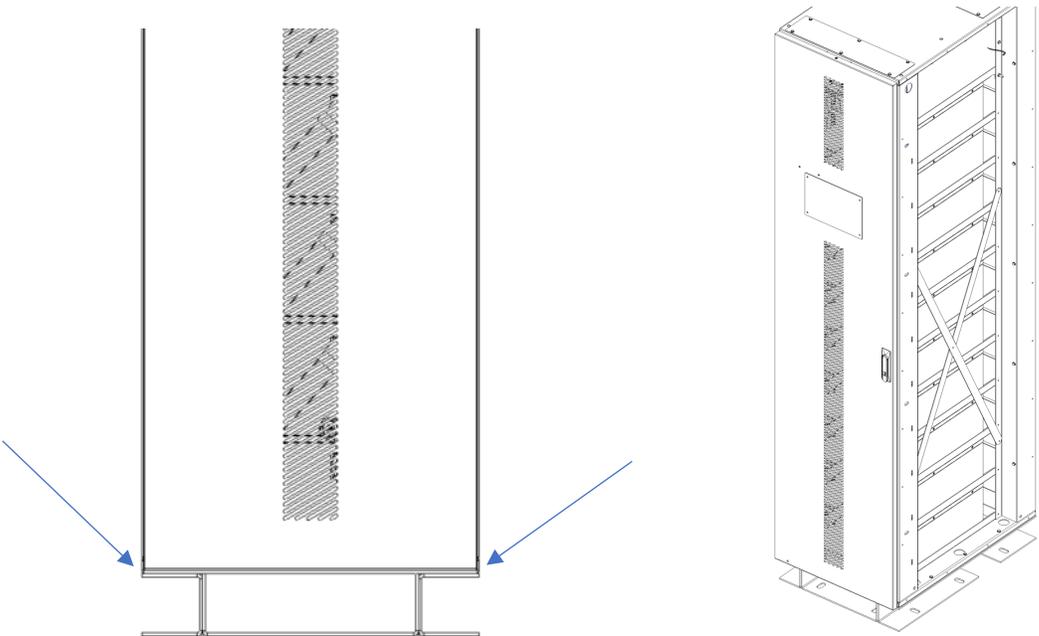
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5.3.6 To ensure stability of the rack during transportation it is recommended that the top of the rack is strapped to the frame of the forklift using a ratchet strap. Below image shows the locations where the strap can be attached.



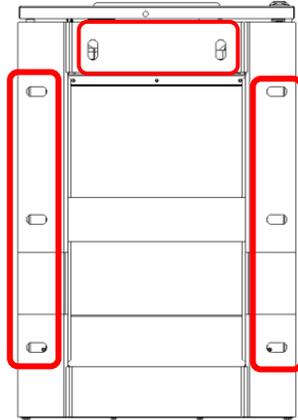
5.3.7 Position the first rack in place.

5.3.8 Remove the angle brackets and side panels from both sides to get access to anchoring locations.

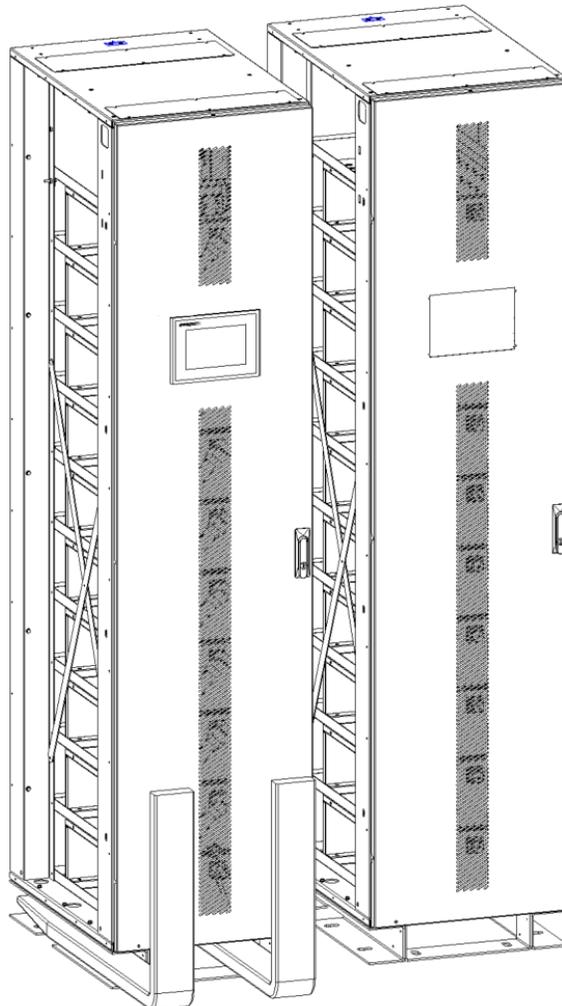


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5.3.9 Secure the rack with the anchoring bolts to the floor. There are 3 mounting locations on each side and 2 optional locations on the front.

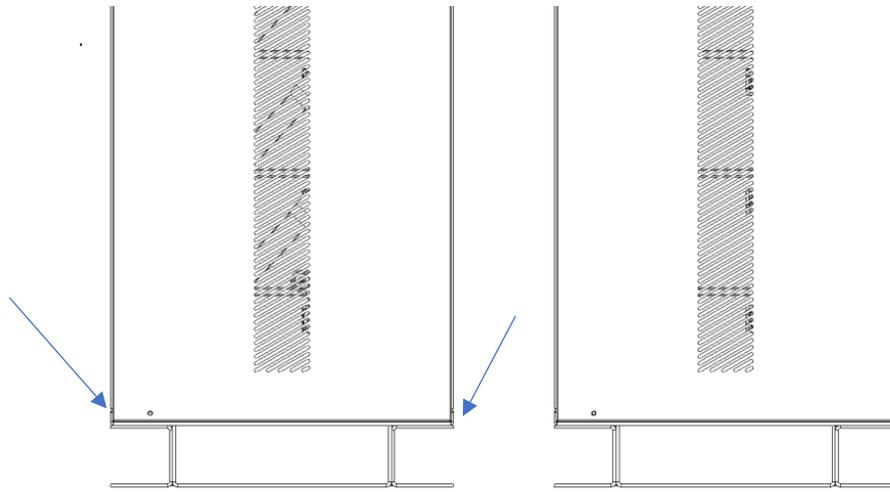


5.3.10 Place the second rack beside the first one that is already in place. Leave about 8-10" in between to be able to remove angle brackets.



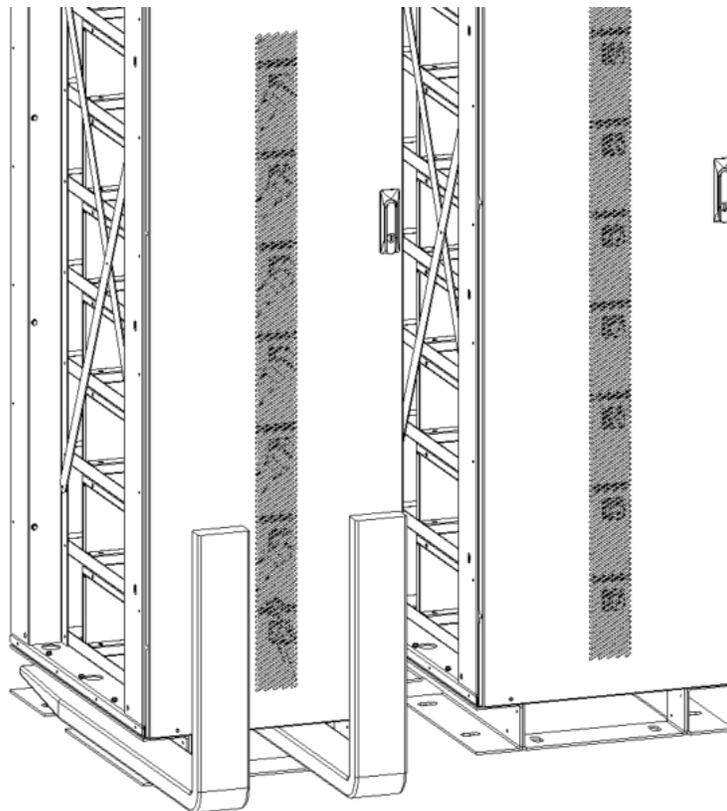
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5.3.11 Uninstall both side angle brackets from the 2nd rack.



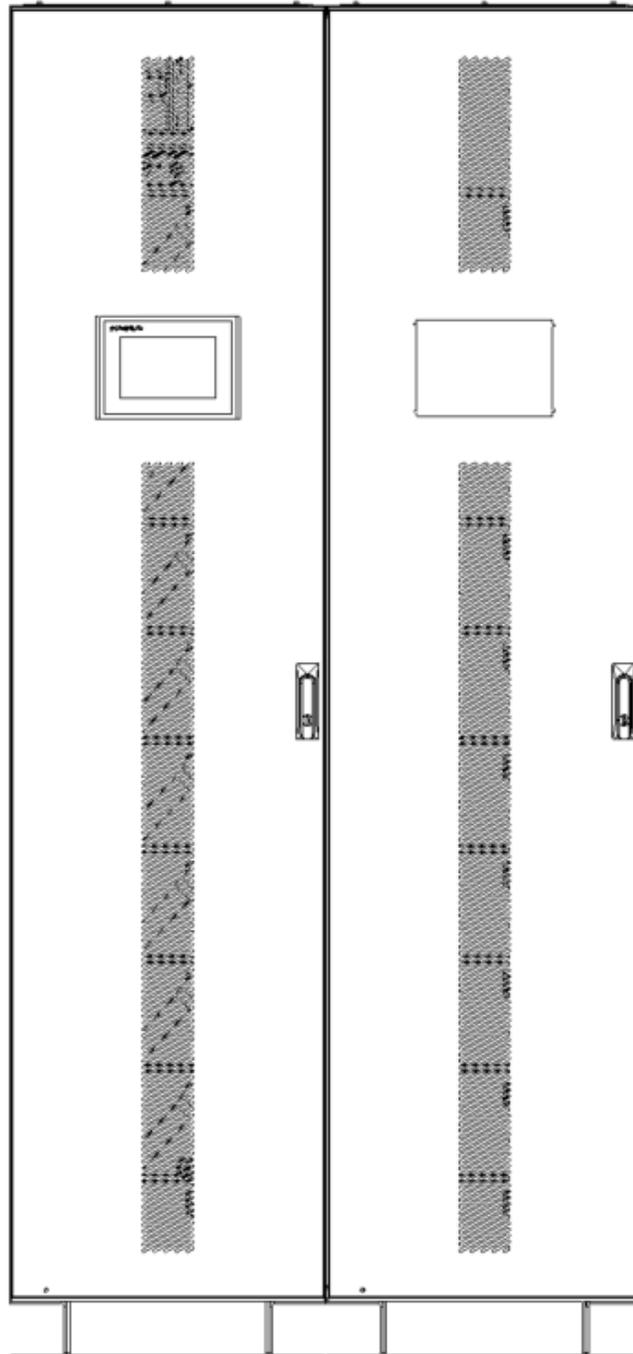
5.3.12 Reposition the forks so that they are about 220mm (8.5 inch) apart.

5.3.13 Slowly insert forks, one through the middle and the second one to the left side of the rack.



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- 5.3.14 Slightly lift the rack and reposition it adjacent to the one already in place.
- 5.3.15 Anchor 2nd rack to the floor.



5.4 Cabinet Mounting (Non-Seismic)

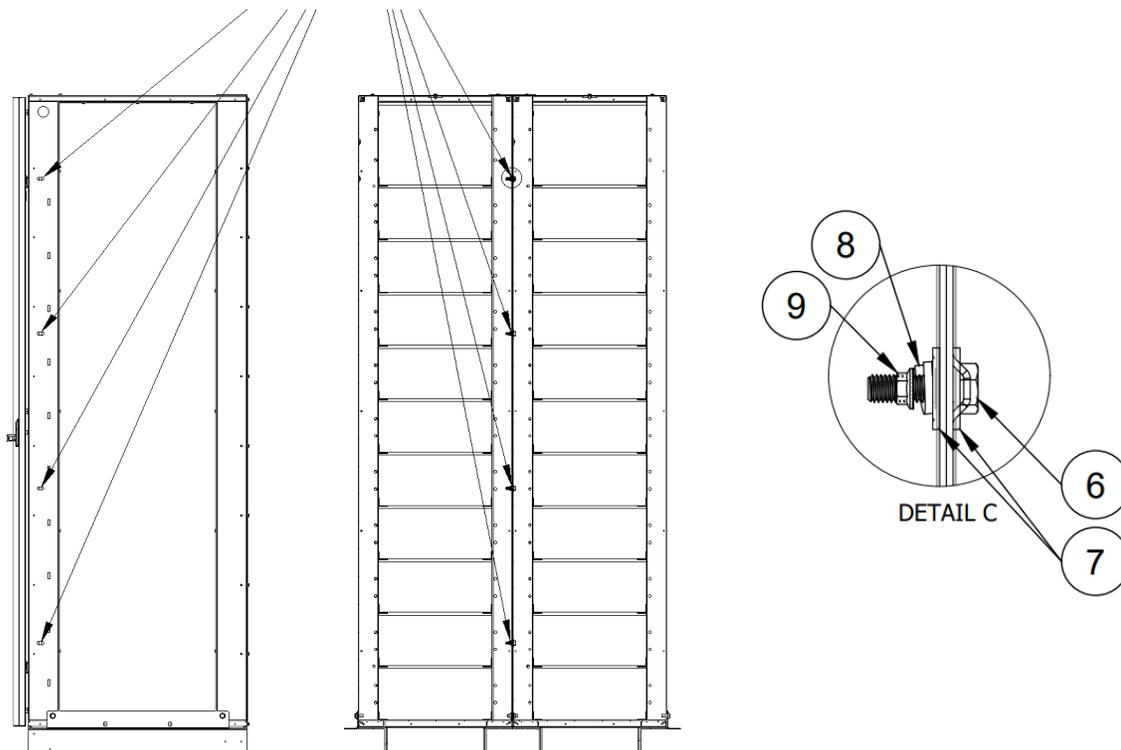
5.4.1 Rack mounting hardware:

| Fastener Location | Size | Hardness | Thread Pitch | Material |
|--|---|--------------------|------------------|----------|
| Floor Anchors (Not included) | M10*30L M12*200mm (min) (seismic) | HRC32 Grade 8.8 | 1.5 mm (0.06 in) | SS304 |
| Multi Rack Fasteners (MPLHP-51255-MCIK) | M8*25L (Side) | HRC32 Grade 8.8 | 1.5 mm (0.06 in) | Steel ZP |

| | |
|---|--|
|  | <p>For Seismic Applications please consult with a Local Engineer to ensure concrete and anchoring are correct.</p> |
|---|--|

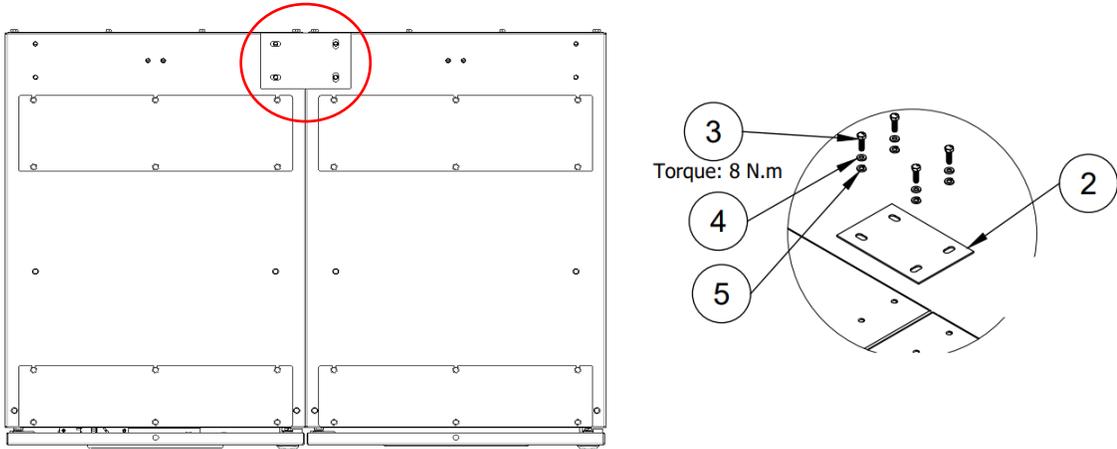
5.4.2 After all racks in a string have been positioned in place and mounted to the floor connect all racks adjacent racks together using M8 hardware provided in the multi-cabinet connection kit MPLHP-51255-MCIK.

| | | |
|---|-----------------|---|
| 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 |

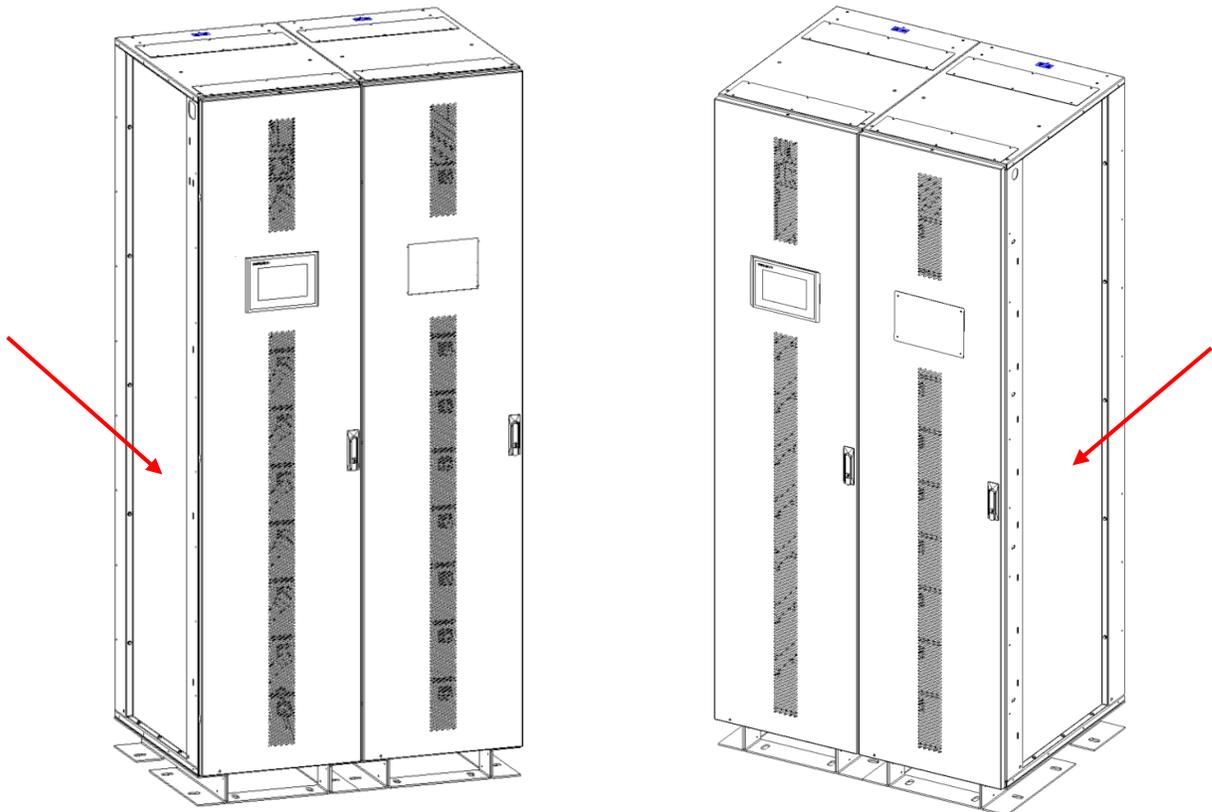


5.4.3 Connect the adjacent racks together on the top of the cabinet using connecting plate and M6 hardware from the multi cabinet kit MPLHP-51255-MCIK

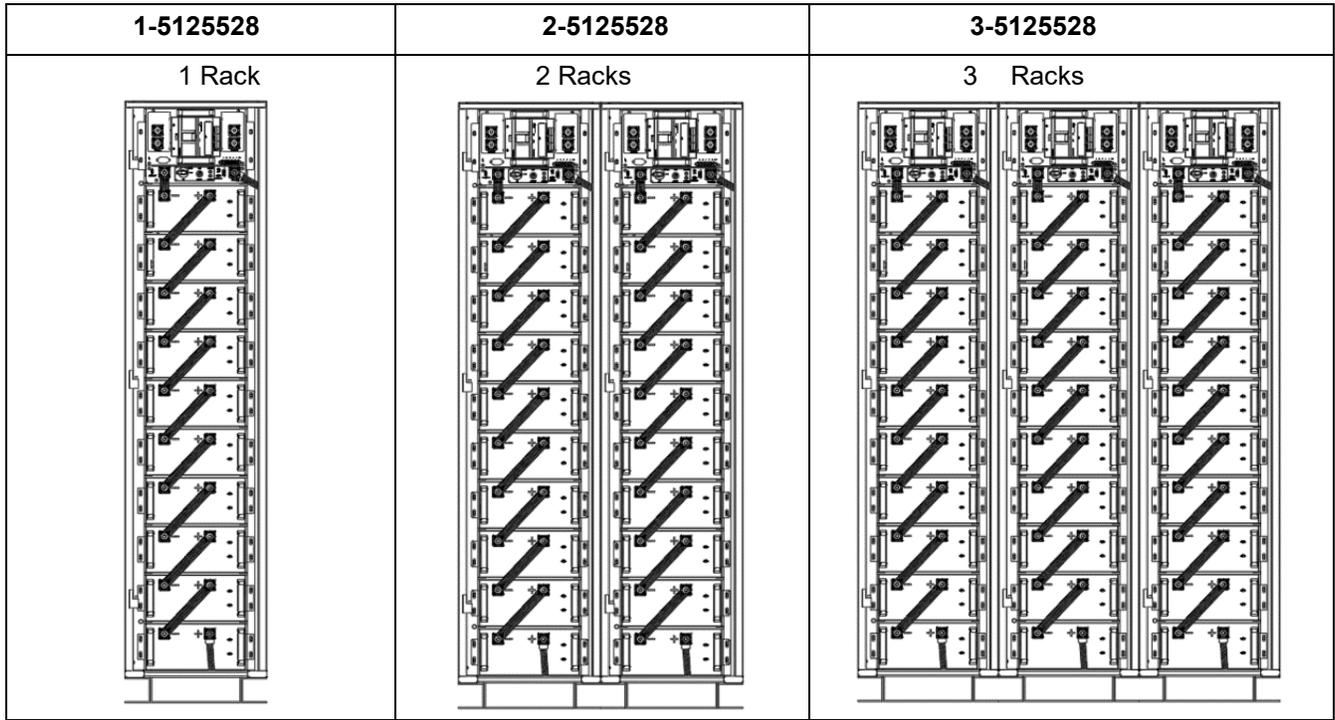
| | | |
|---|-----------------|---|
| 2 | HWR-PLT20150100 | MPLHP-51255 Multi-Rack Connecting Plate |
| 3 | HDW-HHCSZP-M620 | M6x20 Hex Head Cap Screw, Grade 8.8 Zinc Plated |
| 4 | HDW-FWZP-M6 | M6 Flat Washer Grade 8.8 Zinc Plated |
| 5 | HDW-LWZP-M6 | M6 Lock Washer Grade 8.8 Zinc Plated |



5.4.4 Reinstall side panels on the outer cabinets of the string.



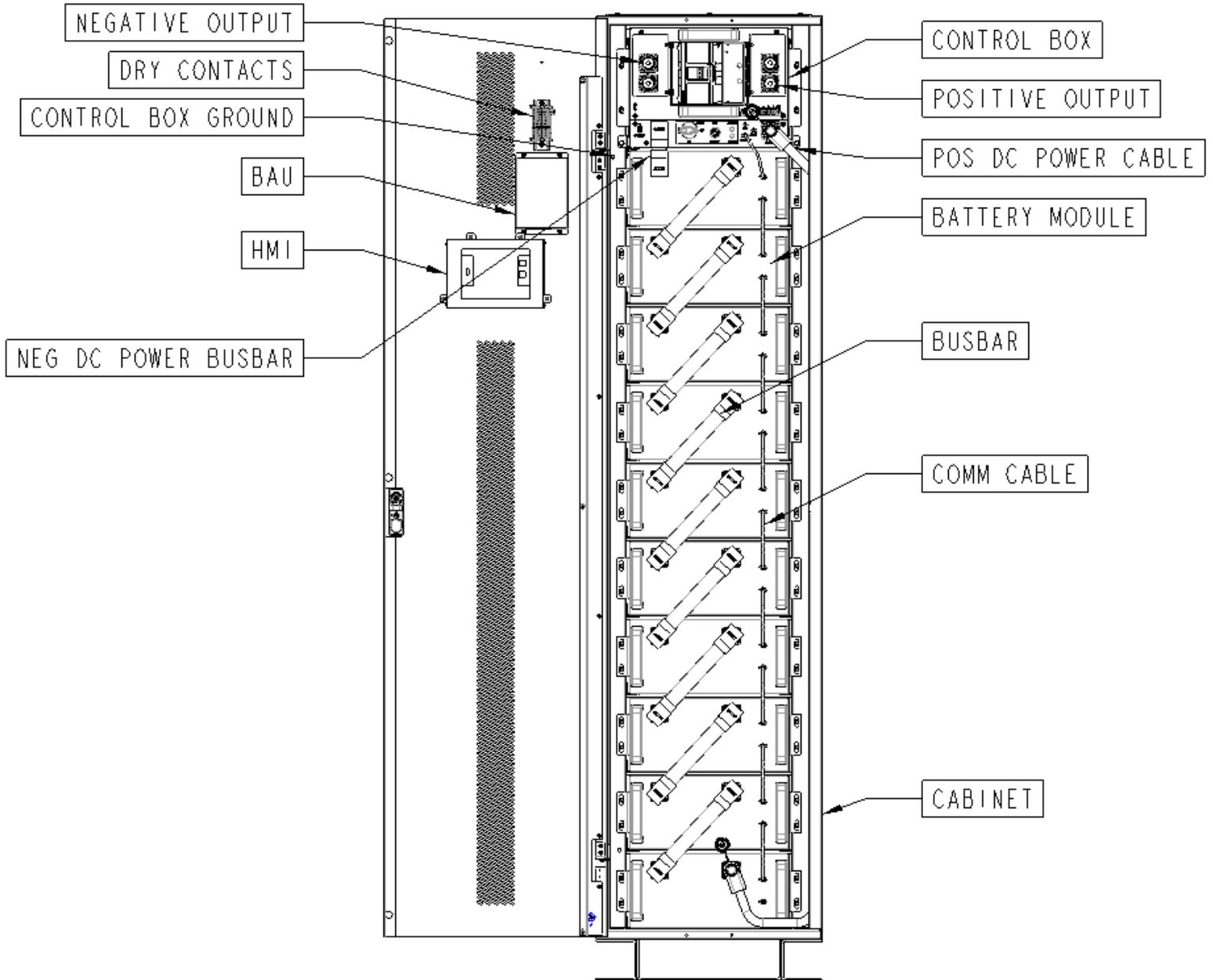
5.4.5 Example Layouts for Different Configurations



| | | | | |
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5.4.6 Component location diagram

Fig 6-1 Component locations



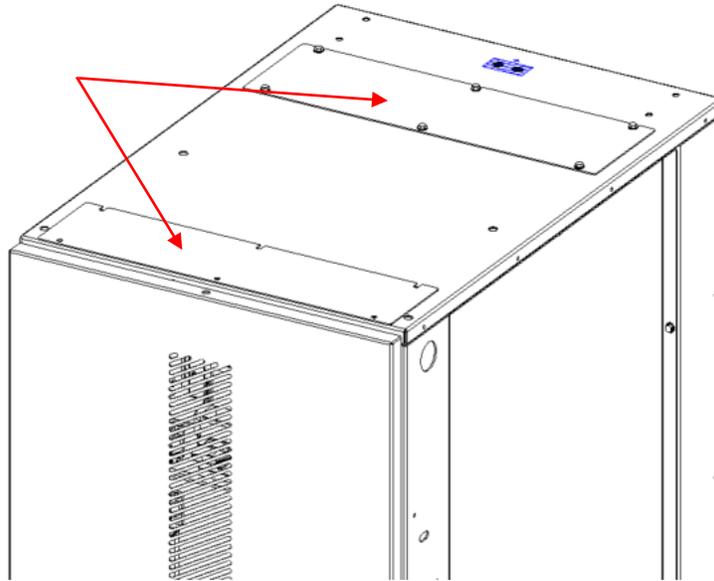
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| | |
|---|--|
|  | <p>For Empty Unassembled Cabinets Proceed to Section 11 for Component Installation before proceeding.</p> |
|---|--|

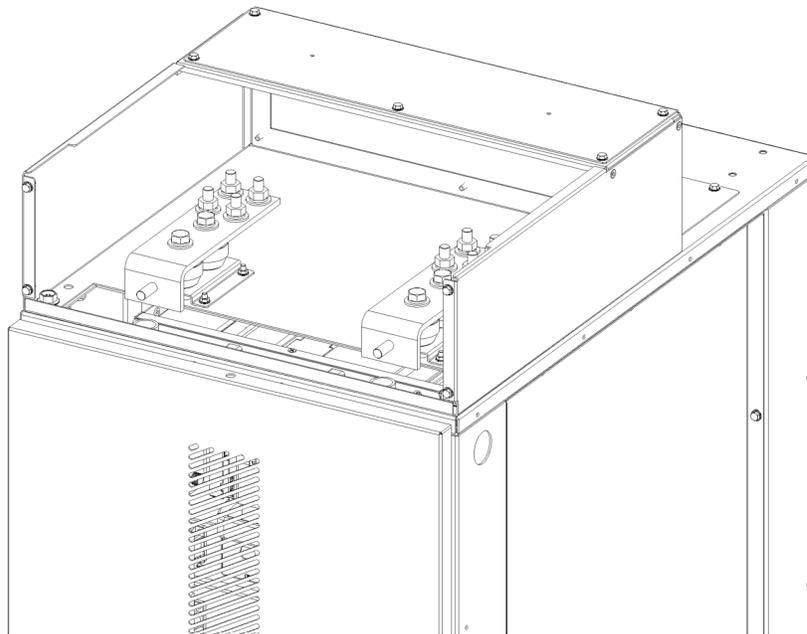
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6. Conduit Landing box installation (OPTIONAL)

- 6.1 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.
- 6.2 Remove 2 plates on the top of the cabinet by unscrewing 2 sets of 6 M6 bolts.

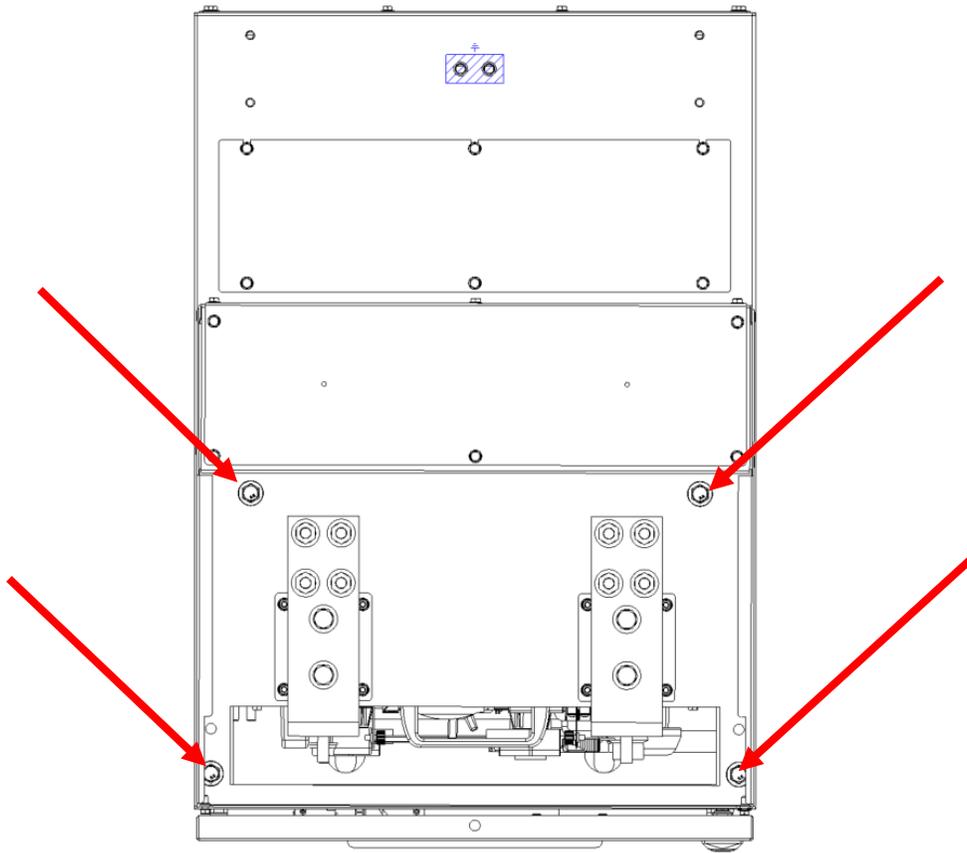


- 6.3 Remove the front cover from the CLB and place the box on top of the cabinet. Ensure the mounting holes are aligned.

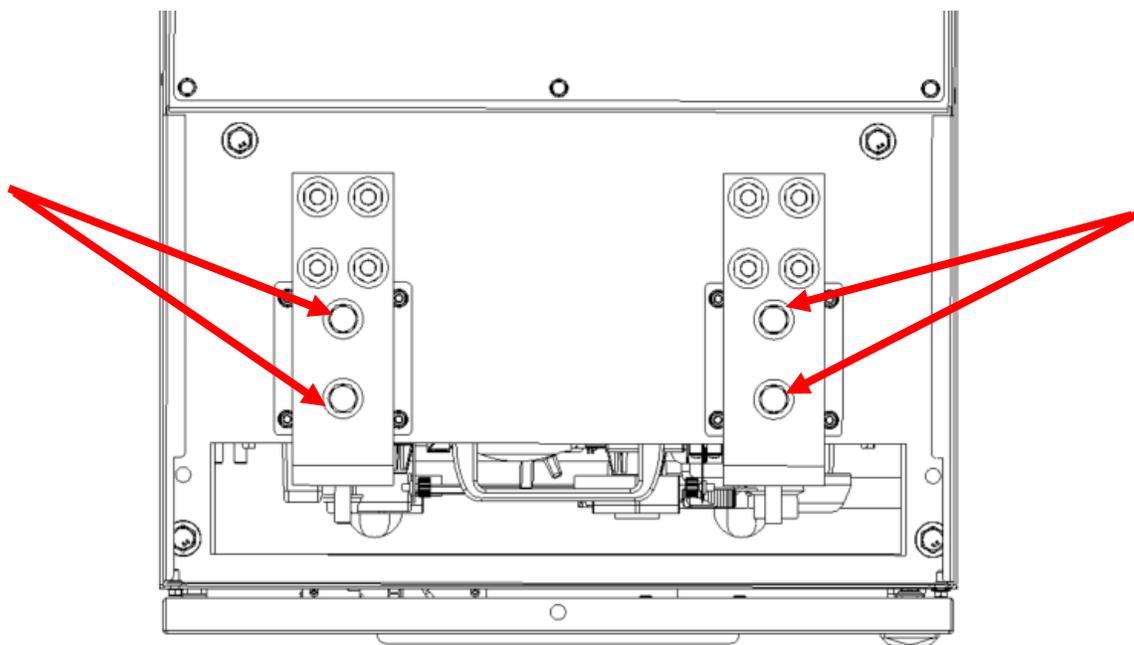


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6.4 Secure the box to the top hat using (4) M8 bolts. Tighten these bolts to 12Nm.

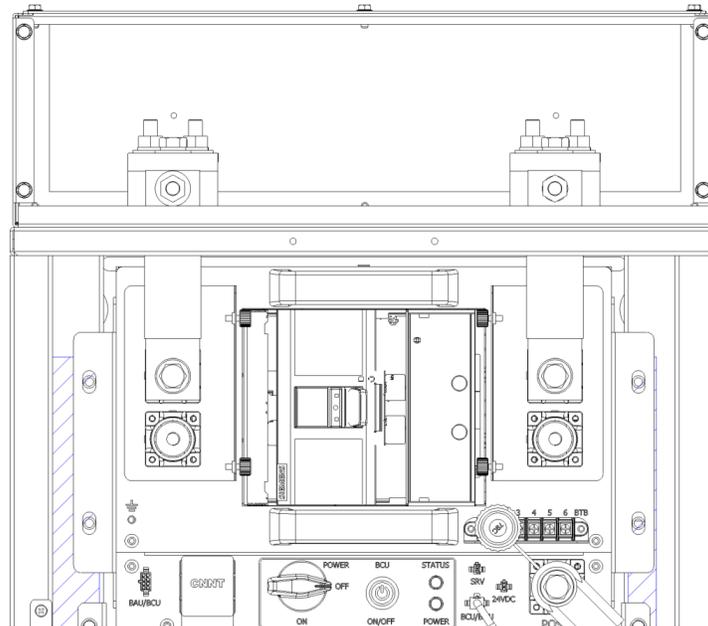


6.5 Loosen up 2 M10 busbar mounting bolts.

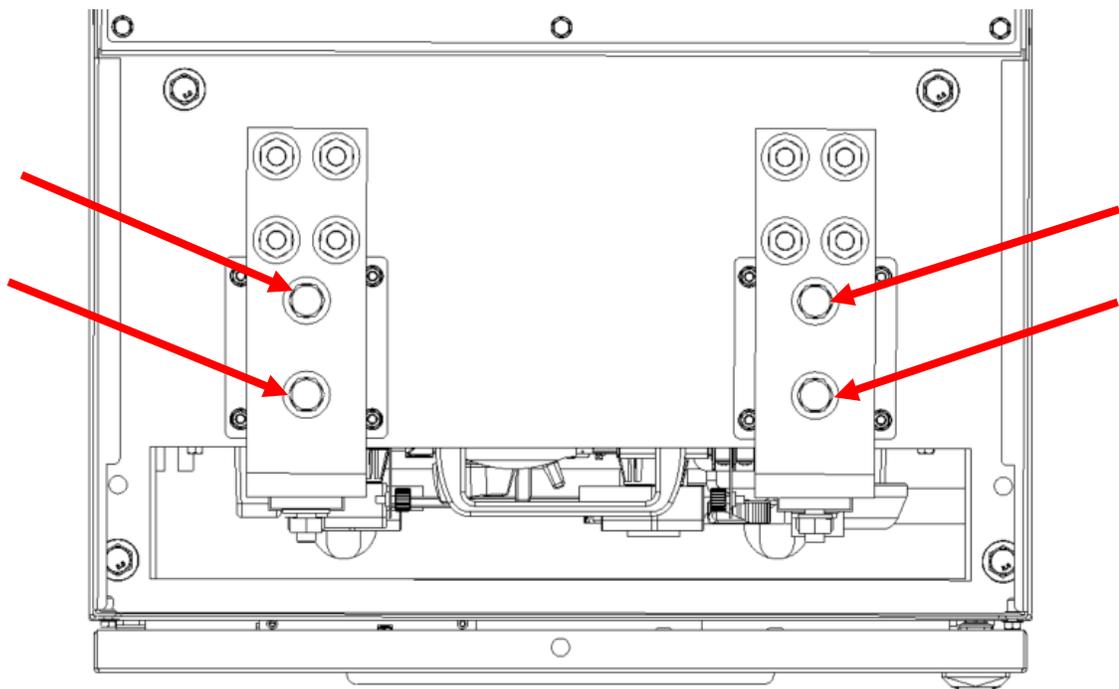


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6.6 Connect the busbars to the control box output terminals using the provided hardware. Tighten the Bolts and Nuts to 25Nm torque.

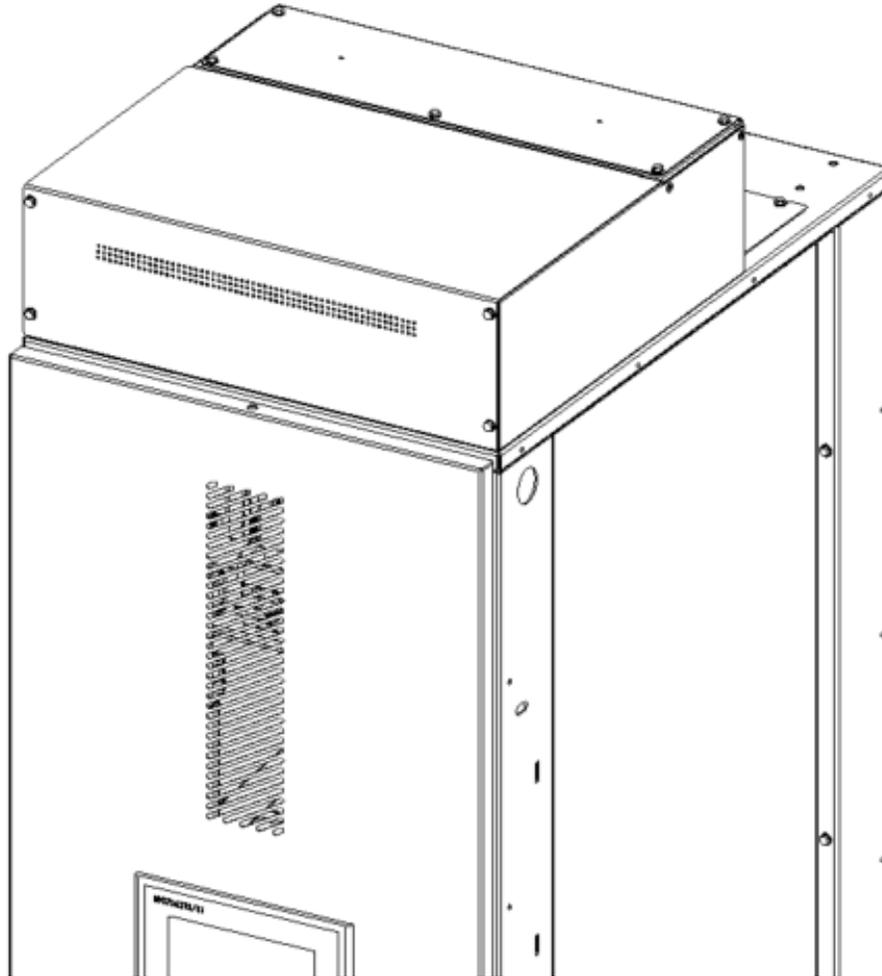


6.7 Ensure the busbars from the Landing Box are properly aligned with the busbars going to the control box and are making good contact. Tighten the M10 busbar mounting bolts inside the Landing Box.



| | | | | |
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6.8 After the power output cables have been connected to the busbars reinstall the cover.





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7. Output Power Cable Connection

- 7.1 Refer to national and local electrical code for guidance on acceptable external wiring practices.
- 7.2 Material and labor for external wiring requirements are to be provided by designated personnel.
- 7.3 For external wiring, use 90°C copper wire.
- 7.4 Refer to NEC Article 250 and local codes for proper grounding practices.
- 7.5 The battery cabinet frame is not referenced to the DC circuit.
- 7.6 Installations in excess of 30 Meters /100ft are not recommended.
- 7.7 Care should be taken to ensure the battery wiring used between the battery and the UPS should not allow a voltage drop of more than 2 VDC at rated battery current.

| Voltage Drop at 30 Meters /100ft | | | | | | |
|-----------------------------------|--------|---------|-------|-------|-------|-------|
| | | Current | | | | |
| | | 200A | 250A | 300A | 350A | 400A |
| Wire Size | 000 | 2.501 | 3.126 | 3.752 | 4.377 | 5.002 |
| | 0000 | 1.983 | 2.479 | 2.975 | 3.471 | 3.967 |
| | 250MCM | 1.679 | 2.098 | 2.518 | 2.938 | 3.357 |
| | 300MCM | 1.399 | 1.749 | 2.098 | 2.448 | 2.798 |
| | 350MCM | 1.199 | 1.499 | 1.799 | 2.098 | 2.398 |
| | 400MCM | 1.049 | 1.312 | 1.574 | 1.836 | 2.098 |
| | 500MCM | 0.839 | 1.049 | 1.259 | 1.469 | 1.679 |
| Voltage Drop at 15 Meters /50ft | | | | | | |
| | | Current | | | | |
| | | 200A | 250A | 300A | 350A | 400A |
| Wire Size | 000 | 1.251 | 1.563 | 1.876 | 2.188 | 2.501 |
| | 0000 | 0.992 | 1.24 | 1.488 | 1.735 | 1.983 |
| | 250MCM | 0.839 | 1.049 | 1.259 | 1.469 | 1.679 |
| | 300MCM | 0.699 | 0.874 | 1.049 | 1.224 | 1.399 |
| | 350MCM | 0.6 | 0.749 | 0.899 | 1.049 | 1.199 |
| | 400MCM | 0.524 | 0.655 | 0.786 | 0.918 | 1.049 |
| | 500MCM | 0.419 | 0.524 | 0.63 | 0.734 | 0.839 |
| Voltage Drop at 7.62 Meters /25ft | | | | | | |
| | | Current | | | | |
| | | 200A | 250A | 300A | 350A | 400A |
| Wire Size | 000 | 0.635 | 0.794 | 0.952 | 1.112 | 1.271 |
| | 0000 | 0.503 | 0.629 | 0.755 | 0.881 | 1.008 |
| | 250MCM | 0.426 | 0.533 | 0.639 | 0.746 | 0.852 |
| | 300MCM | 0.355 | 0.444 | 0.533 | 0.621 | 0.71 |
| | 350MCM | 0.304 | 0.38 | 0.456 | 0.533 | 0.609 |
| | 400MCM | 0.266 | 0.333 | 0.399 | 0.466 | 0.533 |
| | 500MCM | 0.213 | 0.266 | 0.319 | 0.373 | |

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- 7.8 The battery cabinet/s is/are installed in a standalone configuration. The term standalone means the cabinets are installed adjacent to the UPS without mechanical linkage or in a separate location, are wired with external customer-supplied conduit and wiring, and may use the battery cabinet breaker as the battery isolation device or a single overcurrent protection and disconnect device located near the batteries. Each battery cabinet has its own overcurrent protection device, an optional built-in trip feature may be used if desired.
- 7.9 Refer to the appropriate UPS Installation and Operation manual for conduit and terminal specifications and locations.
- 7.10 The terminals can accept a single hole lug or a double hole lug with 1-3/4" hole spacing. Below table shows a list of recommended 2-hole lugs.

| Manufacturer | AWG | P/N | Length | Hole Spacing | Hole Dia | Lug Thickness |
|------------------|-----|-----------------|--------|--------------|----------|---------------|
| Burndy | 250 | YA292N | 5.21 | 1.75 | 0.50 | 0.16 |
| | 300 | YA302N | 5.64 | 1.75 | 0.50 | 0.16 |
| | 350 | YA312N | 5.68 | 1.75 | 0.50 | 0.18 |
| Blackburn | 250 | 54868BE | 4.92 | 1.75 | 0.50 | 0.14 |
| | 300 | 54870BE | 5.23 | 1.75 | 0.50 | 0.15 |
| | 350 | 54872BE | 5.40 | 1.75 | 0.50 | 0.18 |
| IlSCO | 250 | ALNN-250-12-134 | 5.06 | 1.75 | 0.56 | 0.33 |
| | 250 | CLWD-250-12-134 | 5.22 | 1.75 | 0.56 | 0.16 |
| | 350 | CLWD-350-12-134 | 5.62 | 1.75 | 0.56 | 0.23 |
| Panduit | 250 | LCCX250-12-X | 5.77 | 1.75 | 0.50 | 0.17 |
| | 300 | LCCX300-12-6 | 5.85 | 1.75 | 0.50 | 0.18 |
| | 350 | LCCX350-12-6 | 6.13 | 1.75 | 0.50 | 0.22 |

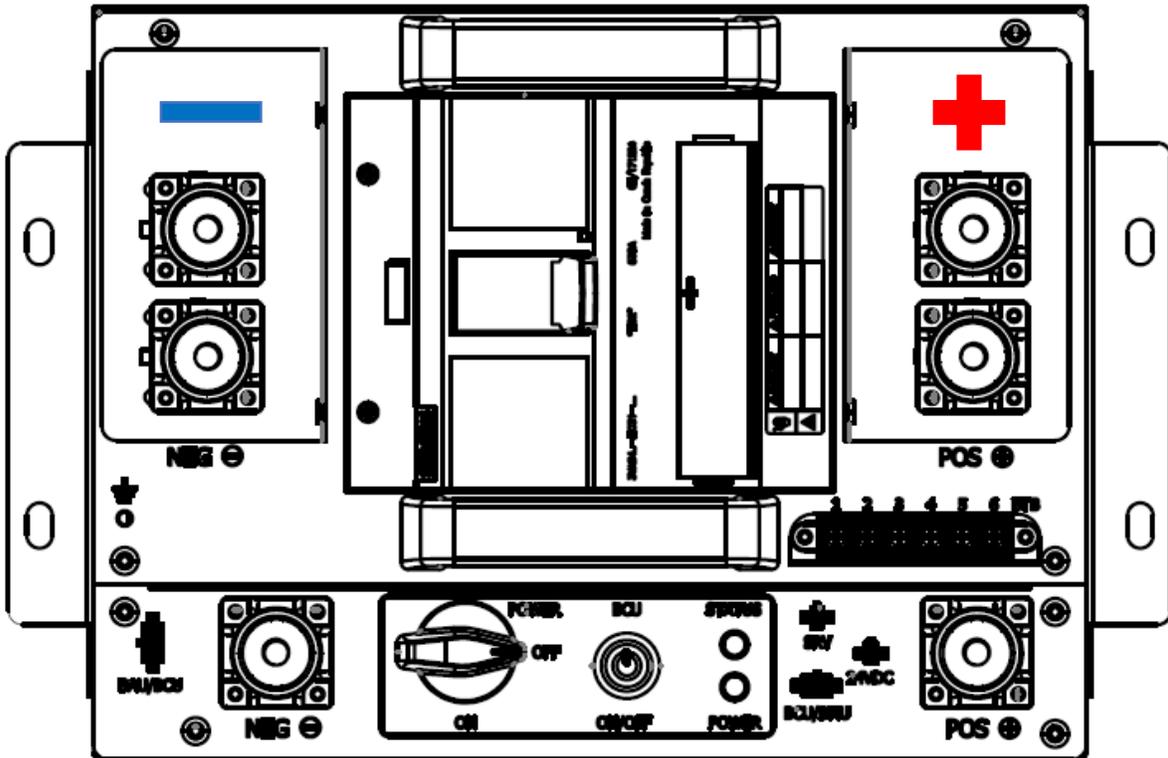
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WARNING



- Exercise extreme caution to prevent short circuits between the positive and negative terminals.
- Exercise extreme caution to prevent positive and negative terminals from contacting anything other than their intended mounting points.
- Ensure control box Circuit Breaker is in the OPEN position.**
- Prior to installation measure the voltage between the terminals. With the Circuit Breaker Open the voltage between terminals should be 0V.**

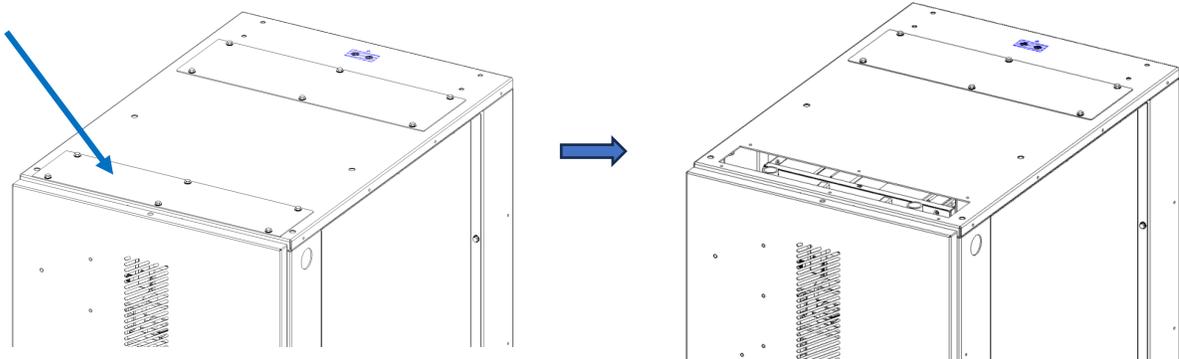
7.11 There are 2 output terminals for the Negative connection and 2 output terminals for the Positive connection on the BCU. They are marked accordingly.



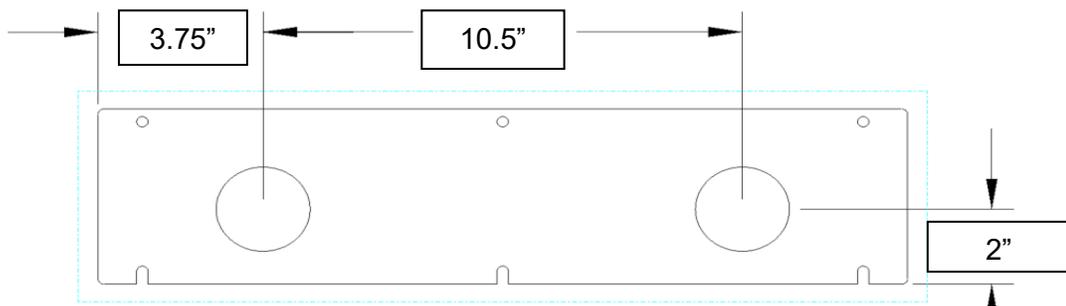
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7.12 Output cables are routed to the BCU from the top of the cabinet.

7.12.1 Remove the front cover plate by removing 6 screws.

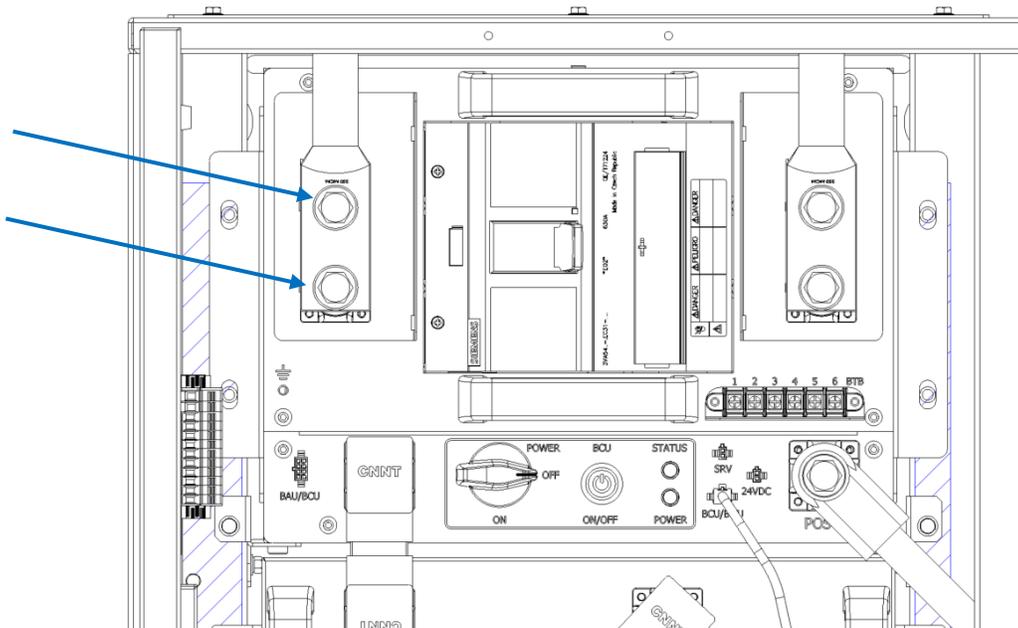


7.12.2 Drilled out 2 holes in the plate. The hole location is specified below. The diameter of the hole depends on the size of the cable and the lugs used.

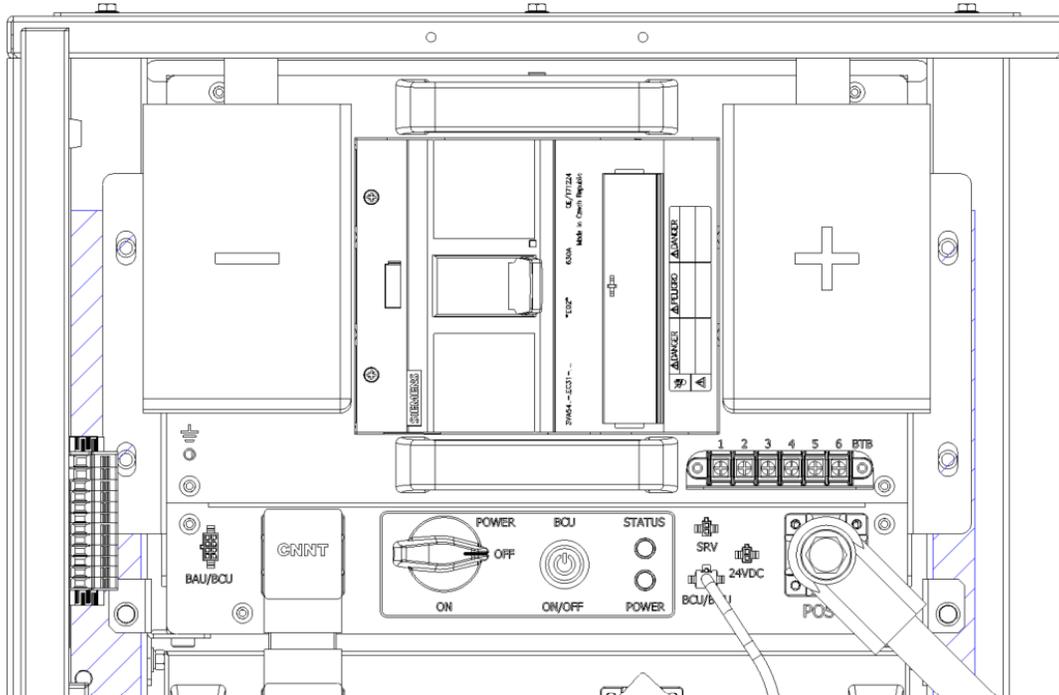


7.12.3 Reinstall the cover and secure, insert grommet or conduit into the holes.

7.12.4 Route the cables to the BCU output terminals and connect using provided M10x25 screws. Torque to 25Nm.



7.12.5 After the hardware has been torqued install the terminal covers.



8. Communication Cable Connection

| | |
|---|--|
|  | <p>This section should be completed by or under supervision of a trained startup technician.</p> |
|---|--|

8.1 Control Box and Module

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

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

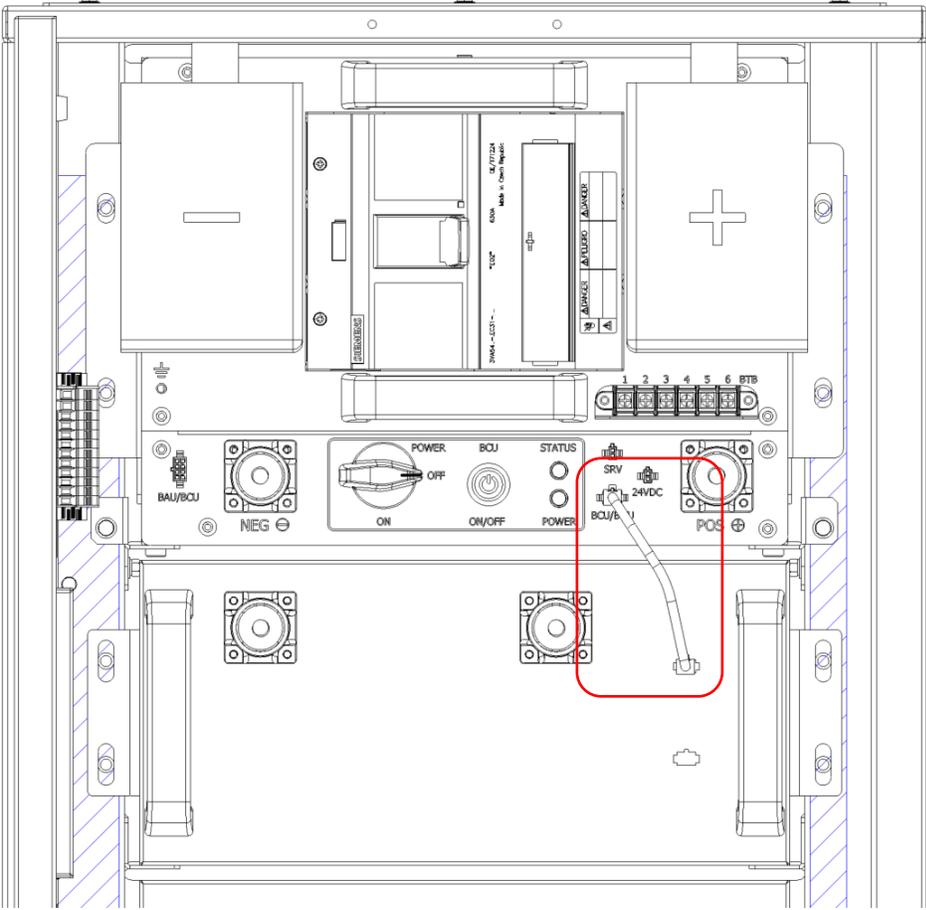
Table 8-1 The Specification of Communication Cable Between BCU and BMU

Note the two cables look similar, but pinouts are different!

| Type | Communication Cable |
|---------------|--|
| BCU-BMU Cable | <p>1 cable for communication between first module to control box. Part number: LHP-CCOM-MC01</p> <div style="text-align: center;">  </div> |
| BMU-BMU Cable | <p>9 cables are needed for communication between modules. Part number: LHP-CCOM-MM01</p> <div style="text-align: center;">  </div> |

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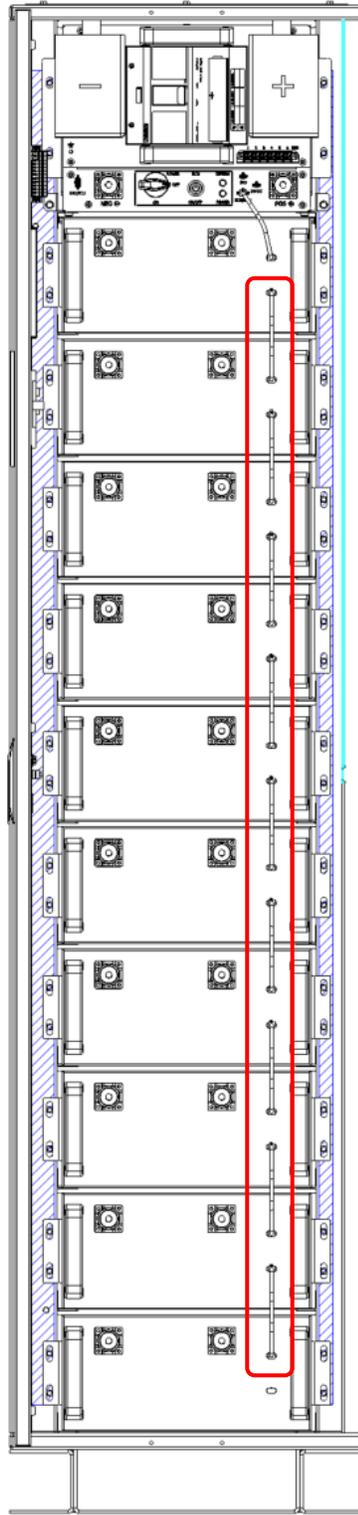
7-2 The Steps for Communication Connection Between Control Box and Module

| 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>  |

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

2

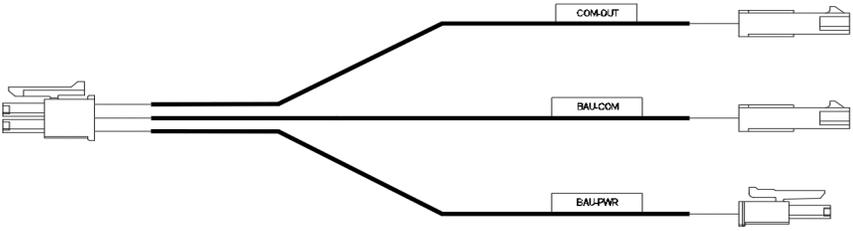
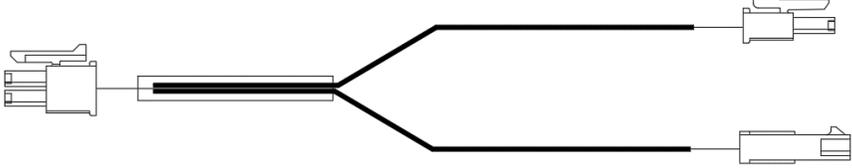
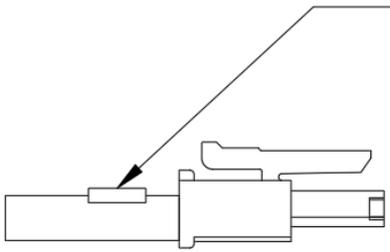


8.2 Control Box and BMS

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

Specifications of signal cables connecting the BMS to control box are included in the following table.

Table 8-3 The Specification of Signal Cable Between BCU and BMS

| BMS | Communication Cable |
|---|--|
| Cabinet 1 BAU-BCU Cable "LHP-CCOM-AC01" |  |
| Cabinet 2 (without HMI) BCU-BCU Cable "LHP-CCOM-CC01" |  |
| Connects to last cabinet's BCU cable. BCU Termination Cable "LHP-CCOM-CT01" |  <p style="text-align: right; margin-right: 100px;">120 Ohm resistor</p> <p style="text-align: center;">See relevant drawings for pin out</p> |

| | |
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|---------------------|--|

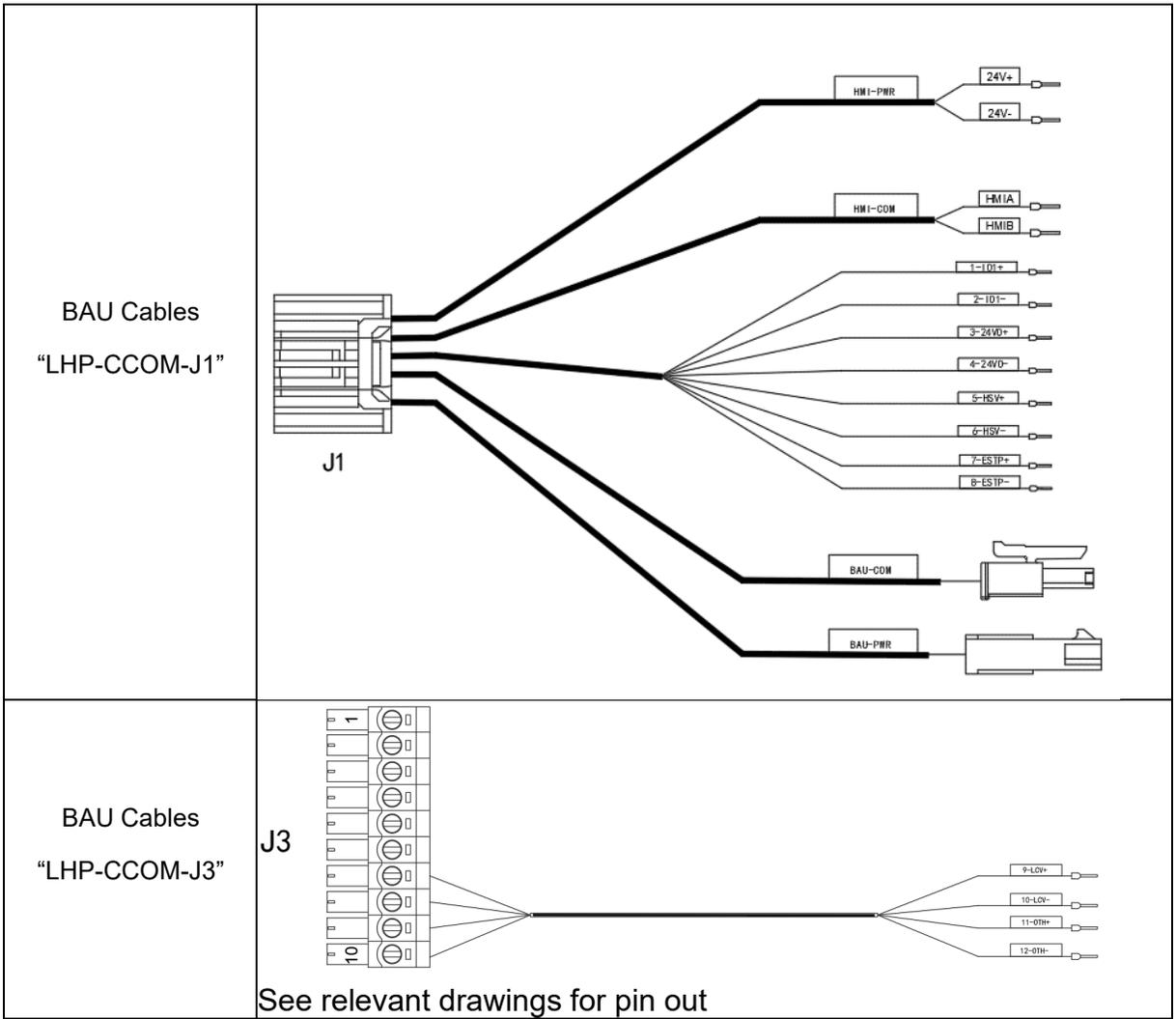
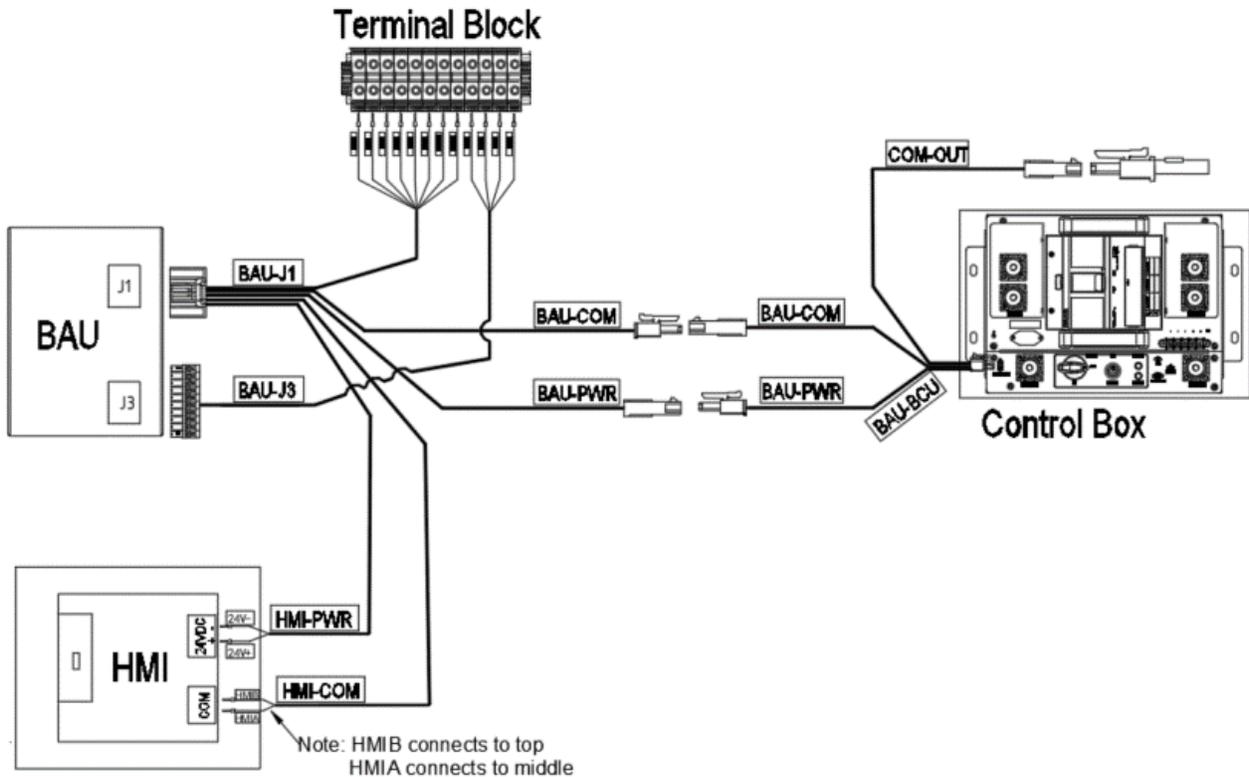


Table 8-4 The Steps for Communication Connection Between Control Box and BAMS

| 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. For more details, refer to relevant drawings. |
| 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. |

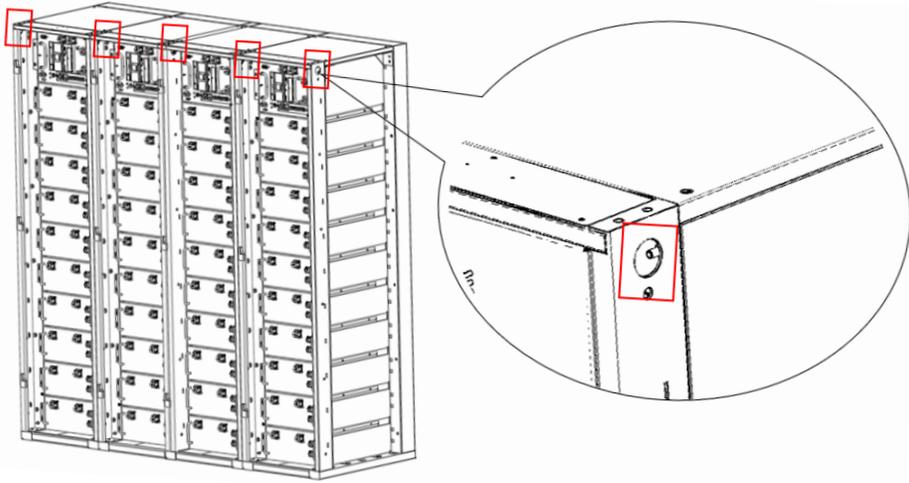
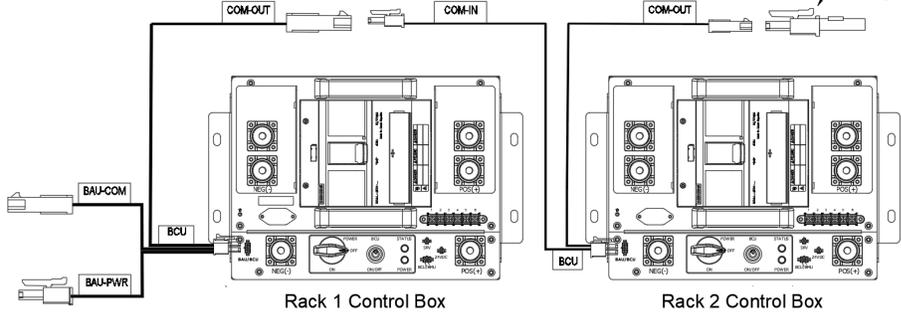


8.3 Multiple Cabinets

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

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

Table 8-5 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="font-size: small;">Note: This cable connects between each rack that are without HMI&BAU</p> <p style="font-size: small;">Note: This cable connects to COM-OUT of the last rack in a system.</p>  <p style="text-align: center;">Rack 1 Control Box Rack 2 Control Box</p> |

9. Busbar Connections

| | |
|---|--|
|  | <p>This section should be completed by or under the supervision of a trained startup technician.</p> |
|---|--|

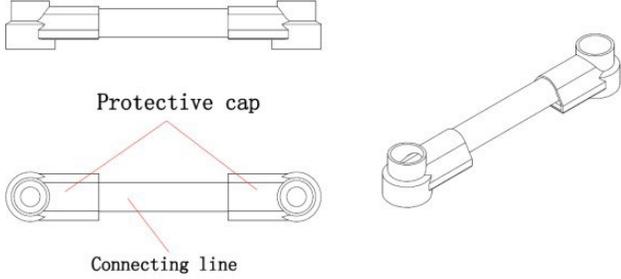
| | |
|---|--|
|  | WARNING |
| | <ul style="list-style-type: none"> ▪ Exercise extreme caution to prevent short circuits between the positive and negative terminal of a single battery module. ▪ Exercise extreme caution to prevent positive and negative terminals from contacting anything other than their intended mounting points. ▪ Only remove module terminal covers when installing bus bars. ▪ Immediately re-install module terminal covers when bus bar installation is complete for each module. ▪ Ensure control box disconnect is in the OFF position. ▪ <u>Prior to installation of the last busbar measure the voltage between the terminals. Due to the nature of the BMS voltage sense leads it is possible to read a system level voltage when the module to control box power connections are installed. The breaker can be open, there is no potential behind this, it is a normal occurrence with the design.</u> |

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

9.2 Tightening Torque Specification

| Screw size | Location | Torque |
|------------|---------------------------------|--------|
| M6 | Module Mounting | 8 N-m |
| M6 | Option Ground (top of cabinet) | 8 N-m |
| M8 | Ground wires | 18 N-m |
| M8 | Cabinet to Cabinet | 18 N-m |
| M10 | Busbars, Input/Output terminals | 25 N-m |

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 black silicone insulating cover on both sides.</p>  |
| 2 | <p>Power cable connecting Control box positive terminal to the positive terminal on the last battery module.</p>  |

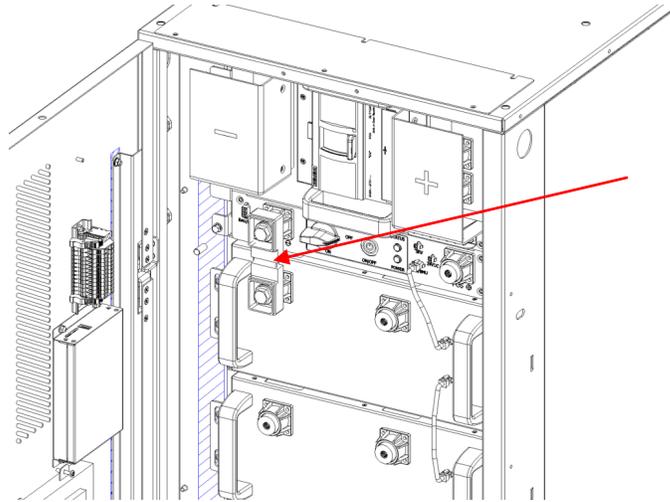


CAUTION

Be observant when installing busbars that the terminal cover is not between the busbar and the battery terminal. The cover should move freely when installed.

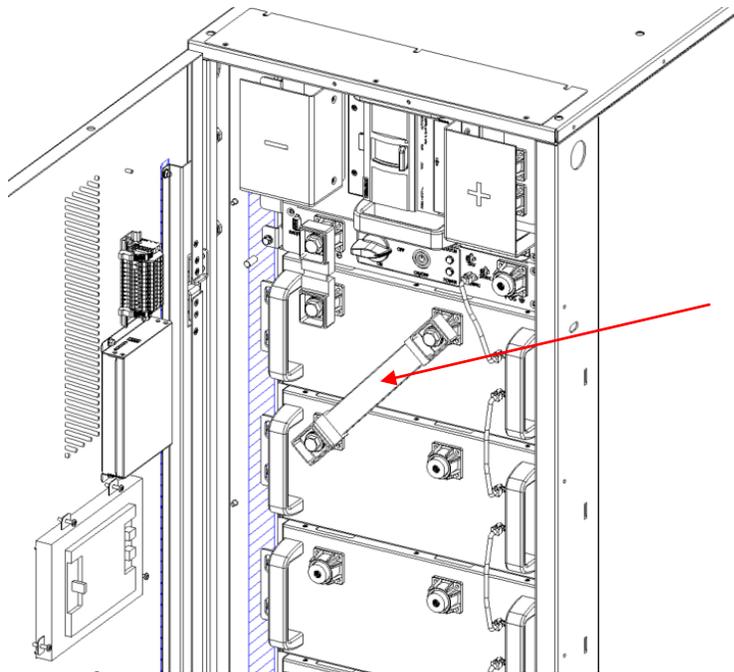
3

Control Box Input - and Module #1 Neg terminal is connected using an M10 screw. (PLEASE OBSERVE CAUTION THAT THE TERMINAL COVER DOES NOT FALL BETWEEN BUSBAR AND TERMINAL)



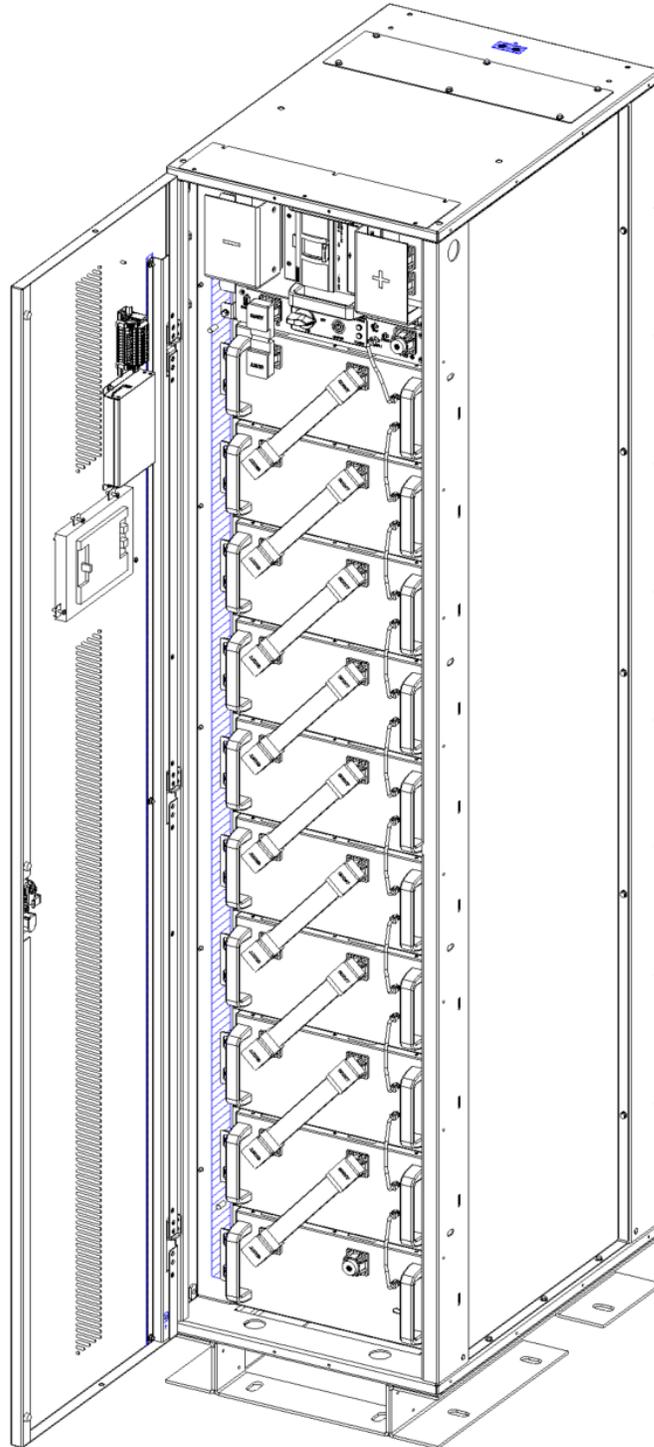
4

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



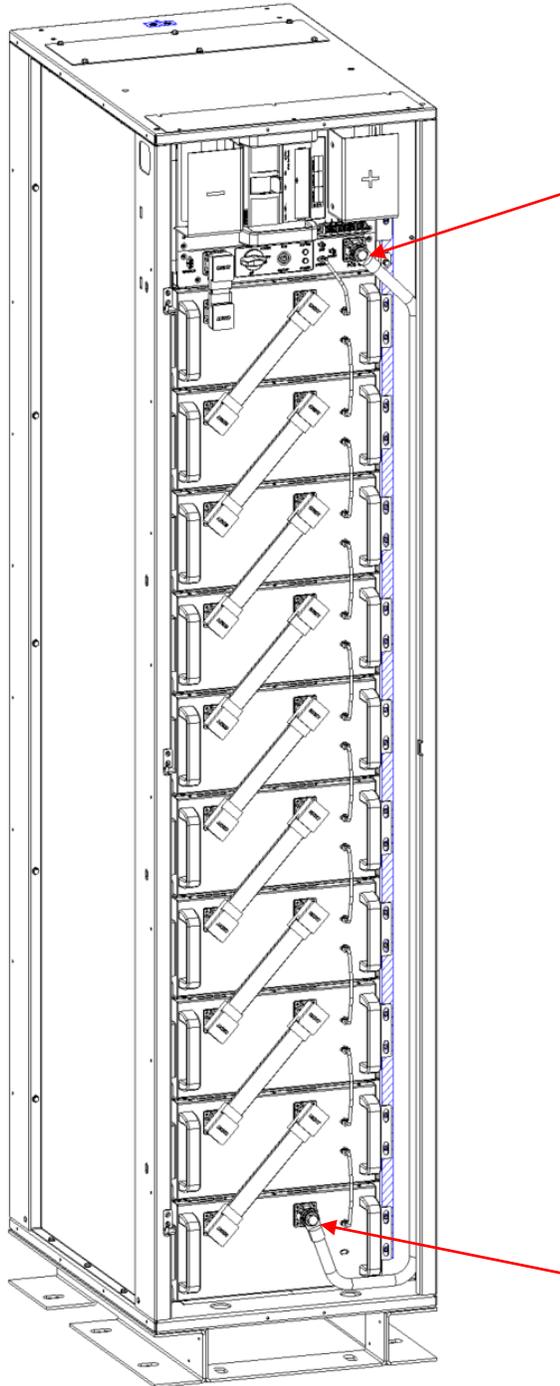
Continue with step 4 until you have connected 10 battery modules

5



Connect Power Cable between Module #10 Positive terminal and Control Box Input positive terminal.

6



Installation Complete

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10. 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.

10.1 Definition of Storage

- 10.1.1 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.
- 10.1.2 Stored Batteries, kept under specific conditions detailed in this document, retain the ability to perform their designed function.

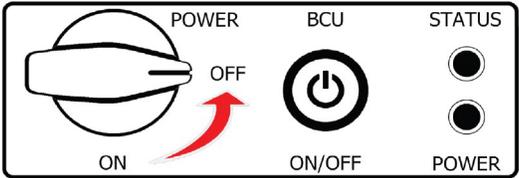
10.2 Storage post-installation

- 10.2.1 Batteries should be stored any time the charger is expected to be in the off state for greater than 48 Hours.
- 10.2.2 The following conditions should be observed when storing batteries that have been installed and started/commissioned.
 - 10.2.2.1 Batteries should be stored at 100% Charge
 - 10.2.2.2 Control and logic Power should be secured to prevent battery discharge.

| | |
|--|---|
|  | WARNING |
| | <p>Failure to place the power switch and BCU on/off PB in the OFF position will result in permanent damage to the battery modules and loss of warranty coverage.</p> |

ATTENTION

**TO AVOID BATTERY
SELF-DISCHARGE
TURN BMS POWER
OFF ON ALL RACKS
WHEN BATTERY IS
NOT ON CHARGE**



| | | | | |
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10.3 Temperature Range

- 10.3.2 Acceptable Storage temperature range: -10°C to 40°C, recommended storage temperature range: 15°C to 30°C.
- 10.3.3 Battery modules can be kept at -10°C minimum condition without damage but must be heated up to 15°C before charge & discharge operation.

10.4 Relative Humidity

- 10.4.2 The relative humidity shall not be higher than 95%

10.5 Storage Preinstallation Condition

- 10.5.2 Recharge is required to recover capacity loss due to self-discharge during storage and transportation before operation.
- 10.5.3 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.

10.6 Storage Post-Installation Condition

- 10.6.2 The charger should be secured.
- 10.6.3 Battery Breaker should be open on all racks.
- 10.6.4 BCU On/Off Push Button should be in the OFF position, and the main Power switch should be OFF.
- 10.6.5 Before returning to service or discharge testing, the system shall be recharged to 100% SOC.

10.7 Inspection Interval and Recharge Program Table

| Storage Temperature | Inspection Interval | Recharge Program |
|---------------------|---------------------|---|
| -10C – 0C | Every 6 Months | The modules must be heated up to at least 15°C before charge & discharge operation; |
| 0C – 24C | Every 6 Months | |
| 25C – 30C | Every 4 Months | Refer to the Charge Procedure in the following section |
| 31C – 35C | Every 3 Months | |
| 36C – 40C | Every 2 Months | |

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%

10.8 Stored battery Charge Procedure

- 10.8.2 Every 6 months modules should be charged during storage if the module voltage measures 52V or below.
- 10.8.3 For installed systems, the UPS/Charger should be used where possible. If the UPS is not

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available and if the system has not been installed, module level charging can be performed as follows.

10.8.4 Tools needed

- 60v power supply
- Multimeter
- Cables

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

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

10.8.7 Connect the battery to the Power Supply.

10.8.8 Turn ON the Power Supply.

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

11. Component installation

| | |
|---|---|
|  | <p>The following Instructions are for installation of components that are usually pre-installed. Follow these instructions if these components were removed during installation or if the components were shipped separately.</p> <p>These installation instructions can also be used as a reference when replacing components.</p> |
|---|---|

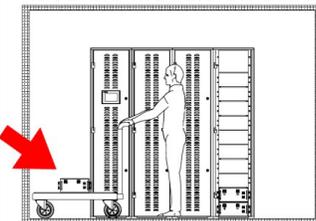
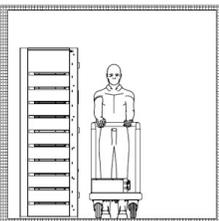
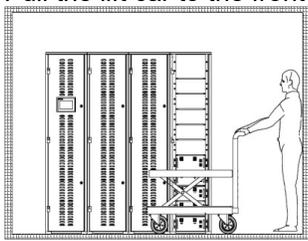
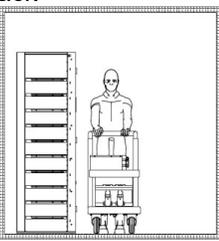
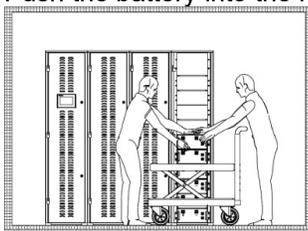
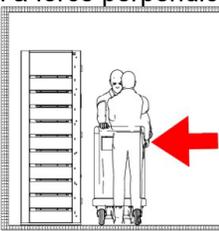
11.1 Battery Module installation (Pre-installed)

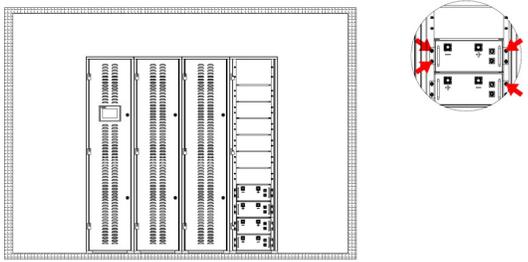
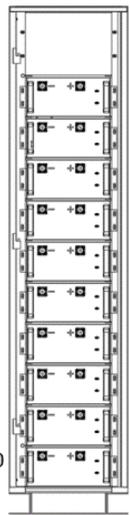
| | |
|---|---|
|  | <p>WARNING</p> <ul style="list-style-type: none"> <input type="checkbox"/> Only insulated tools should be used. <input type="checkbox"/> A battery lift is recommended due to the weight of the modules. |
|---|---|

11.1.1 Transport battery modules to the installation location and then lifting and placing of the battery modules according to the installation diagram.

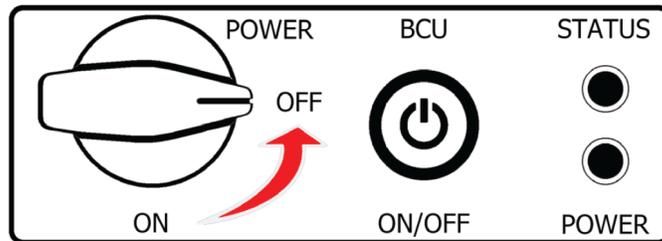
11.1.2 Install Battery Modules from the bottom up.

Table 11-1 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>   | |

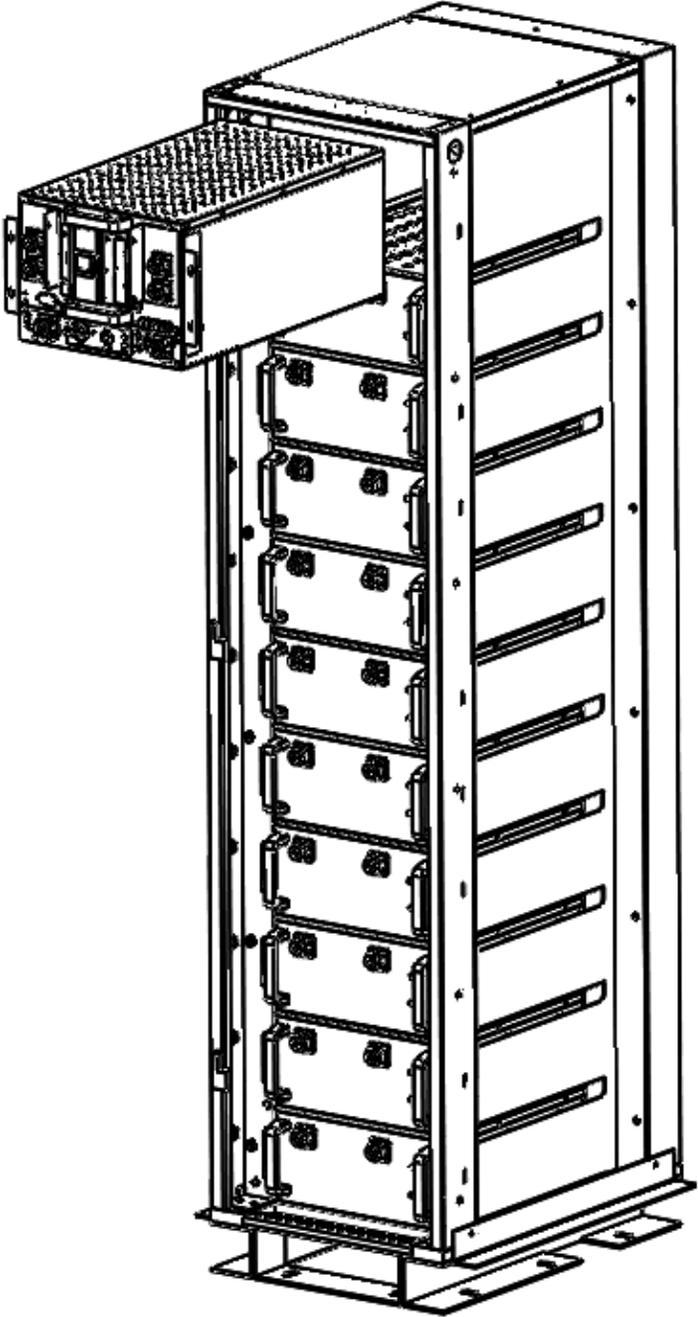
| | |
|---|---|
| 4 | <p>Attach each to the rack with four M6 x 15L bolts After the module is inserted in the rack (Torque: 9 Nm)</p>  |
| 5 | <p>Repeat steps 1 to 5 until all battery modules are populated into the rack</p>  |

11.2 Control Box Installation (Pre-Installed)



| | |
|---|--|
|  | WARNING |
| | <ul style="list-style-type: none"> ▪ The Isolation switch in the Control Box should be in the —OFF position during installation. ▪ Verify both green status lights are —OFF ▪ Attach each Control Box to its cabinet with four M6 x 25L screws with torque of 8 Nm. |

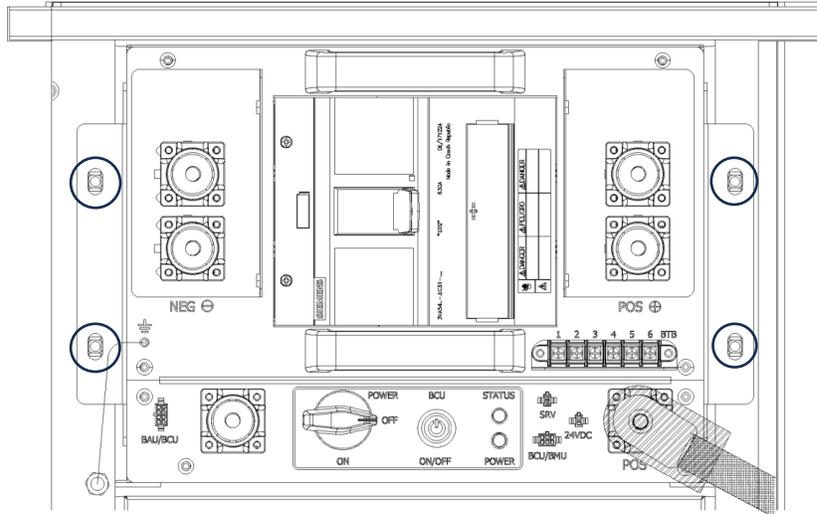
Table 11-2 The Steps for Control Box Placing

| Steps | Control Box Placing |
|-------|--|
| 1 | <p data-bbox="380 367 1315 441">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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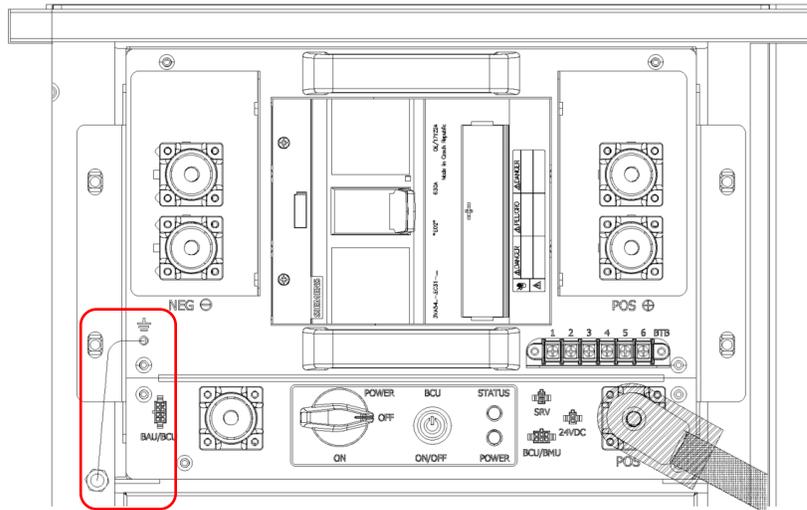
2

Secure the control box in the rack using the four M6 bolts. Fastening torque is 8 Nm.

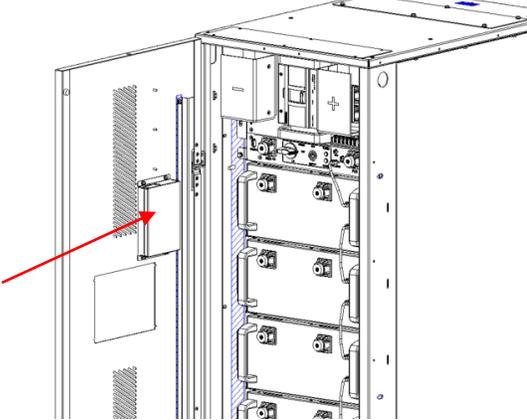
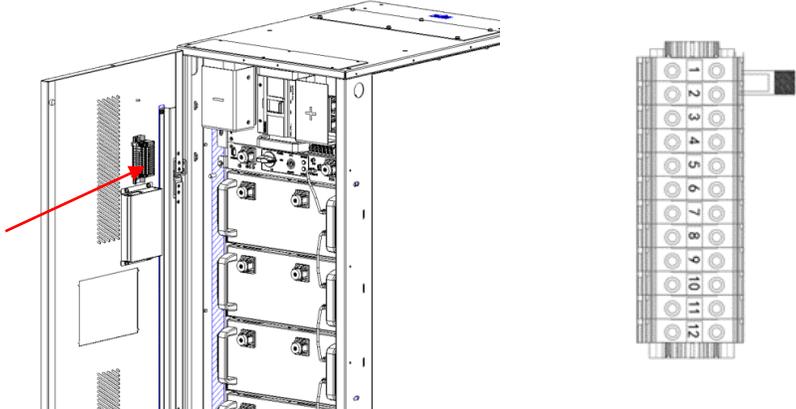
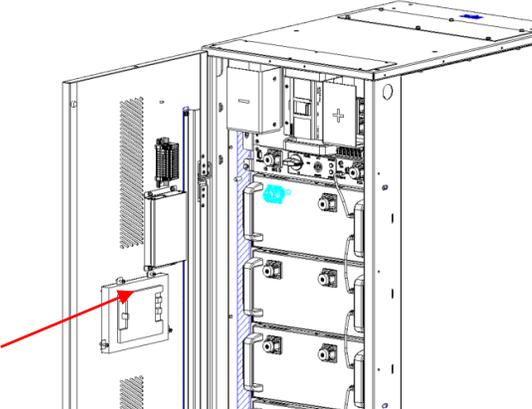


3

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.



11.3 BMS installation (Pre-Installed)

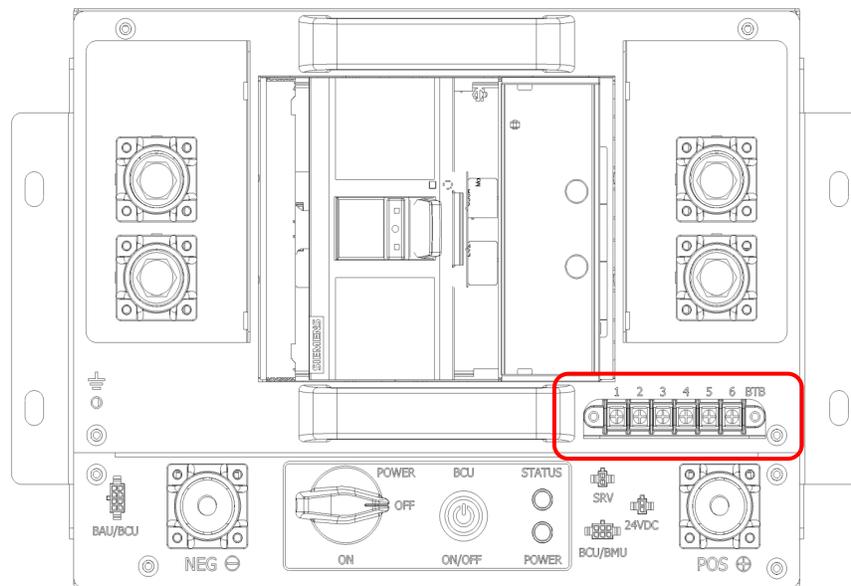
| Steps | BAMS Placing |
|-------|---|
| 1 | <p>Install the BAU component of the BMS in the designated position on the door using 4x M4 Nuts. Torque to 2.8Nm</p>  |
| 2 | <p>Attach the Dry Contacts terminal Block to the Door using 2x M4 nuts. Torque to 2.8Nm.</p>  |
| 3 | <p>Install the HMI in the designated 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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12. Circuit Breaker Accessories

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

| | |
|---|---|
|  | <p>Note: the necessary accessories are determined by the UPS requirements. Check for which accessories are needed in the UPS documentation or by contacting the UPS manufacturer.</p> |
|---|---|

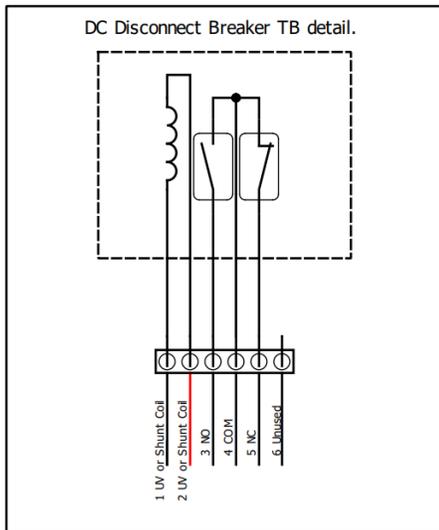


- 12.1 **Aux Contact** is used to check if the Circuit Breaker is in Open or Closed position.
- 12.2 **UVR** – Under Voltage Release. UVR requires DC voltage (24V or 48V) to be constantly supplied to keep the breaker in the closed position. Once the Voltage is removed the UVR will open the breaker.
- 12.3 **Shunt Trip** – Works 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.

| | | | | |
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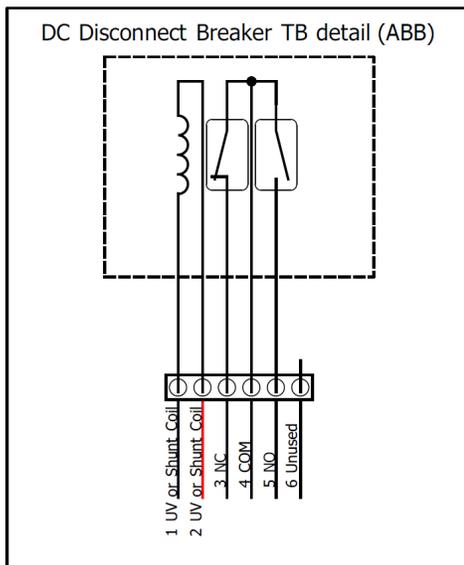
12.4 Accessories Pinout (**Siemens Breaker**)

- 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**

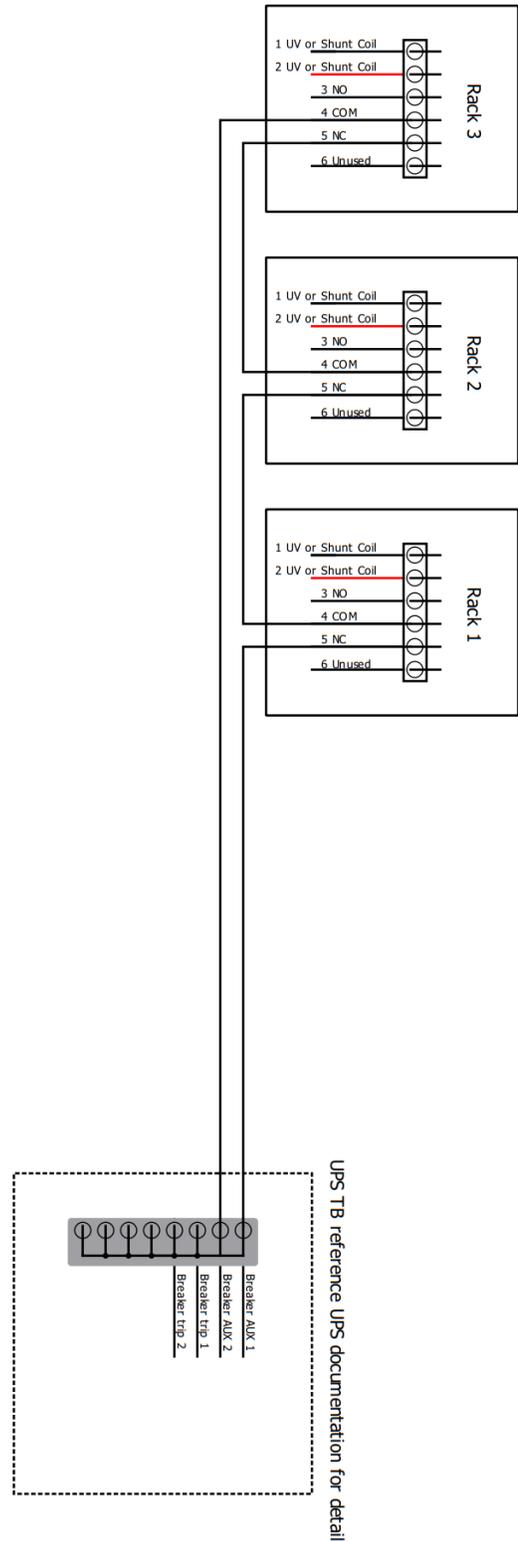
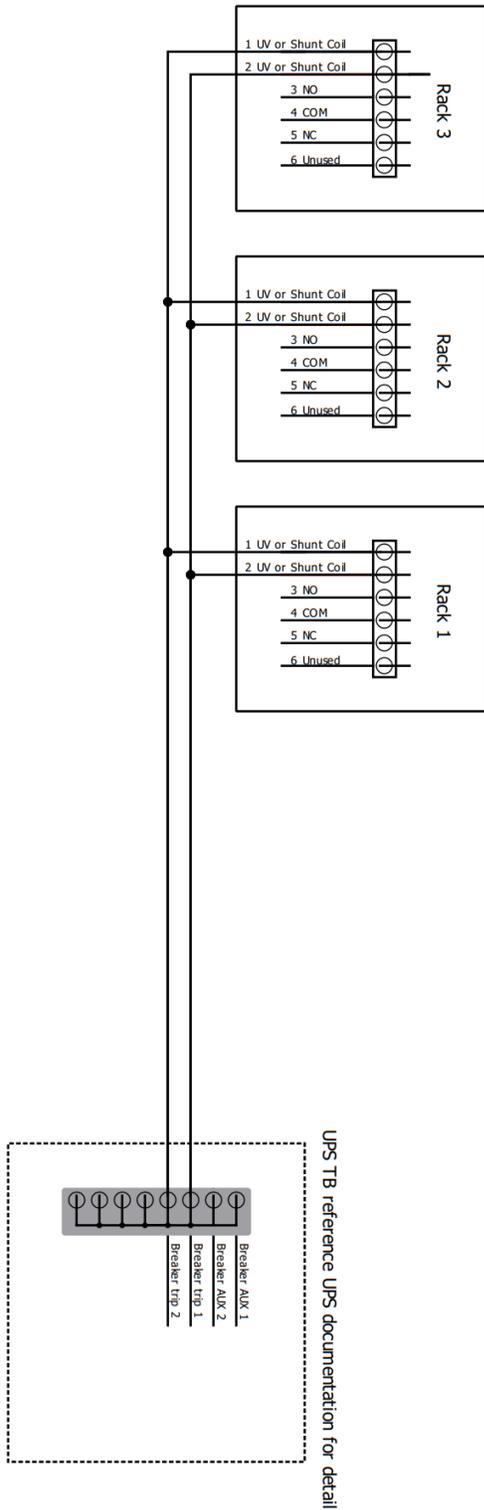


12.5 Accessories Pinout (**ABB Breaker**)

- 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**



12.6 Accessories Multi-Rack Wiring (Siemens Breaker).
 12.6.1 For ABB breaker follow pinout as specified in 11.5.



13. Dry Contacts and E-Stop

E-Stop feature can be utilized by the UPS 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 Number | 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 | High Cell Voltage | Alarm | Cell over voltage Alarm | Normally Closed | HCV - High Cell Voltage |
| 7 and 8 | Any | Critical | Any Critical alarm | Normally Closed | ANY Critical Alarm |
| 9 and 10 | Low String 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 |

13.1 Dry contacts terminal block connection diagram

