



Maxima Battery Pure Lead & Pure Lead

# Carbon Series

## User Manual



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# FOREWARD

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## Purpose

This manual of MAXIMA Pure Lead series batteries describes the main features and specifications, installation, parameter settings and maintenance.

Please read all the information carefully and keep in a safe place for future reference.




## Intended audience



This document applies to the following readers.

- Sales engineers
- Technical support engineers
- Installation engineers
- Application engineers
- Maintenance engineers

## Symbols list

The following symbols are used in this documents:

Symbol	Indication
 <b>DANGER</b>	Danger that can cause serious injuries or even death.
 <b>WARNING</b>	Used to indicate potential danger, it may cause death or serious injury if not avoided.
 <b>CAUTION</b>	Used to indicate medium or low potential danger, it may be cause of minor or normal injuries.

 <b>attention</b>	Used as a warning of potential dangers, if this information is ignored, it may result to equipment damage, data lost, decrease in equipment's performance and other unpredictable results. This should not provoke any human injuries.
 <b>NOTE</b>	Valuable additional information readers should make note of.

## Manual lost

If you lose this manual, please contact MAXIMA customer service center for soft copy.

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# 1 SAFETY

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## 1.1 Overview

Please read this manual carefully before MAXIMA products. All the safety information listed in the manual can be used as guidance to get the proper equipment.

### Attention

Please pay more attention to the notes marked with dangerous, warning, caution before installation, operation, maintenance.

Those statement marked with special signs do not cover all the safety issues, users should your own situation into consideration.

## Compliance with local laws and regulations

Make sure for compliance with local laws or regulations before you begin.

## Requirements before installation

Only qualified persons with enough training and familiar with all safety regulations should be authorized to install, operate or maintain MAXIMA products.

- Installation, operation or maintenance only can be performed by authorized personnel.
- Only authorized personnel should dismantle or repair MAXIMA products.
- Only authorized personnel should replace the components of MAXIMA products
- Any problems which could cause safety issues should be reported to the supervisors.
- Product warranty does not cover the damages caused by inappropriate usage.

## Grounding requirement

Follow these instructions to ground the equipment which has grounding requirements:

- Ground before installation, dismantle after ungrounding.
- Keep the grounding conductor secured.
- No operation without a properly grounded conductor.
- Make sure the equipments are grounded securely before operating.

## Human safety

- No operation under thunderstorm weather.
- Electrostatic protection is required and removal of any wearable conductive objects (i.e. watches, wedding bands, necklaces etc.) is considered mandatory to avoid shocks or burns prior to operation.
- Call fire alarm and evacuate immediately in case of a fire.
- Never re-enter a burning building under any circumstances.

## Equipment safety

- Make sure the equipment are securely installed before operation.
- Check the air vents before operation.
- Tools are necessary before install the panel if there is any bolt needs to be fixed.
- Clean the installation room after any maintenance or commissioning from unneeded objects.

## 1.2 Electrical safety

Safety issue about high voltage, large leakage current and cable.

### High Voltage



#### **DANGER**

- It could be fatal when contact occurs between wet objects and high voltage power conductors.
  - Improper operation may cause fire or shock.
- 

### Large current leakage



#### **CAUTION**

Please ground the system before operation to avoid severe equipment damages and/or human injuries.

---

Grounding the equipments to prevent electric shock if the “electric leakage” signs are pasted to the panel or terminal. Maybe: When a high voltage sign is visible grounding the equipment is mandatory to avoid severe equipment damages and/or human injuries.



## Cable

**DANGER**

- Shutdown power before installation or it may cause electric arcs or sparks and provoke eye injuries.
- Keep distance between cables and sockets greater than 30mm otherwise the cable can be aged and damaged under high temperature.

- 
- Power off before installation or dismantling.
  - Check cable labelling before connection.

## Fuse blow

**CAUTION**

Replace any blown fuse with a new one of the same model to ensure proper equipment operation.

---

## 1.3 Flammable air environment

Safety instructions for operation environment.

**DANGER**

No operation under flammable and/or explosive environment.

---

Any electrical operation is extremely dangerous in flammable environment.

## 1.4 Batteries

Safety instructions for battery operation.

**DANGER**

Read the manual carefully before battery installation or operation.

---

It is very dangerous to operate under flammable environment.

- Follow the regulation to prevent any short circuit or electrolyte leakage or loss.
- The leaked electrolyte will corrode the metal and damage the equipment.
- Short circuit caused by improper operation is very dangerous.
- Break the battery circuit if no load or charge for more than 2 weeks.

## Primary protection

Safety instructions for battery installation and operation:

- Use Insulation tools.
- Protect your eyes.
- Do not wearing watches ,bracelets, rings or anything conductors.
- Wear rubber gloves to protect the damage from acid.
- keep the batteries upward while transportation.
- Keep the batteries away form water, fire, heater.
- Charger off while installation or maintenance.
- The batteries should only be used for directed purpose or there is a risk of making the battery leaky, burning even flamed.
- No modification, impact or there is a risk of making the battery leaky, burning or exploding.
- Keep a distance while maintenance or measuring.
- Keep the batteries away from children.

## Short circuit



**DANGER**

Instantaneous large currents caused by short circuit may very dangerous.

---

Shutdown the system and avoid any short circuit which may caused by conductors if it is possible.

## Toxic gases



**attention**

Only sealed batteries should be used. All batteries should be horizontally placed to avoid the release of any inflammable gas which could corrode nearby equipment.

---

Flammable gas may be released while the batteries' operation, please install in a well ventilated place/area.

## Battery temperature



**attention**

Battery will be damaged or leak under high temperature.

---

Check if there is a leakage when temperature above 60°C.

## Battery leakage



If any leakage, clean it properly and blance the leaky acid with weak base, replenish to normal acid levels.

---

Clean any leaked fluids with the following items.

- NaHCO<sub>3</sub> solution.
- Na<sub>2</sub>CO<sub>3</sub> solution.

Follow the manufacturer's instruction to clean any leaked electrolyte.

Wash your body immediately in case of contactwith electrolyte, if serious go to hospital ASAP after wash.

## 1.5 Aerial working(ladder)

Safety instructions for aerial working.

---



Watch out for falling objects during aerial working.

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Follow the these instructions for aerial working:

- Trained and authorized personnel only.
- Apply protective measures to prevent falling.
- Wear helmet and use safety belt.
- Check all lifting equipment before work.

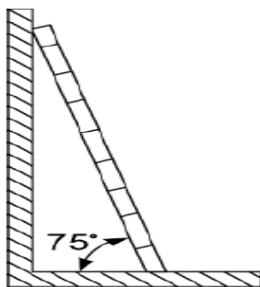
### Checking the ladder

- Check the ladder for any damage.
- Never exceed the maximum load of the ladder.

### Ladder placement

Fix the ladder in steady place with 75°angle, use extra fixing equipment to prevent slipping.

Figure1-1 Instruction for the placement of ladder



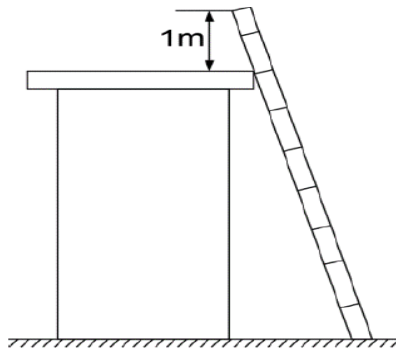
## Catladder

Safety instructions for using a catladder:

- center of body should never deviate out of the edges of the ladder's frame.
- Keep your body balanced and stable.
- Never exceed the 4<sup>th</sup> stairs (from the top to the bottom).

The distance between the top of the ladder and the top floor (vertical height) should be no less than 1 m, for any top floor installations.

Figure1-2 The vertical height of the ladder should no less than 1m from top floor



## 1.6 Mechanical safety

Safety instructions for drilling, lifting and sharp object usage.

### Drilling



No drilling on the battery pack by yourself, it may damage the batteries. Any dust from drilling could cause short circuit or damage the connection performance.

- Wear goggles to protect your eyes.
- Wear gloves to protect your hands.
- Keep the terminals clean, no dust should be on them.

### Sharp tools



Wear gloves to protect your hands.

### Lifting

Wear gloves to protect your hands.

**CAUTION**

- Be careful while lifting.
  - Be careful of heavy components while unpacking.
- 
- Keep your back straight, move smooth while lifting. Do not lift the heavy battery alone.
  - Do not use copper bars or cables to lift the batteries.

## 1.7 Others

### The signal cable

---

**attention**

Separate the signal cables with the others.

---

### Cable installation

Low temperature or vibration could damage the shielding of cables. Follow these regulations to ensure safety.

- All cables should be installed when ambient temperature is above 0°C.
- Relocate the cable in the room temperature for no less than 24 hours if they were stored under 0°C.
- Follow the instructions and operate any cables gently especially under extremely low temperature environments.

# 2 OVERVIEW

## 2.1 Product specification

Figure1-1 Specifications for PLH series

PL H 190 FT (A)  
① ② ③ ④ ⑤

- ① PL—— Maxima pure lead battery
- ② H means long float service life
- ③ Rated capacity 190Ah(final voltage 1.80/cell),norminal voltage 12V(default)
- ④ Front terminal type
- ⑤ (A) means version number

Figure1-2 Specifications for PLX series

PL X 12-400 FT  
① ② ③ ④ ⑤

- ① PL—— Maxima pure lead battery
- ② X means high power series
- ③ Norminal voltage 12V
- ④ Rated power 400W(15 mins rate, final voltage 1.67/cell)
- ⑤ Front terminal type  
Some models will have suffixes (A)

Figure1-3 Specifications for PLC series

PL C 190 FT  
① ② ③ ④

- ① PL—— Maxima pure lead battery
- ② C means long cycle life
- ③ Rated capacity 190Ah(Actual C<sub>10</sub> is a little less than 190Ah, see table 3-4)
- ④ Front terminal type

PL H + C 190 FT

① ② ③ ④ ⑤

- ① PL—— Maxima pure lead battery
- ② H means long float service life
- ③ C stands for Carbon
- ④ Rated capacity 190Ah(final voltage 1.80/cell),nominal voltage 12V(default)
- ⑤ Front terminal type

## 1.2 Product pictures

Figure1-4 Product Pictures



Front terminal battery

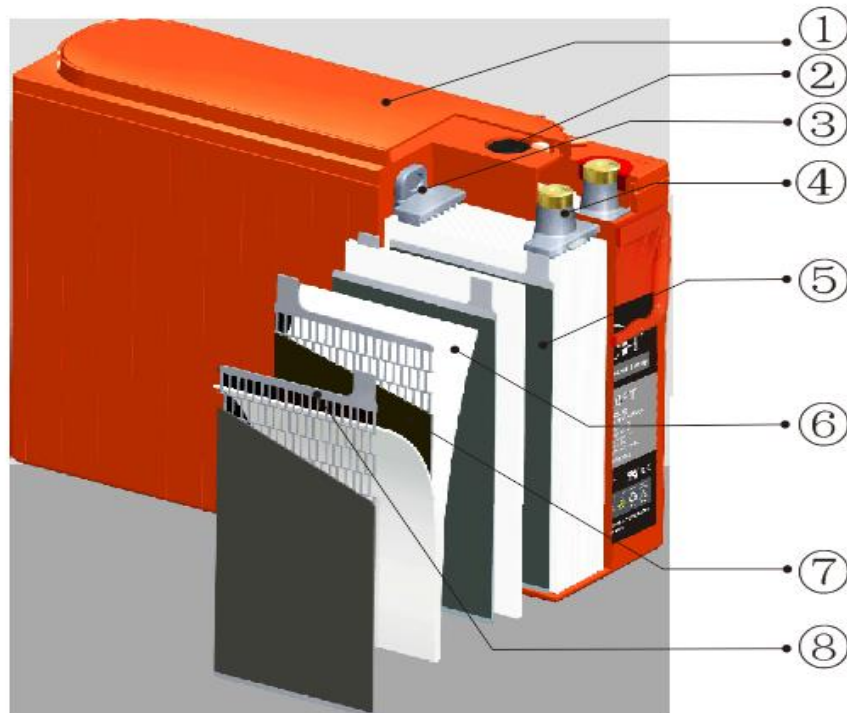
## 1.3 Product characteristics

- VRLA maintenance free.
- Pure lead plate low self discharge.
- 3D plate structure,optimal plate design provides better performance for high power output.
- Special formula and advanced welding technology make sure the excellent discharge power rate(about 20% increasement W/15mr).
- UL94-V0 ABS+PC container more safe.
- Integrated valve design controls water loss,acid fog and improve the explosion-proof performance.
- Oxygen recombination efficiency:≥97%.
- Working temperature -40°C~65°C.
- Long design life.
- Automatic plate making better consistency.

# 3 PRODUCT SPECIFICATIONS

## 3.1 Product structure

Figure1-5 Product structure



- |                 |             |                  |                     |
|-----------------|-------------|------------------|---------------------|
| ① Container     | ② Valve     | ③ Components     | ④ Negative terminal |
| ⑤ Negative grid | ⑥ Separator | ⑦ Positive plate | ⑧ Negative plate    |



Table1-1 Components specification

Part	Function
Grid	Carries the active material and current made by lead alloy, The current will equably spread in it.
Plate	Plate is compiled by the grid and active material. It holds electric power. The service life mostly depends on the plate design and characteristics.
Separator	The separator has a porous design and absorbs most of the electrolyte, so the ions can move from positive to negative plates without allowing the battery shorting circuiting. Separators hold the active material too.
Valve	Keeps water, H <sub>2</sub> O inside the battery for gas recombination and only releases gas above a certain pressure point to prevent the battery from bulging.
Container	Contains the electrolyte, plates etc. Keep the poisonous out and active material in so that the reaction could carry on. Also it helps ventilation. It is made from strong plastic materials with insulating and anti-corrosion properties.
Electrolyte	Electrolyte is a dilute of sulphuric acid made by sulfuric acid and de-ionized water. Main functions of the electrolyte is to participate in the electrochemical reaction by being the conductor in solution between positive and negative ions.

## 1.4 Structure

- AGM separator
 

There are a lot of micro holes in AGM, the Oxygen pass through them and take a part in the recombination reaction. Most of the electrolyte is absorbed in the separator also the AGM helps to increase the pressure when the battery is being built.
- Muti-layer sealing structure
 

PL series battery has unique sealing design makes sure the recombination efficiency more than 97% and no leakage.
- Maintenance free design
 

The consumption of electrolyte is very small because of the advantage of their own institutions, no need to check the proportion of acid and add water etc in using process.
- Vent valve

This kind of exhaust system can release extra air and shut down again automatically, will turn on till air pressure in the shell rise to the limiting value again. This kind of exhaust system improved the efficiency of recombination reaction, ensured that use the PL series which valve controlling lead-acid battery safely.

- Punching thin grid design

Pure lead grid makes sure fast charging ability, thin plate provides more plates and reaction surface improve high power discharge performance.

- Cycle life

Cycle life affected by the deep of discharge.

- Floating charge life

Design life could be 15 years

- Low self-discharge

The self-discharge rate of PL battery is very low under 20°C~25°C. This self discharge rate make storage time can be as long as 24 months.

- Working temperature

-40°C~65°C.

- Advanced automatic product line

High efficiency, reliability and consistency.

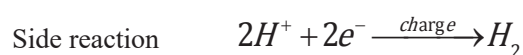
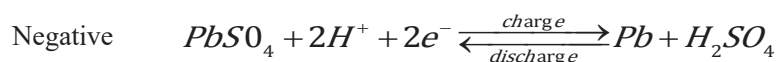
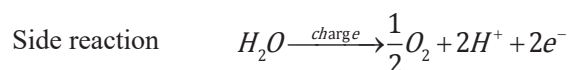
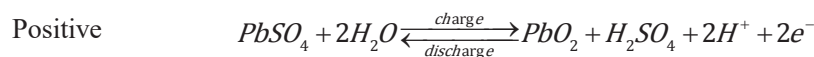
- COS(cast on the strap) and through wall welding

Low internal resistance and better high power discharge performance.

## 1.5 Principle of working

### Principle of reaction

Electrical energy is converted into chemical energy during charging and becomes electrical energy during discharging. The chemical process is shown below.

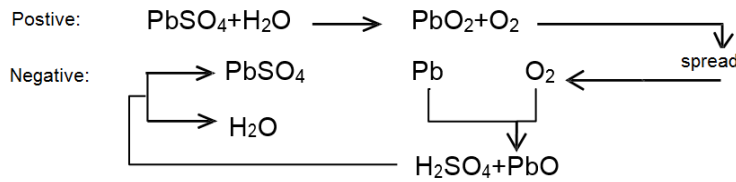


Water is resolved into hydrogen in the negative electrode (starts to evolve when approx. 90% fully charged) and oxygen in the positive electrode (starts to evolve when approx. 70% fully charged) during charging. In the early years battery fail mostly because of

dry out the evolved gas can not recombined again, so it required acid or water refill. The latest VRLA battery overcome this disadvantage gas will be recombined and hydrogen generation controlled too.

## Principle of oxygen recombination

Generally speaking negative plates are designed to have more active material. The oxygen which is generated from the positive electrode will travel through the separators to the negative electrode to oxidize the Pb so hydrogen generation is controlled. This recombination process allows VRLA batteries to have minimal water loss over years of operation making them essentially maintenance free. No refilling is necessary.



The cathode plays a dual role in VRLA batteries. 1. The spongy lead of the plate reacts with oxygen generating from the anode and is oxidized to lead oxide. 2. the lead sulfate of the plate has to accept the electrons which are transferred through the external circuit, react to spongy lead from lead sulfate.

# 4 INSTALLATION GUIDE

---



attention

- No installation when metal dust is present.
  - Do not apply heavy loads on the batteries.
  - Check the connecting point before installation to prevent any short circuit accident.
  - No polarity installation or there will be a risk of short circuit.
  - Always wear insulation protection.
- 

## 4.1 Preparing before installation

### 4.1.1 The installation and operating environment

- Installation location

The batteries should be installed in a dry and clean environment to ensure system and personal safety.

Flammable, explosive and similar dangerous materials or devices are prohibited in the same room. The installation room should be equipped with fire suppressing equipment (such as CO<sub>2</sub> fire extinguishers).

Always keep in mind the structural load of the building and any other structural weigh and force limitations.

- Environment

Operation Temperature range:charge (0~40)°C, discharge (-15~50)°C, storage (-15°C ~40)°C, (20~25)°C is recommended.

Relative humidity: (0% ~95%)RH, non-condensing.

Avoid heat and direct sunlight, avoid high humidity (with condensation) environments.

Altitude: GB3859.2-93.

## 4.1.2 Ventilation

The installation location should be ventilated to avoid accumulation of hydrogen and avoid risk of explosion.

Keep (30~50) cm from the battery bank from each side and 50cm from the top of each side clear.

Please refer to EN 50272-2-2001 Safety requirements for secondary batteries and battery installations chapter 8:

$$Q=v \times q \times s \times n \times I_{\text{gas}} \times C_{\text{rt}} \times 10^{-3}$$

Q—Air flow rate (m<sup>3</sup>/h)

v—Hydrogen dilution requirement, (100%-4%)/4%=24 (tolerance 4%).

q—0.45×10<sup>-3</sup> (m<sup>3</sup>/Ah) evolved hydrogen.

s—safety coefficient s=5.

n—Cells

I<sub>gas</sub>—Quantity of hydrogen/Ah (mA) (1 for floating charge, 8 for equalization charge).

C<sub>rt</sub>—C<sub>10</sub> rated capacity(Ah).

It can be simplified as:

$$Q=0.054 \times n \times I_{\text{gas}} \times C_{\text{rt}} \times 10^{-3}$$

So the minimum area for the ventilation is:

$$A=28 \times Q$$

Q—Air flow rate (m<sup>3</sup>/h)

A—Area (cm<sup>2</sup>) (default air flow speed is 0.1m/s)

Proper ventilation design must be ensured by the installation personnel. Active ventilation is required if the air flow rate is too low.

According to the chinese GB 7260.1-2008 standard section 7.6.7, the manufacturer should do the best to avoid spark on the vent or switch. Isolated battery cabinet or parts are recommended. At least 500mm clearance is recommended between the components that may cause sparks and the batteries venting.

## 4.1.3 Tools

The tools that may be needed are shown in tables 4-1 to 4-4. Installation engineers may use according to the specific circumstances of the installation requirements.

Table4-1 Checklist for tools








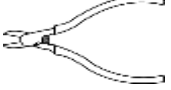
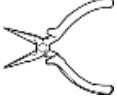







Appearance and name of tools			
Adjustable Wrench	Screwdrivers	Torque wrench	Ratchet
			
Open-End Wrench	Box-End Wrench	Plier	Cutter
			
Needle nose pliers	Marking pen	Measurement tape	Insulated working gloves
			
ladder	Rubber hammer	Power Drill	Vacuum cleaner
			

Table4-2 Transport and packaging tools

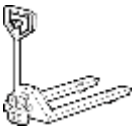

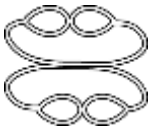

Appearance and name of tools			
Hand fork lifter	Electric fork-lift truck	Lifting rope (Bearing $\geq$ 400kg)	Lever (Bearing $\geq$ 400kg)
			

Table4-3 Electrical installation tools


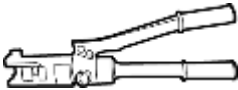
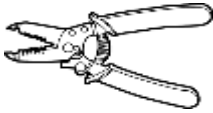
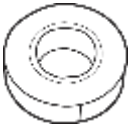

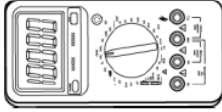
Appearance and name of tools			
Insulating gloves	Power line line clamp	Wire stripper	Insulating tape
			

Table4-4 Tuning tool

Appearance and name of tools			
Clamp Meter	Mutimeter		
			

## 4.2 Initial inspection

**Carrying:** Never allow too much force on the battery terminals to avoid damage of the sealing components. Never put the battery upside down and avoid impact. Never use metallic strings to avoid any short circuit.

**Check:** Packaging and battery appearance for any damage.

**Count:** Battery quantity and accessories.

**Reference material:** Product reference material, such as product manuals, user manuals, installation drawings, etc.

Make sure the components are complete before unpacking. Record anything which is not compliant with your order or may be damaged during transportation. Please contact Leoch customer support immediately.

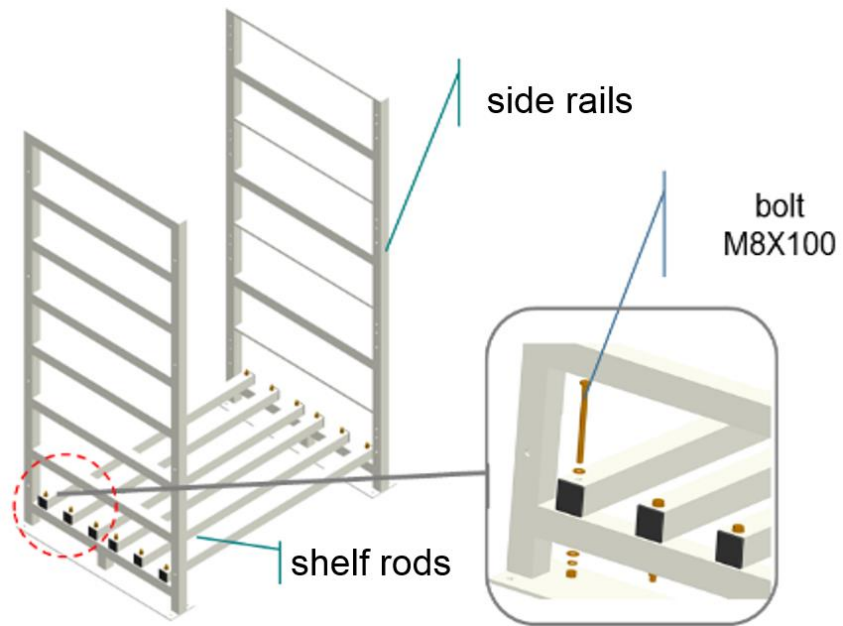
## 4.3 Installation

### 4.3.1 Installing the battery pack

#### Operation steps

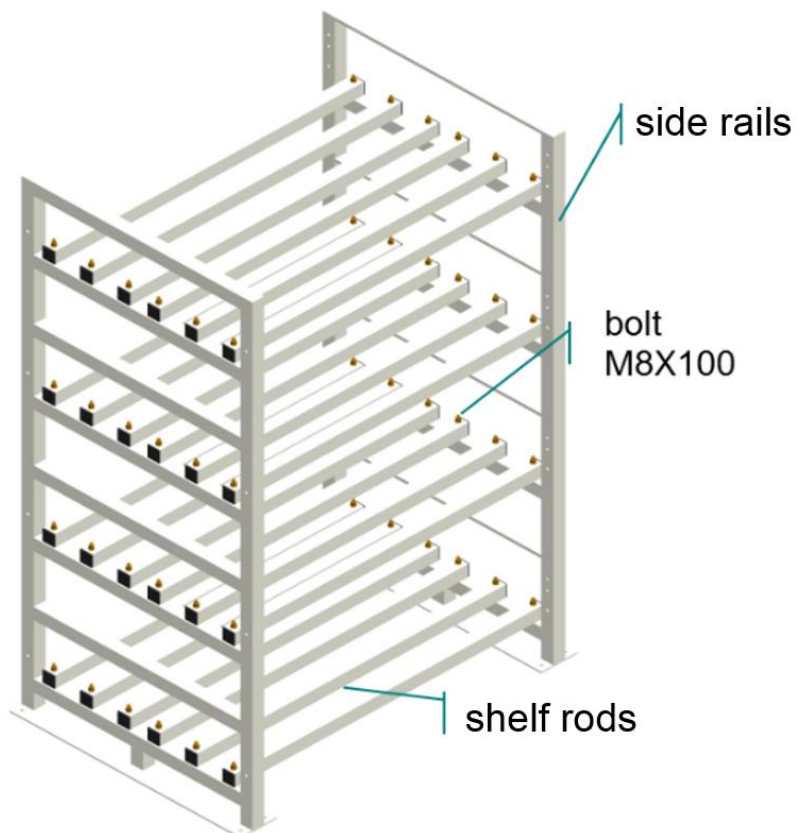
- Step1. Connect the wings siderails of the rack after fix them vertically on the ground with the bolt (M8×100) and stairs.

Figure4-1 Connect the side rails with the bottom shelf rods.



Step2. Install the shelf rods to each layer of the rack and fix them with bolt.

Figure4-2 Installing the shelves



Step3. Install the strip B to the pole of the siderails.



Figure4-3 Install strip B

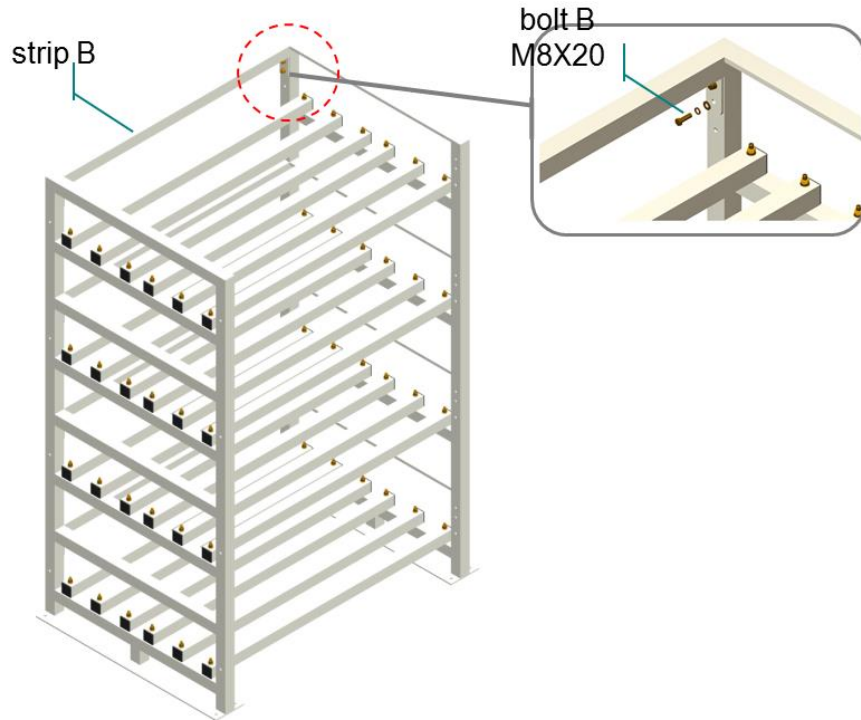
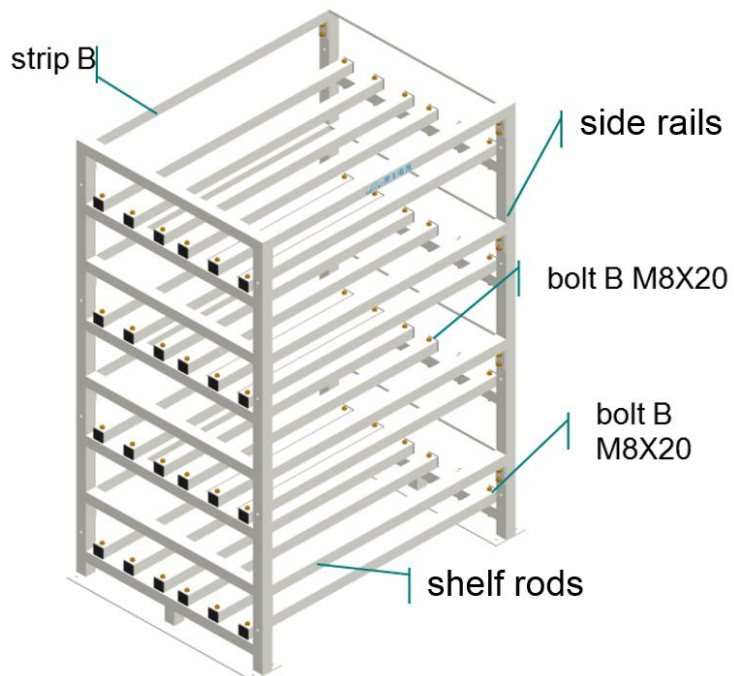


Figure4-4 Final sketch



Step4. Confirm proper installation of rack.

——END

### 4.3.2 Installing fixing bolts

#### Operation steps

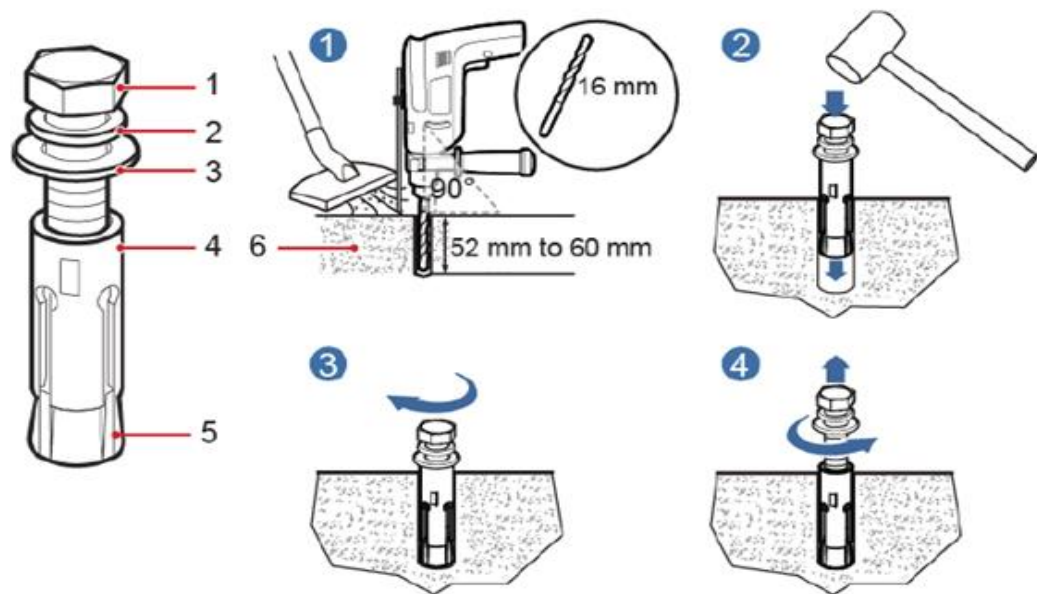
Step1. Drill holes (Φ55mm) with power drill to install racks with fixing bolt.

Step2. Put fixing bolts into the holes, hit them with a rubber hammer if needed.

Step3. Fasten the bolts till the tube is completely inside the hole.

Step4. Unscrew and remove the washer as seen below.

Figure4-5 Install the expansion bolt



① M12 bolt

② Washer

③ Flat washer

④ Expansion tube

⑤ Expansion nut

⑥ Cement floor

——END

### 4.3.3 Installing the batteries

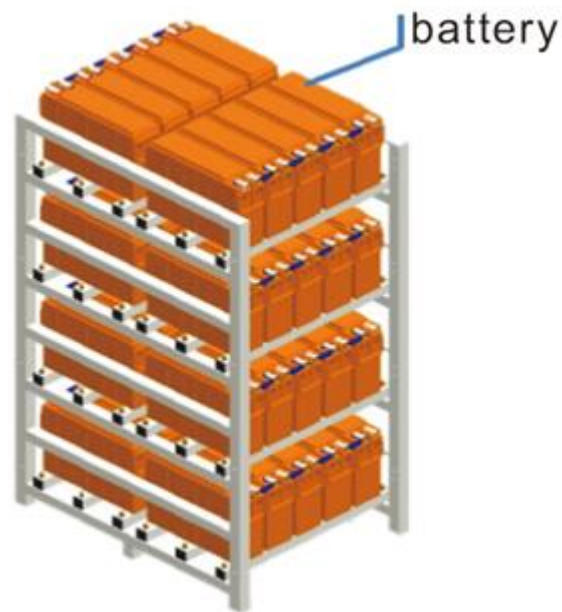
#### Operation steps

Step1. Install the rack with the fixing bolts.

Step2. Remove all strips B which located in the outward.

Step3. Install the batteries from top to down, backwards to forward.

Figure4-6 Schematic diagram of battery placement

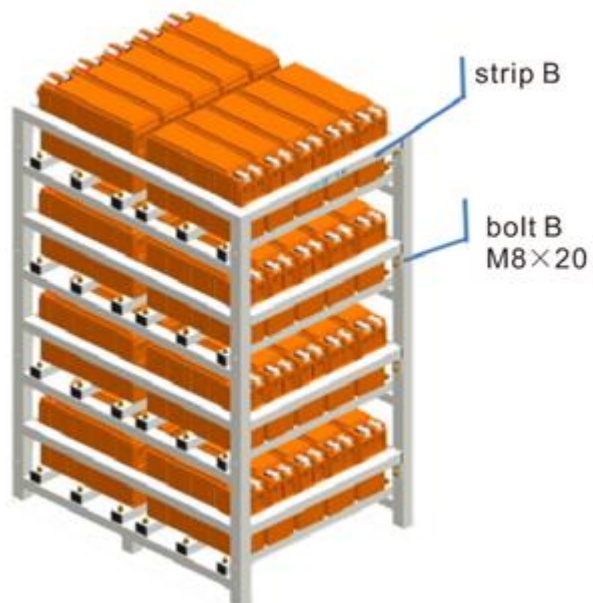


Follow the instructions to avoid missing any connection or short circuits.

---

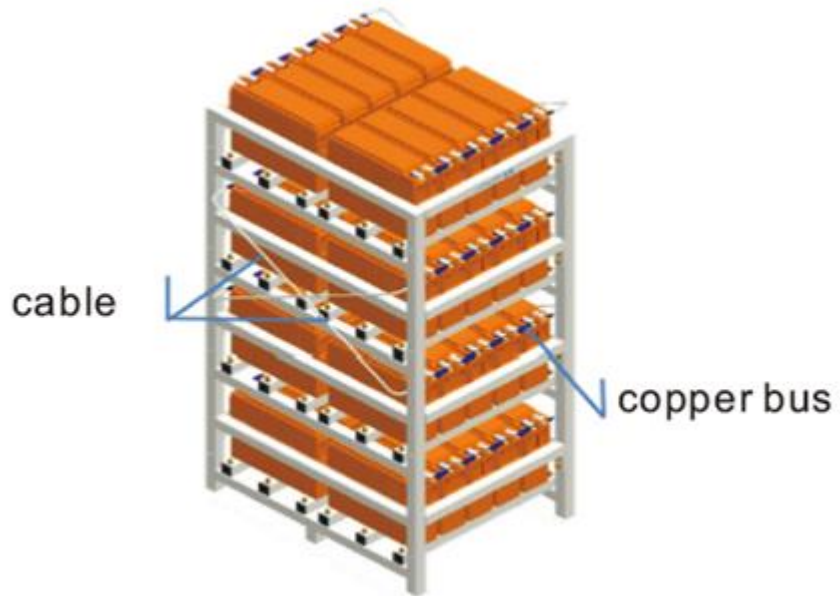
Step4. Reinstall all strips B again.

Figure4-7 After strips B installed



Step5. Follow the instructions to connect the components and isolate any metallic parts.

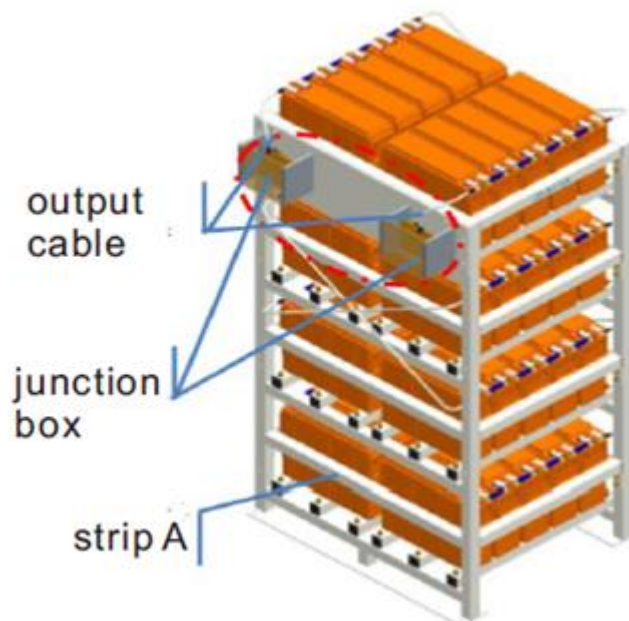
Figure4-8 Schematic diagram of battery connections



- Never reverse connect the batteries.
- The battery terminal torque should follow the manufacturer's recommendation, otherwise damages may be caused due to improper connection.

Step6. Follow the instructions to install the junction box onto the strip A and the steel pillar.

Figure4-9 Schematic diagram after the batteries are installed



Step7. Check the voltage after the batteries were installed.

 **NOTE**

- 1) Consult your administrators if the batteries should be connected to the load.
- 2) Never reverse connect the batteries.

——END

### 4.3.4 Checklist after the installation

Table4-5 Checklist after the installation

No.	Item	Qualified	Note
1	Followed instructions	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> irrelevant	
2	All components were installed	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> irrelevant	
3	No damage	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> irrelevant	
4	All fixing bolts are installed	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> irrelevant	
5	Cables installed and are properly connected	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> irrelevant	
6	Markers or signs are clean	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> irrelevant	
7	All bolts fastened	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> irrelevant	
8	Grounding and breakers are installed	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> irrelevant	
9	Cables installed properly	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> irrelevant	
10	Communication cables installed properly	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> irrelevant	
11	Output cables and communication cables are separated	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> irrelevant	
12	Strips are installed properly	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> irrelevant	

 **NOTE**

- 1) Ready the instructions before you begin.
- 2) It is recommended to use less than 4 strings in parallel connection. Serial connections should be made first. In case more than 4 strings must be used, please contact Leoch Technical department.
- 3) The temperature difference between layers should be less than 3°C.
- 4) Keep distance of 10~ 20mm between the batteries.
- 5) Do not use batteries from different manufactures or different models together.

# 5 SYSTEM DEBUGGING

PL series products are UPS batteries and are an integral part of UPS systems. A full test of the system is required after installation.



- Only qualified personnel can test the system.
- Installation must be completed before test, any operation should comply with the installation manual and local regulations.
- Remove any metallic wearable objects such as watches or jewelry during testing, only isolated tools should be used, avoid direct contact with the terminals.
- Check all components or parts before powering up.
- Shut down the system immediately if any abnormalities appear during testing.

## 5.1 Pre survey check

Please check the power system according to the following items before the system adjustment.

Table5-1 Checklist before test

S/N	Checking items	Qualified	Note
1	All breakers have been cut off.	<input type="checkbox"/> Yes <input type="checkbox"/> No	
2	Confirm that there is no short circuit.	<input type="checkbox"/> Yes <input type="checkbox"/> No	
3	Check color and label of input cable to ensure that the positive and negative polarity is properly connected.	<input type="checkbox"/> Yes <input type="checkbox"/> No	
4	Check if the battery is properly connected in accordance with the schematic diagram of the system, including the attachments.	<input type="checkbox"/> Yes <input type="checkbox"/> No	

S/N	Checking items	Qualified	Note
5	Check that the bolts are tightened in accordance with the recommended torque.	<input type="checkbox"/> Yes <input type="checkbox"/> No	
6	Check all settings, especially the battery management parameters, that are properly set up and according to the user's manual and the configuration requirements.	<input type="checkbox"/> Yes <input type="checkbox"/> No	

## 5.2 Measurement



### WARNING

Follow regulations while testing the system. Any deviation should be confirmed by the manufacturer or it could damage the system.

Battery is an integral part of a UPS system. Testing can be done by the UPS system itself.

Usually there are two testing modes. The first one is to verify the proper connectivity of the batteries and that they can be charged and discharged. Usually named: "quick test mode". In some cases there is also an "expert mode" which can test if the batteries can meet the required backup time under specific conditions set.

### 5.2.1 Instructions for quick test mode

The operation of this mode is relatively simple. Usually it can be initiated by controls on the system or the management software of the UPS.

### Operation steps

Step1. Confirm the discharge load

Step2. Confirm the discharge environment and parameters, including temperature and SOC (State of Charge).

Step3. Ensure all inspection items are ticked ok before any testing.

Step4. Turn on the discharge circuit and start the discharge. The discharge duration is usually between 20%~50% of the system configuration time. At the same time keep logs of temperature, voltage and current.

Step5. After discharging, re-charge the batteries until they reach 100% SOC.

Step6. Check if the batteries can meet the requirement according to the recorded data.

——END

## 5.2.2 Instructions for expert test mode

The expert test mode requires high technical skills, batteries will be tested with dummy loads. Please consult the UPS system manufacturer.

### Operation steps

- Step1. Confirm discharge load. Check if the load is required to online all the time, if so it is recommended to test the battery in the period which the power fail is not frequently occurred.
- Step2. Confirm the discharge environment, including the temperature, the battery is full charged state.
- Step3. Ensure that all inspection items before the test.
- Step4. Turn on the discharge circuit, start the discharge until the battery requires the discharge termination voltage, at the same time do a good data record in the testing process, including the battery voltage, current and other information.
- Step5. After discharge, turn on the charge circuit until the battery is fully charged or switch into float charge state, record the data including the voltage and current.
- Step6. Check if the battery can meet the requirement by the recorded data.

——END

## 5.3 Instructions after testing

Duty manager is necessary ( $\geq 24$ h) if the system is online for the first time to avoid leaky or thermal runaway accident, etc.

Please confirm the following information and operation before leaving the system installation and power up.

Confrim the following conditions after installation and powering up.

- Disconnect the test equipment and clean it up.
- Confrim the system operation is all OK for a while.
- Confirm the operation is OK before the lock then door then hand over the keys to the manager.



# 6 SYSTEM RUNNING

Battery manage parameters should be determined by the actual situation such as battery quantity, capacity etc. These parameters are the base data source for the BMS module of the UPS system.



attention

If battery parameters are configured wrongly, it will affect the battery charge/discharge and the service life.

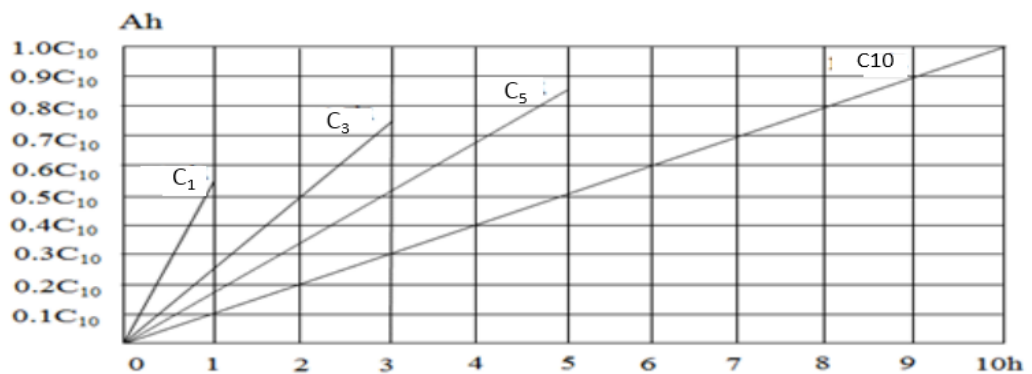
## 6.1 Discharge

### Discharge current

Battery can not be discharged at any current or it will be damaged, because the manufacturer set the constrain rules for discharge to ensure the safety.

As figure 6-1 shows capacity increase with the decrease of the discharge current. For example a 100Ah ( $C_{10}$ ) battery can discharge for 10A for 10 hours but only 1h for 55A and it's capacity become 55Ah.

Figure6-1 Lead Acid battery capacities in different discharge rates



## Final voltage

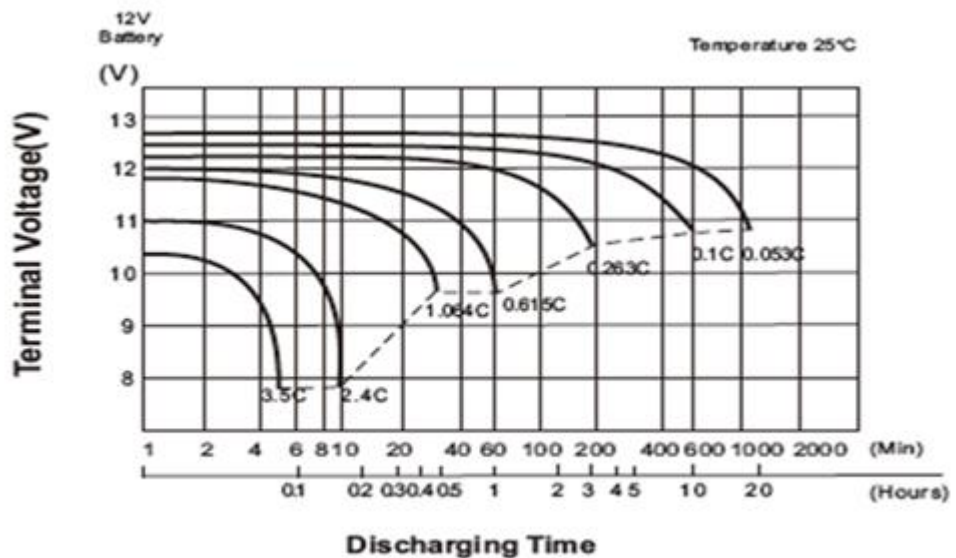
As we can see from the discharge curve, the voltage will drop rapidly when it reaches critical and little energy can be harvest, if we continue to discharge it will has some bad influence on the battery,so the discharge must be stop at the critical voltage and we call the critical voltage the final voltage

The final voltage decrease with the increasing of the discharge current. A lot of lead sulfate will be generated when the battery charged under small current and it will cause damage to the battery. The volume will increase  $0.57 \times 10^{-3}$  (liter/Ah) at the negative plate and  $0.43 \times 10^{-3}$  (liter/Ah) at the positive plate, these increased volume will damage the plate and cause the active material fall off.

When battery is discharged to the final voltage, it is not allowed to discharge by the small current or will be damaged for over discharge.

Figure 6-2 shows the final voltage under different discharge rate, different manufactures has different rules, refer the manual for more information

Figure6-2 Final voltage for Lead acid battery in different discharge rate

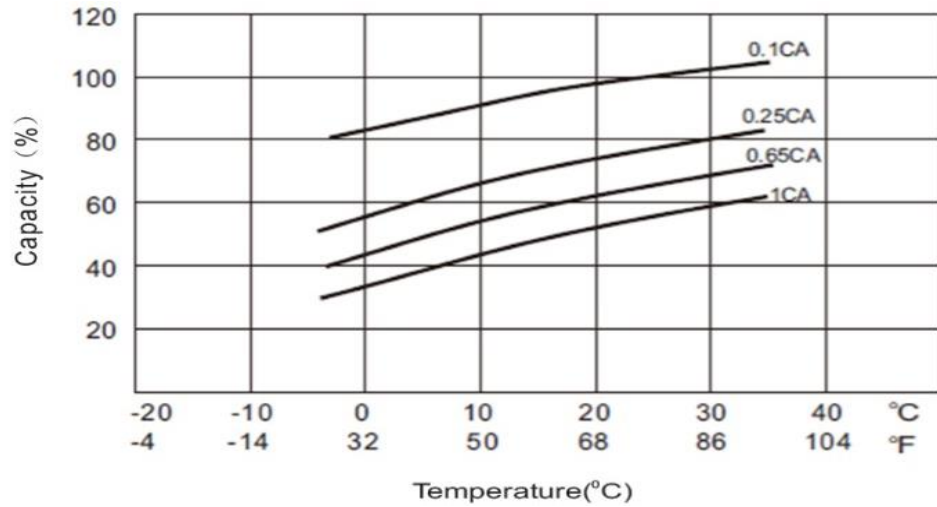


## Temperature effect

Capacity increase with the temperature. It can be affect by the discharge current (discharge rate) and it becomes more obvious when discharged at bigger current.

Figure 6-3 shows the capacity is related to the discharge current and it becomes more obvious with the increasement of the discharge current.

Figure6-3 Discharge capacity and temperature



## 6.2 Charge

### Charge character

Figure 5-1 shows the constant charge characteristic the charge voltage is increasing with the charge time. However at the final stage the charge voltage will increase rapidly for the oxygen is produced on the positive plate.

So we can tell the charge status by the increasement of charge voltage.

The charge voltage should increase with the decreasing of the temperature.

Figure6-4 Constant current charge characteristic curve

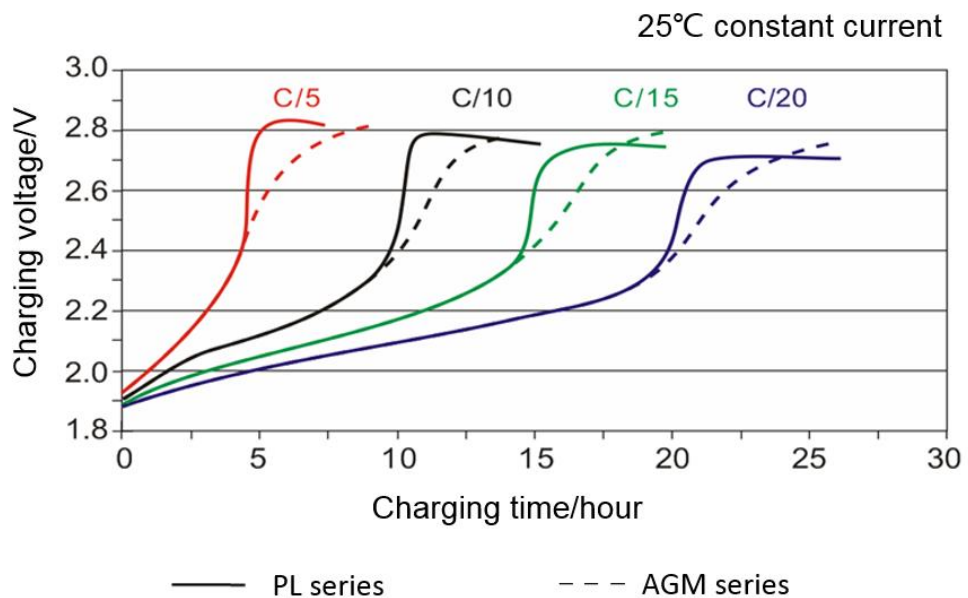
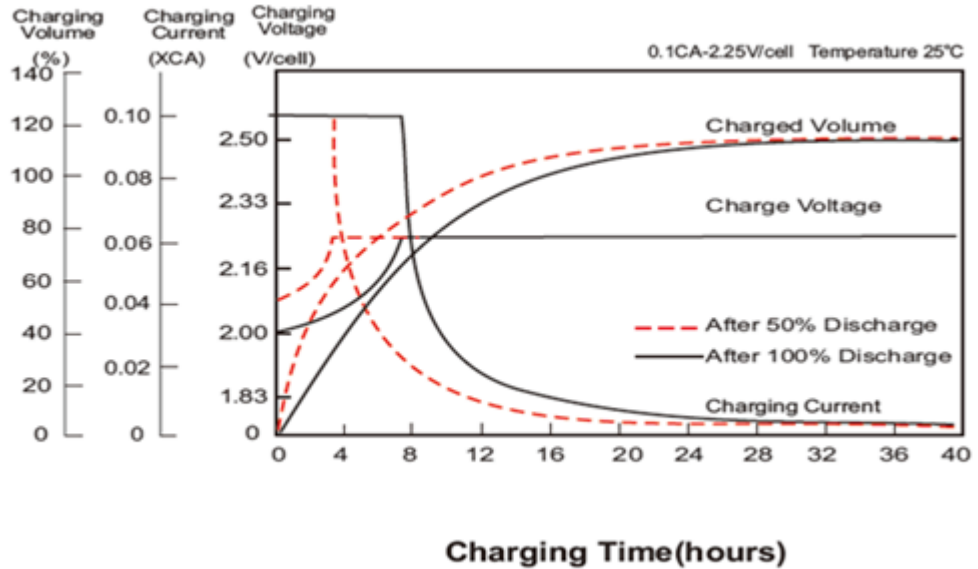


Figure 5-2 shows the constant voltage charge characteristic. The default setting is 2.25V/cell and the max initialize charge current is 0.1C<sub>10</sub>. The charge current decrease with the charge time and reach the minimum at the final stage. Charge mode is affect by the temperature too the charge at the final stage will increase with the raise of temperature.

Figure6-5 Constant voltage charge characteristic curve



## Charge voltage

Batteries will self-discharge so the charge voltage should be properly set so they could be fully charged.

Table 6-1 shows the three mode for constant voltage charge.

The float charge is the mode to keep the batteries fully charged.

Equalization charge is another mode to every cell in the string in the same status.

It is recommended to increase the charge voltage in order to fully charge the batteries rapidly under cycle using.

Table6-1 Charge moldes for batteries

Type	Float Charge (V/Cell)	Equalizing charge (V/Cell)	Cycle use (V/Cell)
Pure Lead	2.27	2.35	2.35~2.40

### NOTE

- 1) The maximum initialize charge current of PL battery series battery can not above 1.0C<sub>10</sub>.

## Equalizing charge

Equalization charge the battery with any one of the below conditions.

- Discharged capacity is above the 20% or according to power supply's setting.
- Storage time above 3 months or longer.
- In battery group when the float charge voltage of one unit is below 2.16V/Cell.
- New battery is installed and debugged, but not in operation model yet.

Float charge use for more than one year.

## Temperature compensation

To get a better battery usage life take the temperature compensation into consideration (deviated from 25°C).

When temperature compensation is used, it can charge in different temperature condition, even when the temperature increase, the current will not become too big at the end of charge time, so it will avoid the heat effect caused by the high temperature.

In float charge state, temperature compensates using 25°C as datum mark, the coefficient is -3mV/cell/°C.

Decrease -5mV/cell for every one 1°C increasement (Compensation -5mV/cell/°C) on cycle use.

## Ripple

Due to the charge equipment's character, there is some AC component over lay on the DC, this AC component and load feedback will cause the battery in extra temperature rise and lead plate stress and distortion.

Ordinary the limit for ripple voltage and ripple current is that 0.5% of float charge (RMS/Root Mean Square, is a common formula method to define AC ripple or current); ripple current (RMS) should not exceed 5A/100Ah rate capacity; while fast charge, the instantaneous value allow to get to 10A/100Ah rate capacity.

# 7 MAINTENANCE

To get the optimal service life for batteries, the service people should check and maintain in a proper time.

Keep a good record in the process of maintenance, it will help to check the battery group's parameters.



attention

- The engineers should get professional training in the following maintenance process. Follow the regulations and take proper protection.
- All the equipment used during the maintenance should be insulated, consult the Leoch engineers and service center if any components need to be replaced.
- It is necessary to maintain the batteries at fixed period by the following requirement, or it will influence the battery or system normal running, meanwhile it decreases the battery's normal usage life.

## 7.1 Battery maintenance

Some routine maintenance can refer to table 7-1 ~ table 7-3, maintenance items include but not limit to the contents below.

### Monthly checking

Table7-1 Checklist for monthly maintenance

Item	Content	Standard	Maintenance
Battery temperature	Measure the infrared temperature measure instrument to measure the temperature on the battery terminal and battery case.	Below 35°C	When temperature is above the standard, please look for the cause, and deal with it or consult with the factory.

Item	Content	Standard	Maintenance
Float charge total voltage for battery group	Measure the output terminal voltage of battery group	The measure value is the same as the equipment, the deviation don't exceed $\pm 0.5\%$ , and satisfy the setting standards of float charge in current temperature.	<ul style="list-style-type: none"> <li>When deviate the standard value, it should be based on the actual measure value</li> <li>If the equipment could not get to the allowed error scope after adjustment, the equipment should be reported to repair.</li> </ul>
Battery appearance	Check whether battery is inflated, acid leakage and injury.	Appearance normal.	If appearance is not normal, if affected to be normal use, please change the battery.
	check whether there is dust or dirty.	Clean appearance.	Wipe off the dust by wet cloth.
	Examine the connector, terminals rusted or other normal.	No rust.	If there is rust, swipe off the rust, change the connection line, cover anti rust agent.
Connection part	Use the wrench check the screw is loose or not.	satisfy the torque request by manufacture.	If loose, please tighten the loose screw and bolt.
	Battery group connection, terminal clearance, no abnormal.	No rust.	When minor rust happens, remove the connection line, dipped in clean water and remove the rust by steel brush, then tighten up. If worst rust happens, please change the connection line.
Safety valve examination (2V battery)	Lightly shake the safety valve, check the installation is solidly or not.	Safety valve is solidly installed, no movement happens.	If safety valve moves, please tighten the safety valve.
	Visual inspection the safety valve nearby has crystal or not.		please wipe off by dry cloth. If happens again, please consult with the manufacturer.
Switch test	Break AC supply. Batteries will supply the power Follow the station's regulations.	No power down. Switch works well	Check the battery if the output voltage drops too fast or site down.

## Seasonal checking

Table7-2 Checklist for seasonal maintenance

Checklist for seasonal maintenance.also check the system by table 7-1 bofre it.

Item	Content	Standard	Maintenance
Bolt	If the bolt are tight.	Follow the manufacturer's guide.	Follow the manufacturer's guide.
Floating charge voltage	Checking floating charge voltage.	2V series the difference should less than 90mV 12V series the difference should less than 480mV	Discharge 10% then equalizing charge then floating charge for 2~3 months,if still fail replace them.
Failed battery repirement		The floating charge voltage should meet the standard.	Equalizing charge for 10h then discharge it,Repeat it for 3 times if serious. If still fail contact us to replace it.

## Annual maintenance

Table7-3 Checklist for annual maintenance

Checklist for annual maintenance also check the system by table 7-1 and table 7-2 bofre it.

Item	Content	Standard	Maintenance
Bolt	If the bolt are tight.	Follow the manufacturer's guide.	Follow the manufacturer's guide.
Discharge test	Discharge the batteries in 30%~40% DOD.	The final voltage should above the recommended voltage.	Equalizing charge then the floating charge for 1~2 months if still fail contact us.

 **NOTE**

- 1) Follow the guidance to maintain the batteries.
- 2) Follow the manual to set or maintain the batteries.
- 3) Wear protections and insulate the tools to prevent any shock.
- 4) Take proper equipments.
- 5) Keep the “Inspection comes first keep safety” in mind.



## 7.2 Checklist for common failure

Frequently failure and solutions are shown in table 7-4.

Table 7-4 Checklist for common failure

Specification	Service life	Mark
Damage	Damage during transportation.	<ul style="list-style-type: none"> <li>● Return the batch to us for evaluation.</li> <li>● If just some batteries are damaged just replace them.</li> </ul>
Floating charge voltage	Floating charge voltage is abnormal.	<ul style="list-style-type: none"> <li>● Checking the settings.</li> <li>● Equalizing charge the batteries.</li> </ul>
Floating charge voltage	Too high or too low.	<ul style="list-style-type: none"> <li>● Check if any short circuited or open circuited batteries then replace them.</li> </ul>
Floating charge current	Zero charge current.	<ul style="list-style-type: none"> <li>● Check the connection and voltage for each cell.</li> <li>● Ignore it if it is just the charge current too low(beyond the tolerance).</li> </ul>
	Floating charge current is bigger than 0.05C <sub>10</sub> after being charged for 48 hours.	<ul style="list-style-type: none"> <li>● Check if any battery fail or too hot (15°C above environment temperature) or valve fail or the settings wrong.</li> <li>● If no error found just replace the battery.</li> </ul>
Leakage	White crystal on terminal or somewhere else.	<ul style="list-style-type: none"> <li>● Clean it with a rag if it is false alarm.</li> <li>● Clean it if just a little leakage (a little crystal) but if it happens again replace the battery.</li> <li>● If leakage in terminal rag it then replace the battery.</li> </ul>
Thermal runaway	Thermal runaway	<ul style="list-style-type: none"> <li>● Check and clean the valve.</li> <li>● Check if there is any not fully charged battery (&lt;2.05V/cell) in the circuit.</li> <li>● Check the settings.</li> <li>● Replace the damaged batteries.</li> </ul>
Can not be charged	No power.	<ul style="list-style-type: none"> <li>● Check the connections.</li> <li>● Check if any leakage, broke, thermal runaway.</li> <li>● If no errors found, check the open circuit voltage if it is below 2.05V/cell, replace it.</li> </ul>
Capacity drop fast	Capacity or voltage drops fast.	Replace them or contact us.

# 8 COMPONENTS REPLACEMENT

---

## 8.1 Replace battery

Battery is consumable product and has certain service life, it should be replaced in service life take the use condition and ambient temperature into consideration to keep the system reliable.

### Precondition

The battery is considered to be changed if the battery performance is not satisfied the requirements or standards after testing.

Confirm the system can be under the risk of black out and maintained.

### Operation steps

Step1. Cut off the battery from system.

Step2. Dismantle the connectors from the batteries by insulation tools.



If there is space interference and need to dismantle the batteries nearby, mark the batteries and unpack the batteries following the current flow sequence, meanwhile keep the insulation protection.

---

Step3. Put the new battery in the ready position, and replace the old one by new one.

Step4. Connect the battery connector in order.

Step5. Connect the batteries to the system, and check the parameters to make sure they are OK.

—END

## 8.2 Replace the connecting accessories

### Precondition

Check if the connecting accessories must be changed, and prepare the new components for replacement.

The system can be disconnected and maintenance is ready.

### Operation steps

Step1. Disconnect the batteries for the system.

Step2. Dismantle the accessories by the isolated tools.



attention

If there is space interference and need to unpack the batteries nearby, mark the batteries and unpack the batteries following the current flow sequence, meanwhile keep the insulation protection.

---

Step3. Put the new accessories in the ready position, and replace the old one by new one.

Step4. Connect the battery connector in order.

Step5. Connect the batteries to the system, and check the running parameters to make sure they are OK.

——END

# 9 ENVIRONMENT PROTECTION

## 9.1 Toxic and poison

Table9-1 Checklist for toxic and poison

		Toxic and poison					
		Pb	Hg	Cd	Cr(VI)	PBB	PBDE
Terminal	Cu	○	○	○	○	○	○
Container		○	○	○	○	○	○
Inner material		×	○	○	○	○	○

## 9.2 Recycle



■ This mark indicates that the product can not be classified with other waste. In order to prevent potentially hazardous substances from hazardous waste disposal hazards to the environment and human health, please refer to the classification of waste recycling in order to promote the sustainable use of material resources.



In order to recycle the used equipment, please use the recycling system or contact the manufacturer or seller of the product or the local authority to manage the waste products.

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