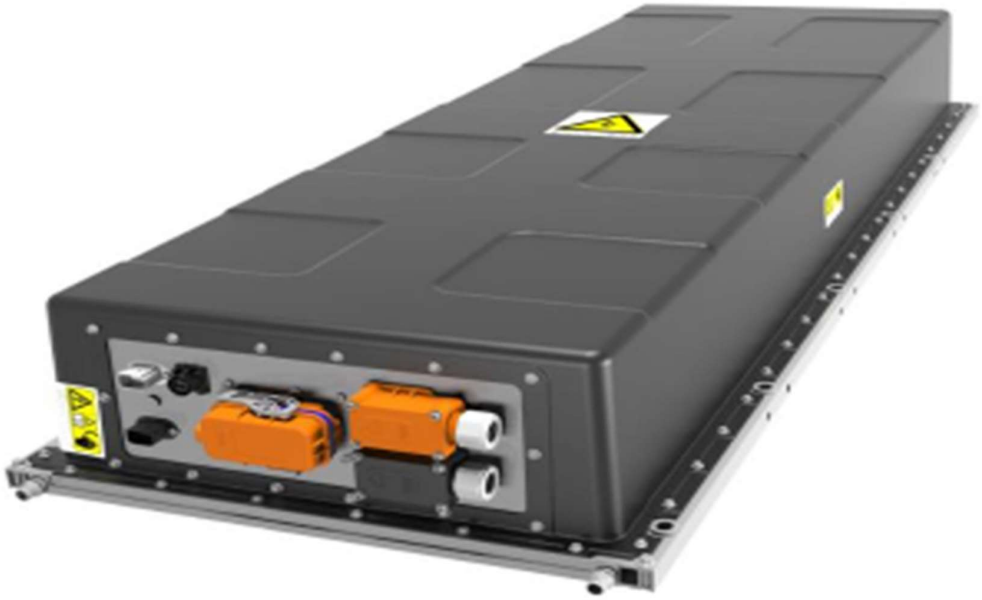
Maintenance of Stored Battery

C/G pack and H pack



Revision	Date	Authors
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1. Introduction

Please read this manual carefully before using this equipment. If you have any questions or comments, please contact CSI for further assistance and support.

Failure to adhere to the outlined recommendations in this document may lead to serious injury, death, damage to battery packs, and voiding of the warranty.

All battery packs should be handled with care using appropriate HV Personal Protective Equipment (PPE) following industry standard HV precautions.

⚠ **Caution: This product uses high voltage and only trained professionals should carry out repairs and maintenance. Read this manual carefully before use.**

2. Personal Protective Equipment (PPE)

All personnel working with high voltage batteries should wear the appropriate personal protective equipment at all times.

Class 0 insulated gloves rated for up to 1,000 VAC are recommended when working with the battery pack systems. Boots with non-conductive, electrical shock-resistant soles and heels are also suggested as added protection.

⚠ **Attention: HV gloves should be checked for integrity before each use and tested every 6 months to ensure insulating properties are intact. If gloves show signs of damage or excessive wear, they should be disposed of immediately.**

3. Tools and Equipment

Charging batteries requires a power supply with enough capacity to charge a battery to 70% SOC.

A battery discharger may also be needed if batteries are charged over 70% SOC for long term storage.

A CAT III rated Multimeter rated for 600V is required to measure voltage of the battery pack to determine State of Charge (SOC)

Insulated hand tools are also needed to remove and install the MSD and HV cables. ¼" drive socket and ratchet, screwdriver, and pliers are recommended.

A 3/8" drive torque wrench is also needed to secure the battery terminal hardware.

4. Storage environment requirements

Battery pack SOC should be measured every 3 months to ensure the is no excessive drain due to environmental changes and to maintain battery warranty.

Battery packs should be stored in a cool, dry environment away from direct sunlight and the elements.

Optimal storage conditions to maximize battery life:

- Storage environment temperature 25C-35C (77F-95F)
- If batteries are stored in temperatures above 35C, climate controlled storage is highly recommended to reduce the risk of diminished capacity.
- Storage environment humidity 10%-85% Relative Humidity
- SOC 40%-70% SOC

Recommended Storage time (based on SOC):

- Up to 3 months at 40% SOC
- Up to 6 months at 60% SOC

Caution: Battery work area must be free of corrosive or explosive chemicals, conductive dust, and heat sources.

Battery storage location should be equipped with cameras, building sprinklers, and fire/smoke detectors.

Note: Contact your local fire authority for any additional requirements per local ordinances.

5. Charging Procedure

Precautions:

- Touching the Positive and Negative battery terminals simultaneously should be avoided at all times even with MSD removed.
- The MSD should not be installed when working on the Positive or Negative Battery terminals or cables.
- Personnel working on HV battery systems must be HV certified and trained on proper use of PPE and HV protocols.
- Metal jewelry (Watch, bracelet, rings, Etc.) Should be removed prior to working on Battery system.
- Charging the battery system requires staff on duty during the entire procedure to monitor battery and charger. **Battery system should not be left unattended while charging.**
- The battery work area should be cordoned off to keep unauthorized personnel away from HV.

Connecting the Charger

Before connecting the charger cables to the battery, ensure the MSD is removed and Both the AC and DC breakers on the charger are in the OFF position.

With the MSD removed, install the MSD Safety cover (CSI P/N 360340-00475) Shown in Fig. 1

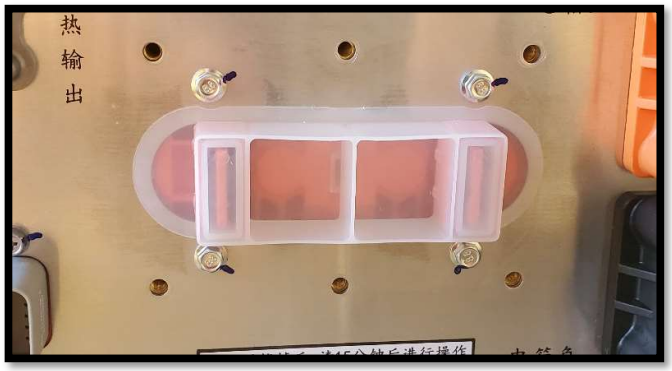

Fig. 1 MSD Safety cover

Install Cables

Install the Negative cable onto the Battery HV terminal using the supplied hardware on the pack, then install the Negative cable into the battery charger. Twist the cable to lock the cable into the charger.

Install the Positive cable onto the Battery HV terminal using the supplied hardware on the pack, then install the Positive cable into the battery charger. Twist the cable to lock the cable into the charger.

Danger! Do not touch the positive and Negative battery terminals simultaneously under any circumstance.

Note: Torque the battery terminal bolts to 30N.m (22Lb-Ft)

Using the appropriate PPE, remove the MSD Safety Cover (P/N 360340-00475) and install the MSD.

Power on the battery charger, turn on the AC circuit breaker, turn on the DC circuit breaker, and begin charging by following the on-screen prompts.

Charger Settings

Using the Battery charger (CSI P/N **PACKCHG-002 Fig. 2)** we will need to adjust the settings to achieve our target SOC of 70%.

Fig. 2 Battery Charger

Note: H Pack (1P96S) 228Ah cannot be charged using battery charger PACKCHG-002

Example settings using C pack (1P63S) 173Ah for calculations

Assumptions:

Pack Capacity: 173Ah

Present voltage: 207.018VDC

Target SOC 70%

The voltage of a single cell is 207.018VDC/63 = 3.286, according to Fig. 2 the SOC = 30%

Charging capacity = (SOC target – SOC present) * Nominal Capacity

Target SOC=70%=3.328VDC

Charging Capacity: (70%-30%)*173Ah= 69.2Ah

Charging time 6.92 Hours (Theoretical charge time 69.2Ah/10A=6.92 Hours)

Charger Parameter settings:

PACK/Module number: default
Nominal Capacity: 173Ah
Battery type: Lithium iron phosphate
Cell Qty: 63
Cell voltage difference: 0 mV
CC Charge voltage: 209.664V (VSOC=70%=63*3.328V=209.664V)
Protection voltage: 218.35V
CC Charge current: 10A
Current threshold: 0.5A
Charging time 6.92 Hours (Theoretical charge time 69.2Ah/10A=6.92 Hours)

Cell high voltage: button off
Capacity set: 69.2Ah
SAVE→ Charging test

Charging to 70% SOC

The table below in Figure 3 gives the target voltage to reach 70% SOC for storage for different battery packs.

If a different SOC is desired, proceed to section 5.1 to determine values needed for various SOC ranges.

Battery Pack	Number of cells	Nominal Voltage (in VDC)	Capacity (in Amp Hours)	Target Voltage (70% SOC)	PACKCHG-002
H Pack (1P72S)	72	230.4	302Ah	239.616	X
H Pack (1P96S)	96	307.2	228Ah	319.488	N/A
C Pack (1P36S)	36	115.2	302Ah	119.808	X
C Pack (1P48S)	48	153.6	228Ah	159.744	X
C Pack (1P63S)	63	201.6	173Ah	209.664	X
G Pack (1P30S)	30	96	302Ah	99.84	X
G Pack (1P39S)	39	124.8	228Ah	129.792	X
G Pack (1P54S)	54	172.8	173Ah	179.712	X

Fig. 3

Caution: The battery and charger should not be left unattended during charge cycle.

Once the Charge cycle is complete, Shut-off the AC and DC breakers on the charger and

allow the battery to sit for 1 hour for the voltage to settle.

Using a CAT III Multimeter, measure battery voltage and determine new SOC. Place the battery back into storage and record the charge event for warranty.

5.1 Calculating State of Charge (SOC)

In order to calculate SOC, we need to have some information about this battery pack. We will need to determine battery capacity in Amp hours (Ah), number of cells, and nominal voltage.

All of this information can be found using the name plate affixed on the battery pack. An example of this name plate is found in Fig. 4

Fig. 4 Battery data plate
Line 4 shows pack P/N which includes Ah rating

Calculating capacity

Begin by confirming battery nominal capacity in Amp hours (Ah), each battery pack is equipped with a label that has battery information.

The formula used is: Ah=kWh/V

Using this H01 battery pack as an example: 70,470Wh /309.12VDC=227.97Ah we will round up to 228Ah.

Calculating Number of cells.

The formula used to find the number of cells is:

# of Cells = System Voltage (On name plate)/3.22Vdc (nominal Cell voltage)

For this example: 309.12VDC/3.22VDC= 96 cells

This example shows that our 228Ah H01 pack has 96 cells in series.

Cell Voltage calculation

Using the information we gathered in the previous steps, we can use the table in Fig. 5 to calculate SOC by measuring the pack voltage in its current state.

In this example let's use a C pack (1P63S) 173Ah for our calculations:

Nominal Pack voltage: 201.6
Pack Energy: 35kWh
Pack Capacity: 173Ah
Number of Cells: 63
MEASURED VOLTAGE: 207.018

207.018VDC/63 cells = 3.286 VDC per cell = 30% SOC

Using the table in Figure 5, our battery pack is at approximately at 30% SOC in this example.

SOC	Cell Voltage
100%	3.466
95%	3.334
90%	3.332
85%	3.331

80%	3.330
75%	3.329
70%	3.328
65%	3.328
60%	3.327
55%	3.298
50%	3.290
45%	3.289
40%	3.288
35%	3.287
30%	3.286
25%	3.270
20%	3.253
15%	3.229
10%	3.204
5%	3.184
0%	2.795

Fig. 5 SOC Table

If you have questions or need support, please contact CSI directly.