
	Date	Revision	File Name	Page
	Jan 25, 2024	6	MPITD-MAN-SRV-5125528.doc	(1/15)
Description / Title	<b>MPLHP-5125528 Service Manual</b>			

# LiFePO<sub>4</sub> – **MPLHP51255 Battery System** Service Manual



	Date	Revision	File Name	Page
	Jan 25, 2024	6	MPITD-MAN-SRV-5125528.doc	(2/15)
Description / Title	<b>MPLHP-5125528 Service Manual</b>			

**Read this manual carefully.**

**Retain these instructions for reference.**

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	Date	Revision	File Name	Page
	Jan 25, 2024	6	MPITD-MAN-SRV-5125528.doc	(3/15)
Description / Title	<b>MPLHP-5125528 Service Manual</b>			


Table 11-1 History of Version Upgrade

Version	Date	Change
V 1.0	13/07/2021	Document Created
V1.1	17/01/2022	Added sections 1,2,3,4
V1.2	27/01/2022	Edits to sections 1, 4, 5, 6
V2.0	09/03/2022	Added storage and charge sections
V3.0	9/26/2022	Updated version
V4.0	1/30/2023	Updated format, file name and system image
V5.0	05/03/2023	Updated inspection and charge procedure
V5.1	08/04/2023	Added rack differential recovery and update charge procedure

	Date	Revision	File Name	Page
	Jan 25, 2024	6	MPITD-MAN-SRV-5125528.doc	(4/15)
Description / Title	<b>MPLHP-5125528 Service Manual</b>			

## Contents

Important Safety Instructions .....	5
1. Battery System Indicators .....	8
2. Maintenance Recommendations .....	9
3. Warranty .....	10
4. Charge and Balance Procedure .....	10
4.1 Charge Procedure .....	10
4.2 Balancing .....	11
5. Storage Guidelines .....	11
5.1 Definition of Storage .....	11
5.2 Temperature Range .....	11
5.3 Relative Humidity .....	11
5.4 Storage-Preinstallation Condition .....	11
5.5 Inspection Interval and Recharge Program Table .....	12
5.6 Charge Procedure .....	12
6. Troubleshooting .....	12
7. Repair or Replacement Procedures .....	14
8. Frequently Asked Questions .....	15

	Date	Revision	File Name	Page
	Jan 25, 2024	6	MPITD-MAN-SRV-5125528.doc	(5/15)
Description / Title	<b>MPLHP-5125528 Service Manual</b>			

## 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.

MPLHP 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.




### **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.

	Date	Revision	File Name	Page
	Jan 25, 2024	6	MPITD-MAN-SRV-5125528.doc	(6/15)
Description / Title	<b>MPLHP-5125528 Service Manual</b>			



### **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!

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.

	Date	Revision	File Name	Page
	Jan 25, 2024	6	MPITD-MAN-SRV-5125528.doc	(7/15)
Description / Title				
<b>MPLHP-5125528 Service Manual</b>				

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 23-25Nm (203-220 in-lbs.) using a M10 hex head screws. The BMS and cabinet disconnect control box power connections torque is 23-25Nm (203-220 in-lbs.) 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.

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	 

	Date	Revision	File Name	Page
	Jan 25, 2024	6	MPITD-MAN-SRV-5125528.doc	(8/15)
Description / Title	MPLHP-5125528 Service Manual			

## 1. Battery System Indicators

### 1.1 Main Control Box Power Disconnect Switch

- 1.1.1 This switch can be found on the front of the control box on each string in the system. The black knob, shown in image below, controls main string level power. When in the “Off” position all BCU/BAU power will be disconnected, and both the “Status” light and “Power” will be off.
- 1.1.2 When the switch (1) is turned to the “On” the BCU of that string will now be getting the required voltage. However, the BAU and HMI screen will not be powered up during this step. Completion of this step will give you a Green light for “Power” no light for “Status” signifying the system is powered on but not online.
- 1.1.3 To power the BAU and HMI, String 1 in the system will need to have the On/Off switch shown as #2 in image below depressed. Once pushed, the “Status” light will light up Red and “Power” light will remain green. This signifies a properly powered up system. You will hear a beep from the HMI and it will illuminate. Follow this procedure for all strings in the system to allow all BCU’s to communicate to the BAU/HMI.



### 1.2 Powering Up the BCU and BAU

- 1.2.1 Two green lights (Status and Power) Signify the BCU and BAU/HMI systems are properly powered internally (DC power BMS), and the system contactors are closed. These lights do not have any relation to battery alarms, battery health, or battery operation.



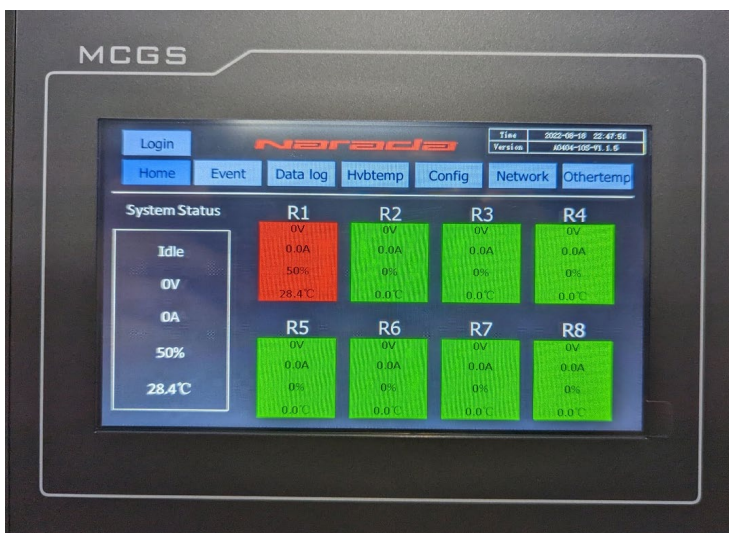
## 2. Maintenance Recommendations

### 2.1 Daily or Weekly Inspection List – Recommended

- Check Status and Power Lights – Both Green
- Ensure Breaker is in Closed/On Position
- View alarm list via HMI (steps shown below)




- If there are alarms, please note them and contact your service provider or MPINarada directly at [Tech@MPINarada.com](mailto:Tech@MPINarada.com)
- Maintain Humidity and Temperature settings for proper operation
- Validate string float voltage for each string



### 2.2 Annual Battery PM – Required

- Measure and record the following for each string
  - Rack Voltage
  - Max Cell Voltage

	Date	Revision	File Name	Page
	Jan 25, 2024	6	MPITD-MAN-SRV-5125528.doc	(10/15)
Description / Title	<b>MPLHP-5125528 Service Manual</b>			

- Min Cell Voltage
  - String Temperature
  - Current
  - State of Charge (%)
  - Max Cell Temperature
  - Min Cell Temperature
  - Active Faults/Alarms
  - Room Temperature
  - Relative Humidity
  - Open Circuit Voltage
- Download the HMI Data File using provided flash drive and email to service provider or direct to MPINarada at [Service@MPINarada.com](mailto:Service@MPINarada.com)
  - Physical Checks to be performed
    - Validate connection integrity of 10% of connections – Re-torque.
    - Validate and inspect communication and wires for defects – replace wires as needed.
    - Inspect connections for excessive heat.
    - Update any software (see configuration manual as needed) – ONLY to be done by trained MPINarada service provider.

### 3. Warranty

#### 3.1 Warranty Overview

Battery system must be stored in 0 – 40C condition, <90% RH, and the above recommended and required maintenance should be followed. Annual PM is required, along with any requirements outlined in formal MPINarada warranty document, to maintain OEM warranty.


#### 3.2 Warranty Requirements

- Submittal for Warranty Requests
- MPINarada Lithium Warranty Form filled out and submitted to [RMA-Warranty@MPINarada.com](mailto:RMA-Warranty@MPINarada.com)
- This does require data and info from the battery system to be completed.

### 4. Charge and Balance Procedure

#### 4.1 Charge Procedure

- 4.1.1 Set the UPS charge voltage to 562V and The UPS shut down voltage to 440V. The system will charge and balance until the Min/Max Cell Voltage (VPC) differential is within 0.03V. (Max VPC – Min VPC = Differential)

	Date	Revision	File Name	Page
	Jan 25, 2024	6	MPITD-MAN-SRV-5125528.doc	(11/15)
Description / Title	<b>MPLHP-5125528 Service Manual</b>			

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

#### 4.2 Balancing

The BMU automatically places a small load across the higher voltage cells to drain energy from them until the cell voltages are within 0.03V of each other. This process may take approximately 72 hours after the first start up. Racks will stop the charge for 1 hour for the individual rack when a high cell voltage (3.75V) is detected. The charge contactor will close again when the High cell recovery value (3.45V) has been reached AND 1 hour has elapsed. The rack is available for discharge during this time.

## 5. Storage Guidelines

### 5.1 Definition of Storage

Battery modules are in open circuit state without connecting to any electrical devices, kept under specific conditions and retain the ability to perform a specified function.

### 5.2 Temperature Range


- Battery module has passed UN38.3 certification. In thermal rest test, battery modules are stored for at least 12h at  $72\pm 2^{\circ}\text{C}$ , followed by storage for at least 12h at  $-40\pm 2^{\circ}\text{C}$  with a maximum time interval of 30min between test temperature extremes, and the procedure is repeated until 10 total cycles are complete.
- Battery module can accept high temperature up to  $90^{\circ}\text{C}$ , same as that in the factory aging test which can last 7 days as a regular process at this temperature.
- Battery modules can be kept at  $-10^{\circ}\text{C}$  minimum condition without damage but must be heated up to  $15^{\circ}\text{C}$  before charge & discharge operation.

### 5.3 Relative Humidity

The relative humidity during shipment shall not be higher than 95%.

### 5.4 Storage-Preinstallation Condition

- Acceptable Storage temperature range:  $-10^{\circ}\text{C}$  to  $40^{\circ}\text{C}$ , recommended storage temperature range:  $15^{\circ}\text{C}$  to  $30^{\circ}\text{C}$ .
- The delivered battery modules are at about 50% SOC.
- Battery recharge is required to recover capacity loss due to self-discharge during storage and transportation before operation.
- During long-term storage, which means the storage period is over 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 battery will be increased to 100%

	Date	Revision	File Name	Page
	Jan 25, 2024	6	MPITD-MAN-SRV-5125528.doc	(12/15)
Description / Title				
<b>MPLHP-5125528 Service Manual</b>				

## 5.5 Inspection Interval and Recharge Program Table

Storage Temperature	Inspection Interval	Recharge Program
-10C to 0C	Every 6 Months	The modules must be heated up to at least 15°C before charge & discharge operation;
0C to 24C	Every 6 Months	Refer to the Charge Procedure in the following section
25C to 30C	Every 4 Months	
31C to 35C	Every 3 Months	
36C to 40C	Every 2 Months	
<p><b>Notes:</b>  <b>If during inspection a module voltage is measured below 52.0V this module needs to be recharged. Reinspect after 6 months.</b>  <b>Modules measuring above 52.0V during initial inspection should be inspected in 2 months increments.</b></p> <p>Relative Humidity must be ≤45%  SOC must be between 5-% and 80%</p>		

## 5.6 Charge Procedure

- 5.6.1 Every 6 months modules should be charged during storage if the module voltage measures 52V or below.
- 5.6.2 Tools needed:
  - Module - 51.2V modules
  - 60v power supply
  - Multimeter
  - Cables
- 5.6.3 Set Power supply to 56V – WARNING a higher setting will damage battery.
- 5.6.4 Set current limit to 0.2C which is 11A.
- 5.6.5 Connect battery to power supply.
- 5.6.6 Turn on power supply.
- 5.6.7 Charge until current goes down to 2A or below.
- 5.6.8 Charging is complete.

## 6. Troubleshooting

### 6.1 Troubleshooting Overview

The battery system must be operated within its operating conditions If repair is required, it must be authorized technicians handling the battery system repair work. If there are any functional


or communication issues or questions that go beyond what this manual describes please contact your service provider or MPINarada directly immediately.

## 6.2 Alarm Table and Action List

Alarm code	Alarm list	Alarm level	Alarm Description	Action
001	Cell over-voltage	Warning	Cell over-voltage warning	None
002	Cell under-voltage	Warning	Cell under-voltage warning	None
003	Under total voltage	Warning	Under total voltage warning	None
004	Over total voltage	Warning	Over total voltage warning	None
005	Charge over current	Warning	Charge over current warning	None
006	Discharge over current	Warning	Discharge over current warning	None
007	Charge over temp.	Warning	Charge over temp. warning	None
008	Charge under temp.	Warning	Charge under temp. warning	None
009	Discharge over temp.	Warning	Discharge over temp. warning	None
010	Discharge under temp.	Warning	Discharge under temp. warning	None
011	Insulation low	Warning	Insulation low warning	None
012	Large difference of total voltage	Warning	Large difference of total voltage warning	None
013	Large difference of temperature	Warning	Large difference of temperature warning	None
014	Large difference of cell voltage	Warning	Large difference of cell voltage warning	None
015	BMU communication failure	Critical	BMU communication failure critical	None
016	BAU communication failure	Critical	BAU communication failure critical	None
017	Cell over-voltage	Alarm	Cell over-voltage alarm	Dry Contact Alarm
018	Cell under-voltage	Alarm	Cell under-voltage alarm	Dry Contact Alarm
019	Under total voltage	Alarm	Under total voltage alarm	Dry Contact Alarm
020	Over total voltage	Alarm	Over total voltage alarm	None
021	Charge over current	Alarm	Charge over current alarm	None - alarm button shown RED or stack shows RED
022	Discharge over current	Alarm	Discharge over current alarm	None - alarm button shown RED or stack shows RED
023	Charge over temp.	Alarm	Charge over temp. alarm	None - alarm button shown RED or stack shows RED
024	Charge under temp.	Alarm	Charge under temp. alarm	None - alarm button shown RED or stack shows RED
025	Discharge over temp.	Alarm	Discharge over temp. alarm	None - alarm button shown RED or stack shows RED
026	Discharge under temp.	Alarm	Discharge under temp. alarm	None - alarm button shown RED or stack shows RED
027	Insulation low	Alarm	Insulation low alarm	None - alarm button shown RED or stack shows RED - Alarm buzzer
028	Large difference of total voltage	Alarm	Large difference of total voltage alarm	None - alarm button shown RED or stack shows RED - Alarm buzzer
029	Cell over-voltage	Critical	Cell over-voltage critical	Contactor open, once parameter recover, contactor close
030	Cell under-voltage	Critical	Cell under-voltage critical	Contactor open, once parameter recover, contactor close (Special low one time cell voltage of 2.0V)
031	Under total voltage	Critical	Under total voltage critical	Contactor open, once parameter recover, contactor close
032	Over total voltage	Critical	Over total voltage critical	Contactor open, once parameter recover, contactor close
033	Charge over current	Critical	Charge over current critical	Contactor open, once parameter recover, contactor close
034	Discharge over current	Critical	Discharge over current critical	Contactor open, once parameter recover, contactor close
035	Charge over temp.	Critical	Charge over temp. critical	Contactor open, once parameter recover, contactor close
036	Charge under temp.	Critical	Charge under temp. critical	Contactor open, once parameter recover, contactor close
037	Discharge over temp.	Critical	Discharge over temp. critical	Contactor open, once parameter recover, contactor close
038	Discharge under temp.	Critical	Discharge under temp. critical	Contactor open, once parameter recover, contactor close
039	Insulation low	Critical	Insulation low critical	Contactor open, once parameter recover, contactor close
040	Large difference of total voltage	Critical	Large difference of total voltage critical	Contactor open, once parameter recover, contactor close

### 6.2.1 Understanding Alarms

- Critical Alarms cannot be changed and are urgent to the health and safety of the system, if critical alarms are present, please contact your service provider or MPINarada directly right away.
- Warning Alarms should not be changed and are serious to the health and safety of the product. If warning alarms are present, they should be noted and presented to your service provider or MPINarada directly.
- Alarm level alarms are not critical to health and safety but should still be noted and presented to your service provider or MPINarada directly.

	Date	Revision	File Name	Page
	Jan 25, 2024	6	MPITD-MAN-SRV-5125528.doc	(14/15)
Description / Title	<b>MPLHP-5125528 Service Manual</b>			

- Alarms are latching and will exist until the state is no longer present. Each alarm has a rest value that will clear the alarm. All alarms are stored in the History tab on the HMI and stored and collected in the USB Data download

### 6.2.2 Discharge Alarms

Understand that alarms present during discharge are normal. The system is intelligent enough to disconnect itself in case of emergency and will do so without human interaction. If alarms are present, please record them and send to your service provider.

### 6.3 Software Update

Only to be performed by MPINarada trained and designated service team. Please refer to configuration manual as needed.

## 7. Repair or Replacement Procedures

### 7.1 BAU Replacement

If the BAU is determined to be faulty, a new unit will be provided and is plug and play. No service software will be needed for installation.

### 7.2 BCU Replacement

If the BCU is determined to be faulty, a new unit will be provided and is plug and play. No service software will be needed for installation.

### 7.3 Battery Module Replacement

If a battery module is determined to be faulty, a new unit will be provided. The new module should be charged to match the SOC of the rack which it is going into. Use instructions in section 5.5 to charge module to 100% SOC. If the rack is at a different SOC use a load bank to discharge module to match the rack SOC. The modules are 55-amp hour capacity, for example to set the SOC to 50% SOC you could discharge at 55 amp for 30 minutes. Follow the instructions in the Installation manual for replace the module.

### 7.4 HMI Replacement

If the HMI is determined to be faulty, a new unit will be provided and is plug and play. No service software will be needed for installation.


### 7.5 Information Needed

For all replacements and warranty work please follow the warranty form and provide the information need to ensure the correct equipment is sent.

### 7.6 How to recover from a rack Voltage difference. There two methods to do this:

#### 7.6.1 Using the UPS to charge an individual rack.

- Disable all the racks using the rack disable feature on the HMI.
- Enable the rack with the low voltage.
- Wait for the rack to reach 562V.

	Date	Revision	File Name	Page
	Jan 25, 2024	6	MPITD-MAN-SRV-5125528.doc	(15/15)
Description / Title	<b>MPLHP-5125528 Service Manual</b>			

- Enable the other racks using the rack enable feature on the HMI.

7.6.2 The second method would be used if the UPS must stay on during maintenance. 600v power supply is required for this method. The current limits should be set to 20 amps or less. Technician must wear appropriate PPE for high voltage.

- Disable the rack with low voltage using the rack disable feature on the HMI.
- Connect the power supply to the battery side of the HV control box.
- Set the power supply to 545V and the current limit to 20 amps or less.
- Wait for the current to drop below 2 amps.
- Disconnect power supply from the rack.
- Properly torques the HV control box terminals that were used.
- Enable the rack using the rack enable feature on the HMI.
- The rack should go back online with the other racks.