Ultracell®

'Quality in Every Language'

Getting Started

UCG - User Manual

Solar Series

Installation & Operation

User Manual

Please read the "Important safety instructions" alongside the rest of the manual before operating this product. Store in a safe place for future reference.
The information in this manual is subject to change without notice.

To browse our products or to read our FAQ page, visit our website www.ultracell.co.uk. Please contact us for any further enquiries. Detailed information regarding our products can be provided upon request.

Please Note:

All information in this document is subject to change without notice.

This manual describes the main features, specifications, installation, parameter settings and maintenance for Ultracell's UCG Solar Series batteries.

Intended Audience:

This manual 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 document.

DANGER
Danger that can cause serious injuries or even death.

WARNING
Used to indicate potential danger, may cause death or serious injury if not avoided.

CAUTION
Used to indicate medium or low potential danger, may cause minor injuries.

ATTENTION
Used as a warning of potential dangers, if this information is ignored, it may result in equipment damage, data loss, decrease in equipment's performance and other unpredictable results.

NOTE
Valuable additional information readers should make note of.

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Contents

SAFETY

Overview

Please read this manual carefully before installation, operation and maintenance of Ultracell's UCG Solar Series batteries. Store in a safe place for future reference. The information in this manual is subject to change without notice.

Attention

Please pay attention to the notes marked with dangerous, warning and caution symbols before installation, operation and maintenance. The statements marked with these symbols do not cover all safety issues and we ask users to take their own situations into consideration.

Compliance with Local Laws and Regulations

Please check compliance with local laws and regulations before you proceed.

Requirements before Installation

- Only qualified persons with the correct training and familiarity with all safety regulations should be authorised to install, operate or maintain Ultracell batteries.
- Installation, operation and maintenance to be carried out by authorised personnel only.
- Do not dismantle or repair Ultracell batteries as this will void the warranty.
- Product warranty does not cover the damages caused by inappropriate usage.

Grounding Requirements

- Ground before installation.
- Dismantle the system after ungrounding.
- Keep the grounding conductor secured.
- Do not operate without a grounded conductor.
- Make sure all equipment is grounded securely before operation.

Human Safety

- Do not operate in poor weather conditions.
- Electrostatic protection equipment is required and removal of any conductive accessories or clothing is mandatory to avoid shocks or burns before operation.
- Sound the fire alarm and evacuate immediately in the event of a fire.
- Do not re-enter a burning building under any circumstances.

Equipment Safety

- Ensure all equipment is installed securely before operation.
- Check air vents before operation.
- Necessary tools are required for system installation.
- Clean the installation area before and after any installation or maintenance.

Electrical Safety

This section covers high voltage, large leakage, current and cable safety issues.

High Voltage

- Keep water or wet objects away from high voltage power conductors.
- To avoid fire or electric shock, operate correctly.

Large Current Leakage

- Ground before operation to avoid equipment damage or human injury.
- Ground the equipment to prevent electric shock. When a high voltage sign is visible, grounding the equipment is mandatory to avoid significant damage to equipment or human injury.

Cable

- Shut down power before installation to avoid electric sparks/shocks and prevent injury.
- Keep the distance between cables and sockets greater than 30mm to prevent cable damage under high temperatures.
- Power off before installation or dismantling.
- Check cable labels before connecting.

The Signal Cable

- Separate the signal cables from the others.

Cable Installation

- Low temperature or vibration could cause damage.
- All cables should be installed when the ambient temperature is above 0°C.
- Keep cables at room temperature for at least 24 hours if they were stored under 0°C.
- Follow instructions and operate cables carefully especially under low temperature environments.

Fuse

- Ensure replacement fuses are of the same model to maintain correct operation.

Short Circuit

- Shut down the system to avoid any short circuits. Large currents caused by short circuits are extremely dangerous.

Environment

- Do not operate in a flammable environment. Keep all flammable/explosive objects away from this area.

Batteries

- Follow instructions correctly to prevent leaking electrolyte. Leaking electrolyte can corrode metal and damage the equipment.
- Take care during operation to avoid short circuits.
- Disconnect the battery circuit if there is no load or charging for more than 2 weeks.

Battery Leakage

- Clean leakage with the following items:
- $NaHCO_3$ solution.
- Na_2CO_3 solution.
- In the case of human contact with the electrolyte, wash away immediately and seek medical advice.

Installation & Operation

- Ensure you are equipped with the correct safety protection before operation.
- Do not wear conductive materials such as jewellery etc.
- Wear rubber gloves to protect hands from acid.
- Wear safety goggles to protect eyes.
- Keep the batteries upright during transportation.
- Keep the batteries away from water, fire and heat.
- Do not charge during installation or maintenance.
- Do not modify or cause impact to the batteries as this can cause leakage, burning or explosion.
- Take care during maintenance or measuring.
- Keep batteries away from children.

Battery Temperature

- Do not expose the battery to high temperatures. This can cause leaking and damage.
- Ensure no leakage occurs if the temperature exceeds 60°C.

Toxic Gases

- Only sealed batteries should be used. All batteries should be placed upright to avoid the release of flammable gases which could corrode nearby equipment.
- Flammable gas may be released during battery operation. Please install in a well ventilated area.

Aerial Work

- Aerial work should be carried out by trained and authorised personnel only.
- Apply protective measures to prevent falling.
- Wear a helmet and safety belt.
- Check all equipment before proceeding.
- Check the ladder for any damage.
- Do not exceed the maximum load of the ladder.
- Fix the ladder in a steady place with a 75° angle. Use extra fixing equipment to prevent slipping.

Mechanical Safety

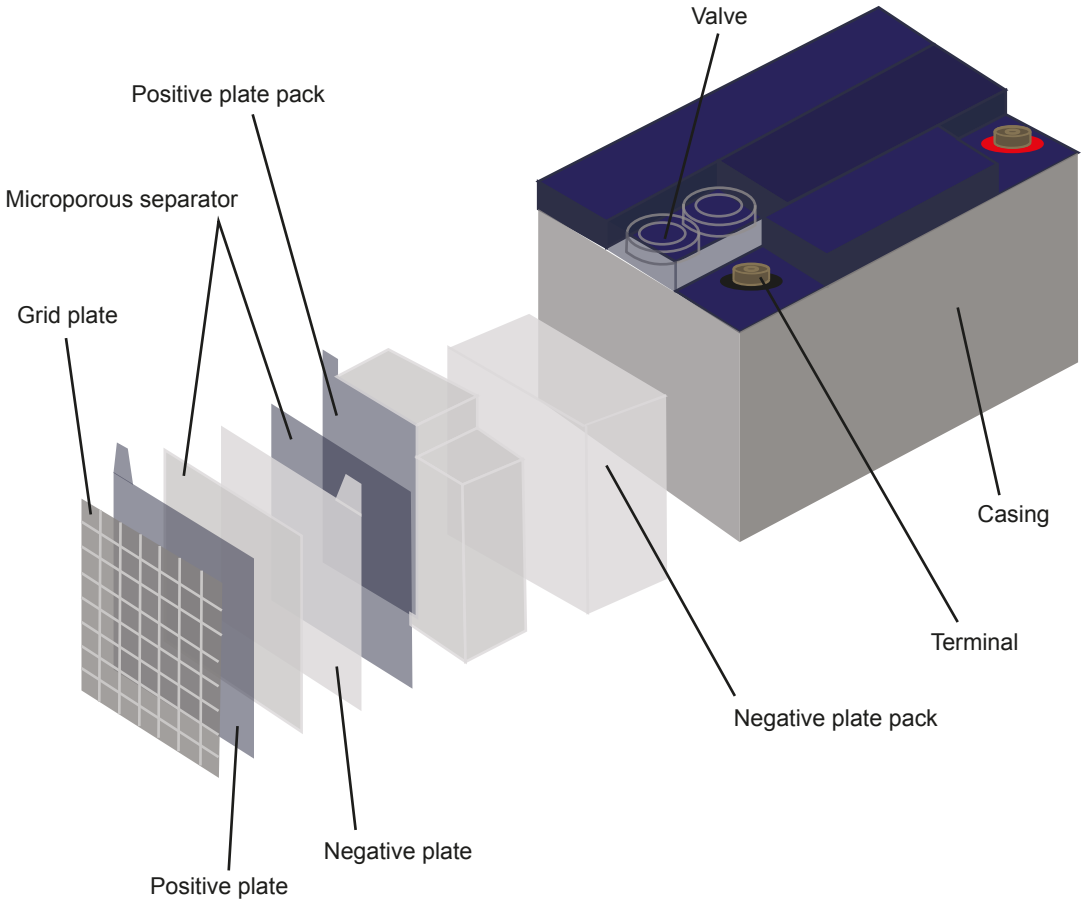
- Take care when drilling, as dust may cause short circuit or interference with the connection.
- Keep terminals clean at all times and clear of dust to prevent short circuit.

PRODUCT SPECIFICATION

UCG Solar Series - Product characteristics

- VRLA maintenance free.
- Special Pb-Ca alloy increases the anti-corrosion performance and provides longer float service life.
- UL94-HB ABS case (UL94-V0 is optional).
- No electrolyte stratification minimizing the risk of water loss.
- Nominal operating temperature range: Discharge -20~55°C, Charge 0~40°C, Storage -15~50°C.
- Integrated valve design for controlling water loss and improving safety and performance.

Product Structure



Components

Grid
The grid carries the active material and current made from lead alloy so the current will spread equally.

Plate
The plate is composed of the grid and active material. This holds electric power. The service life depends on the plate design and characteristics.

Separator
The separator has a porous design and absorbs most of the electrolyte enabling the ions to move from positive to negative plates, without allowing the battery to short circuit. The separator holds the active material.

Valve
The Valve keeps water inside the battery allowing recombination and only releases gas above a certain pressure point to prevent the battery from bulging and swelling.

Container
The container houses the internal components of the battery, made from strong plastic with insulation and anti-corrosive properties, this prevents outside substances from interfering with the active material and electric power of the battery.

Electrolyte
The electrolyte is a dilute sulfuric acid, composed of sulfuric acid and de-ionized water. The main functions of the electrolyte are to participate in the electrochemical reaction by being the conductor between the positive and negative ions.

Structure Detail

AGM Separator
The separator contains micro holes to enable oxygen to pass through. The electrolyte is absorbed by the separator and AGM helps to increase the pressure when the battery is being manufactured.

Multi-layer Seal Structure
The unique seal design of Ultracell's UCG Solar Series batteries ensure high efficiency of recombination reaction over 99% with no risk of leakage.

Maintenance-free Design
The battery consumes a small amount of electrolyte providing a maintenance-free design. Checking the proportion of acid and water is not required.

Vent Valve
Our batteries are equipped with low-pressure, one-way control valves with flame arrestor design that will release excess gas and reseal automatically in the event that gas pressure rises to a level above the normal rate. Improving efficiency and overall battery safety.

Thin grid design
Increased number of plates due to a thin grid design ensures high performance. Well balanced plates to ensure long service life.

Cycle Life
Cycle life is affected by the DOD (depth of discharge).

Float Charge Life
≥38Ah/12V series: 10 years
2V series: 17 years

Low Self Discharge
The self-discharge rate is less than 3% of rated capacity at 20°C ~ 25°C.
Shelf life can last from approx 3 - 6 months.

Operation Temperature
Discharge: -20°C~55°C; Charge: 0°C~45°C; Storage: -15°C~50°C

Recovery Performance
UCG Solar Series batteries have excellent capacity when charging. They can also be recovered well after deep discharge.

Chemical Process
Electric energy is converted into chemical energy during charging and becomes electric energy during discharging. The chemical process is shown below:

Positive plate $PbSO_4+2H_2O \underset{\text{Discharge}}{\overset{\text{Charge}}{\rightleftharpoons}} PbO_2+H_2SO_4+2H^++2e^-$

Side reaction $H_2O \xrightarrow{\text{Charge}} \frac{1}{2}0_2+2H^++2e^-$

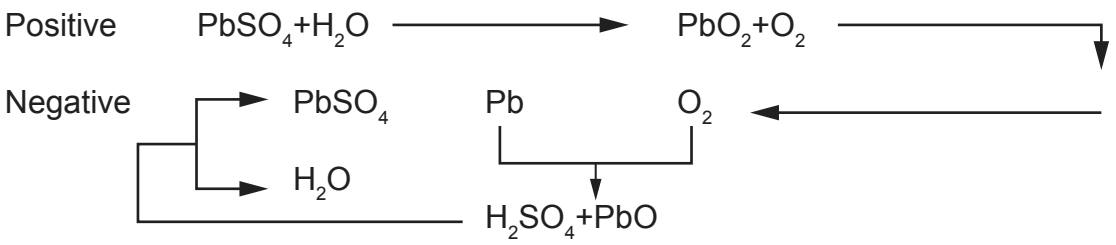
Negative plate $PbSO_4+2H^++2e^- \underset{\text{Discharge}}{\overset{\text{Charge}}{\rightleftharpoons}} Pb+H_2SO_4$

Side reaction $2H^++2e^- \xrightarrow{\text{Charge}} H_2$

Water is resolved into hydrogen in the negative electrode (which starts to evolve when approximately 90% fully charged) and oxygen in the positive electrode (which starts to evolve when approximately 70% fully charged) during charging. Battery failure is common due to a dry out of the evolved gas that can no longer be recombined, so a refill of acid or water would be required. The latest VRLA battery technology overcomes this disadvantage enabling gas to be recombined and hydrogen generation controlled.

Principle of Oxygen Recombination

The negative plates are specifically designed to hold more active material. The oxygen which is generated from the positive electrode travels through the separators to the negative electrode to oxidize the Pb to control hydrogen generation. The recombination process allows the batteries to have minimal water loss over the years of operation making them maintenance-free.



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

INSTALLATION GUIDE

Attention
- Do not install if metal dust is present.
- Do not apply heavy loads on the batteries.
- Check the connection point before installation to prevent short circuit.
- Wear the appropriate protective equipment.

Preparation before Installation

Installation and Operating Environment
- The batteries should be installed in a dry and clean environment to ensure safety to the system and user.
- Flammable, explosive and any other hazardous materials are prohibited in this area. The installation room should be equipped with fire suppressing equipment (such as CO_2 fire extinguishers).
- Recommended operational temperature range: Charge (0~45)°C, Discharge (-20~55)°C, Storage (-15°C~50)°C, (20~25)°C is the recommended optimal temperature.
- Relative humidity: (0% ~95%)RH, non-condensing.
- Avoid heat and direct sunlight, avoid high humidity (with condensation) environments.
- Altitude: GB3859.2-93.

Ventilation
Ensure you are in a well-ventilated area for installation to avoid an accumulation of hydrogen and to avoid the risk of explosion. Keep a distance of 30-50cm from the battery bank on each side. Please refer to EN 50272-2-2001 safety requirements for secondary battery installations

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

Q ——— Air flow rate, (m^3/h).
v ——— Hydrogen dilution requirement, (100%-4%)/4%=24 (tolerance 4%).
q ——— 0.45×10^{-3} (m^3/Ah) evolved hydrogen.
s ——— Safety coefficient s=5.
n ——— Cells.
I_{gas} ——— Quantity of hydrogen/Ah (mA) (1 for floating charge, 8 for equalisation charge).
C_{rt} ——— C_{10} rated capacity (Ah).

This can be simplified as: $Q=0.054\times n\times I_{gas}\times C_{rt}\times 10^{-3}$

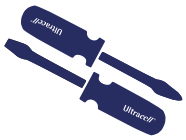
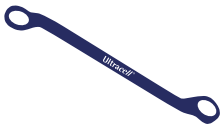
So the minimum area for the ventilation is: $A=28\times Q$
Q ——— Air flow rate, (m^3/h).
A ——— Area (cm^2) (default air flow speed is 0.1m/s)

Correct ventilation design must be ensured by the installation personnel. Active ventilation is required if the air flow rate is too low. Isolated battery cabinet or parts are recommended. At least 500mm clearance is recommended between the components that may cause sparks and the batteries venting.

Installation Tools

Commonly used tools that the field technician may or may not need are shown in the following table:

General Purpose, Electrical, Measuring, Delivery and Unpacking Tools

ADJUSTABLE WRENCH	SCREWDRIVERS	TORQUE WRENCH	SOCKET WRENCH	OPEN END WRENCH
				
RING SPANNER	**PLIERS**	**WIRE CUTTERS**	**NEEDLE NOSE PLIERS**	**MARKING PEN**
				
TAPE MEASURE	**INSULATED GLOVES**	**LADDER**	**RUBBER MALLET**	**POWER DRILL**
				
VACCUM CLEANER				
				

Transport and packaging tools

PALLET TRUCK	FORKLIFT TRUCK	LIFTING ROPE	LEVER
			

Electrical installation tools

INSULATED GLOVES	POWERLINE CLAMP	WIRE STRIPPER	INSULATING TAPE	CLAMP METER
				
MULTIMETER				
				

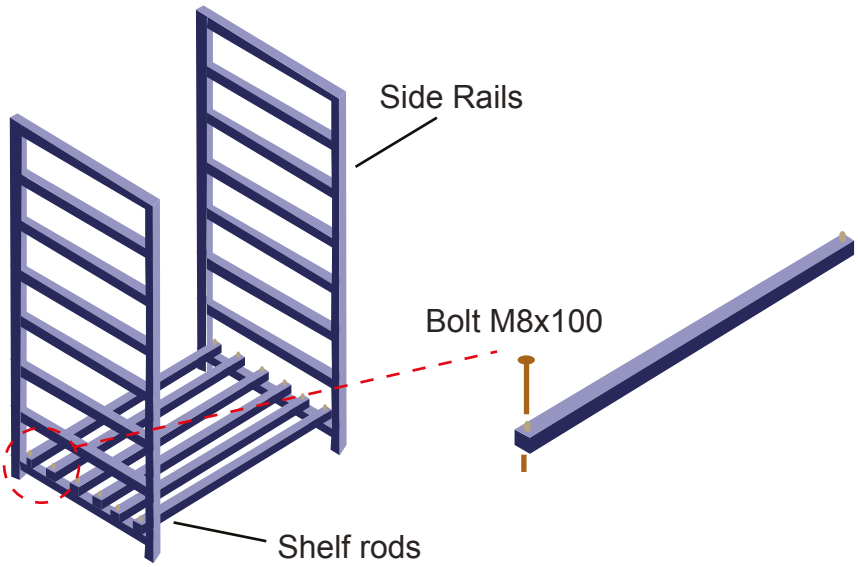
Initial Inspection

- Do not use excessive force on the battery terminals to avoid damage to the sealed components.
- Check the battery and packaging for signs of damage.
- Check the battery quantity and accessories.
- Check for any product reference material. If any of this is missing, please request it.
- Ensure all components are complete before unpacking. Record anything which is not compliant with your order or has been damaged during transport and inform your supplier.

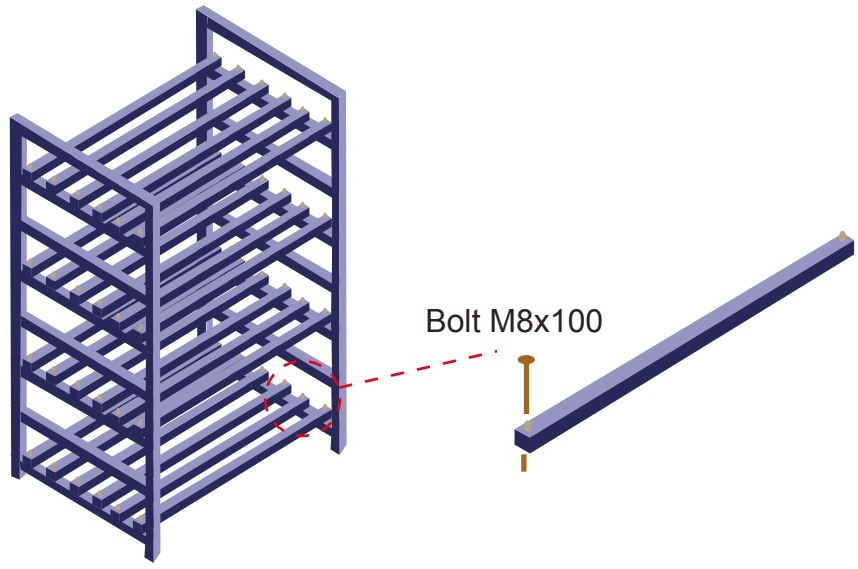
Installation

Connect the side rails and fix them vertically on the ground with bolts (M8X100).

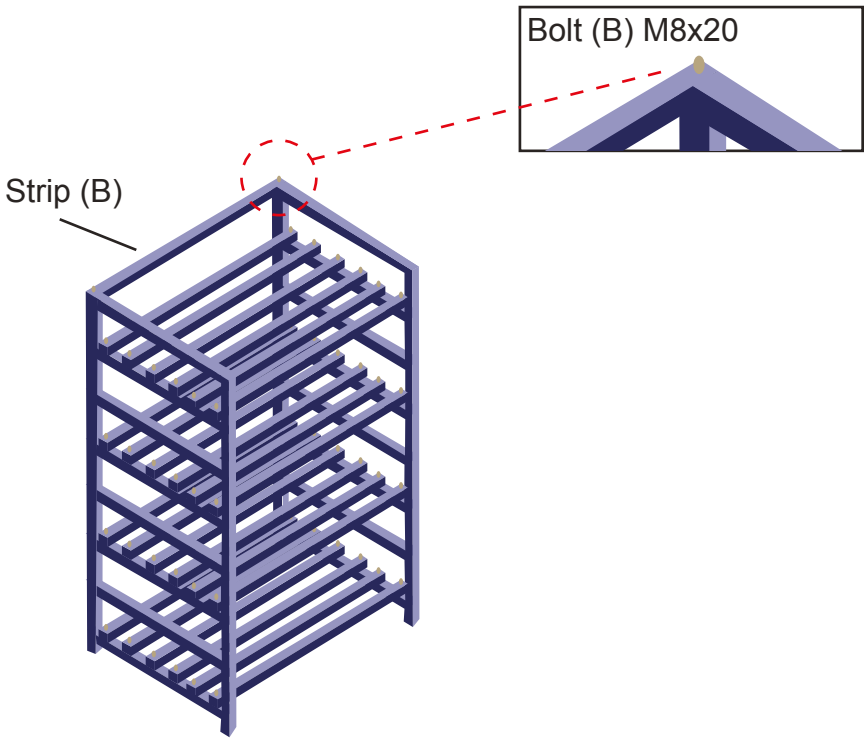
Connect the side rails with the bottom shelf rods.
Please see the figure below:



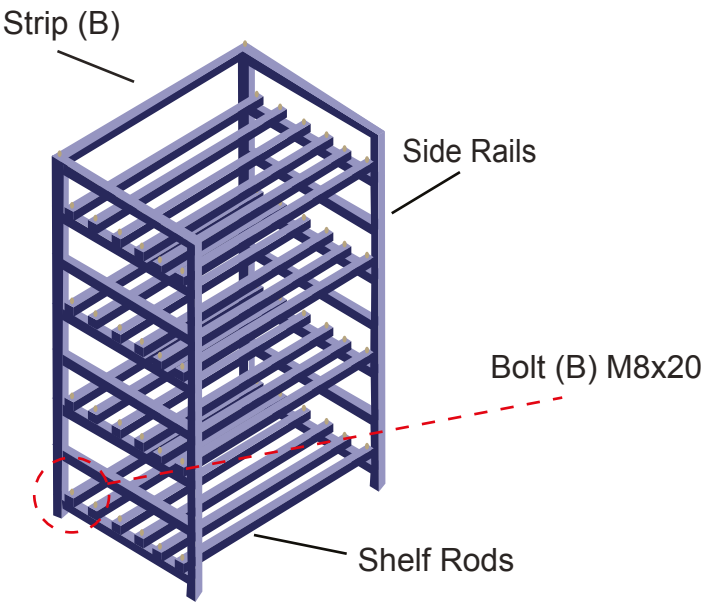
Install the shelf rods to each layer of the rack and fix them with bolts.
Please see the figure below:



Install the strip (B).
Please see the figure below:

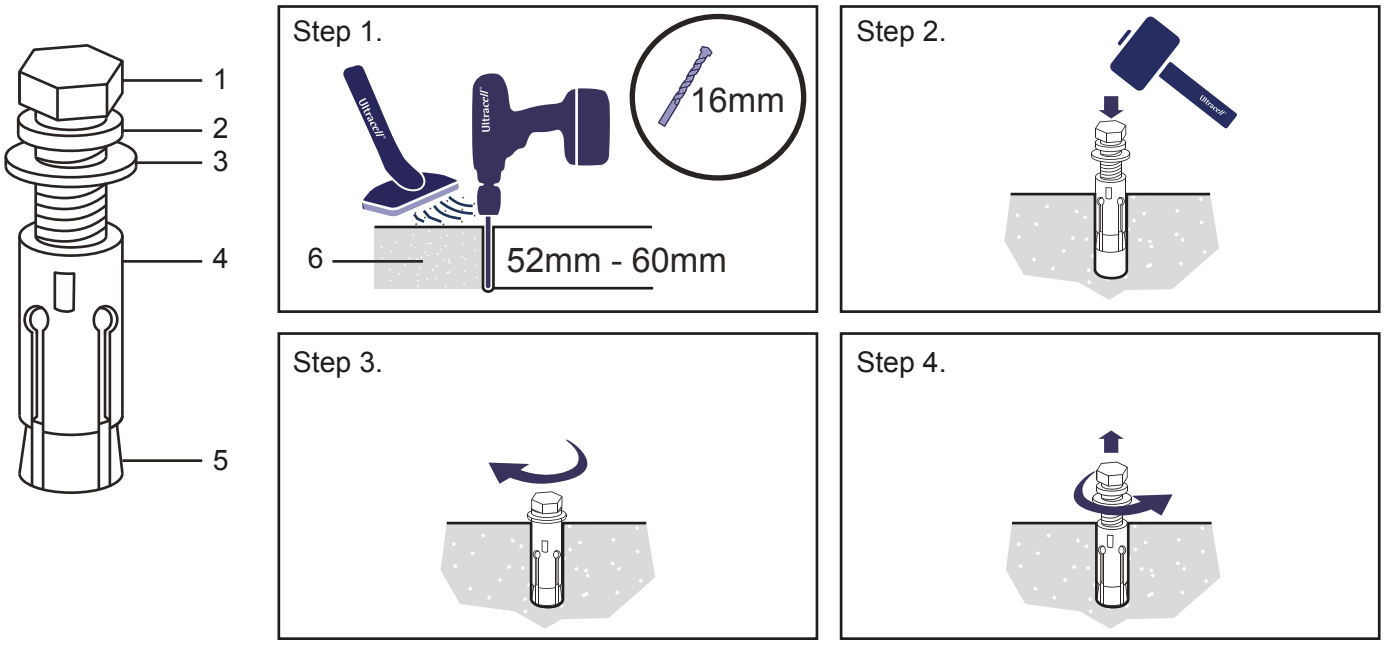


Confirm correct installation of the rack.
Please see the figure below:



Bolts

1. Drill holes (55mm) with a power drill to install the racks with the fixing bolts.
2. Put fixing bolts into the holes, use a rubber hammer if required.
3. Fasten the bolts until the tube is completely inside the hole.
4. Unscrew and remove the washer, as shown in the diagram below.

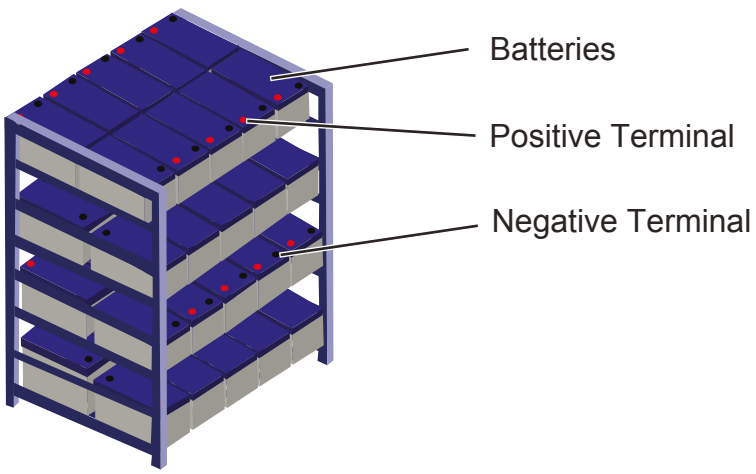


(1) M12 Bolt (2) Washer (3) Flat Washer (4) Expansion Tube

(5) Expansion Nut (6) Cement Floor

Battery Installation

1. Install the rack with the fixing bolts.
2. Remove all (B) Strips, located on the outer edge of the racks.
3. Install the batteries on the bottom shelf to the top shelf and from the rear to the front.

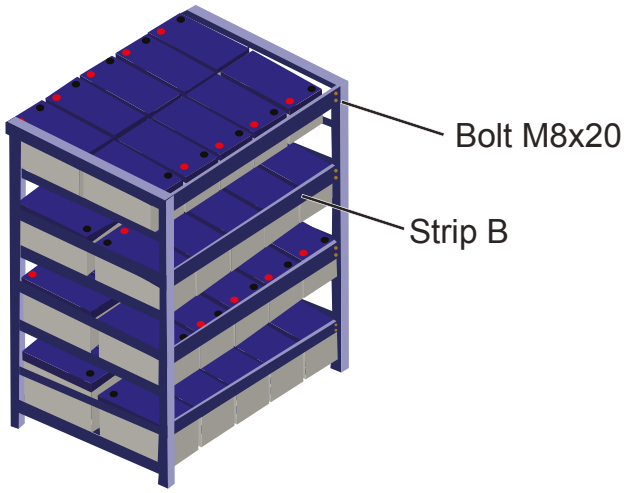


ATTENTION

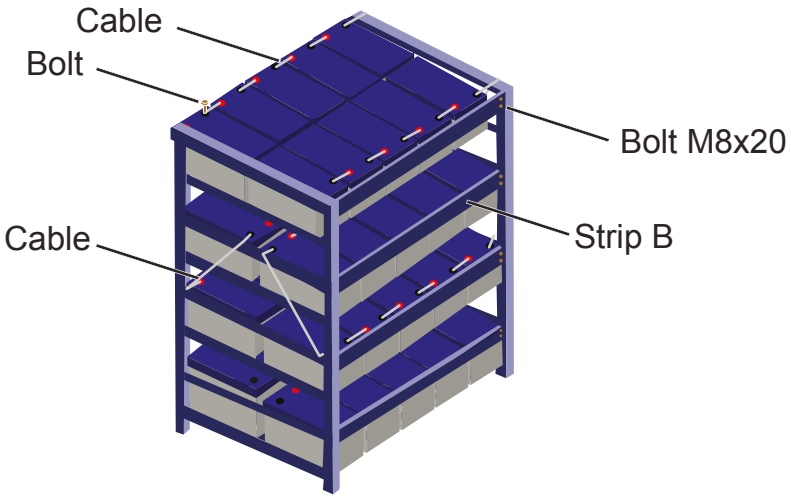
Attention

- Follow the instructions to avoid missing any connections and avoid short circuits.
- The battery terminal torque should follow the manufacturer's recommendation, otherwise, damage may occur.
- Never reverse connect the batteries.

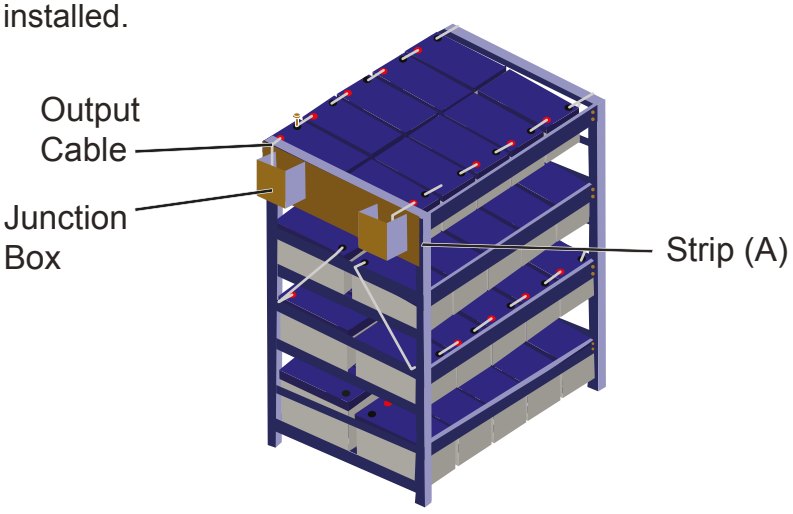
4. Reinstall all (B) Strips



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



6. Install the junction box onto the strip (A) and the steel pillar. Check the voltage after the batteries are installed.



Post Installation Checklist

No.	Item	Qualified	Note
1	Followed instructions.	☐ Yes ☐ No ☐ N/A	
2	All components were installed.	☐ Yes ☐ No ☐ N/A	
3	No damage.	☐ Yes ☐ No ☐ N/A	
4	All fixing bolts are installed.	☐ Yes ☐ No ☐ N/A	
5	Cables installed and are connected correctly.	☐ Yes ☐ No ☐ N/A	
6	Markers or signs are clean.	☐ Yes ☐ No ☐ N/A	
7	All bolts fastened.	☐ Yes ☐ No ☐ N/A	
8	Grounding and breakers are installed.	☐ Yes ☐ No ☐ N/A	
9	Cables installed correctly.	☐ Yes ☐ No ☐ N/A	
10	Communication cables installed correctly.	☐ Yes ☐ No ☐ N/A	
11	Output cables and communication cables are separated.	☐ Yes ☐ No ☐ N/A	
12	All strips are installed correctly.	☐ Yes ☐ No ☐ N/A	

Please Note

- It is recommended to use less than 4 strings in a parallel connection. Serial connections should be made first.
- The temperature difference between layers should be less than 3°C.
- Keep a distance of 10-20mm between the batteries.
- Do not install batteries from different manufacturers or different models together.

SYSTEM DEBUGGING

Ultracell's UCG Solar Series products are an integral part of UPS installations.

- Please note a full test of the system is required after installation.
- Only qualified personnel can test the system.
- Complete installation before testing. Any operation should comply with the installation manual and local regulations.
- Remove any conductive objects such as jewellery etc. during testing. Use the recommended tools only. Avoid contact with the terminals.
- Check all components or parts before powering up.
- Shutdown the system immediately if any abnormalities appear during testing.

Pre-Survey Check

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

Pre-Test Checklist

No.	Item	Qualified	Note
1	All breakers have been cut off.	☐Yes ☐ No	
2	Confirm that there is no short circuit.	☐Yes ☐ No	
3	Check the colour and the label of the input cable to ensure that the positive and negative polarity is correctly connected.	☐Yes ☐ No	
4	Check if the battery is correctly connected in accordance with the schematic diagram of the system, including the attachments.	☐Yes ☐ No	
5	Check that the bolts are tightened in accordance with the recommended torque.	☐Yes ☐ No	
6	Check all settings, including the battery management parameters, are correctly set up and in accordance to the user's manual and configuration requirements.	☐Yes ☐ No	

Warning
Follow regulations whilst testing the system. Any deviation should be confirmed by the manufacturer as it may cause damage to the system.

The battery is an integral part of any solar installation. Testing can be carried out via the UPS system itself. Usually, there are two testing modes. The first testing mode is to verify the connectivity of the batteries and that they can charge and discharge - commonly named “quick test mode”. In some cases, there may be an “expert mode” which can test if the batteries can meet the required backup time under specific conditions.

Instructions for Quick Test Mode

The operation of this mode is relatively simple. Normally, this can be initiated by management controls on the UPS system.

Operation Steps

1. Confirm the discharge load.

2. Confirm the discharge environment and parameters, including the temperature and SOC (state of charge).

3. Ensure all pre-inspection checks have been performed before any testing.

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

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

6. Check if the batteries can meet the requirements according to the recorded data.

Instructions for Expert Test Mode

1. Confirm the discharge load is constantly online. If this is the case, it is recommended to test the battery in the period which power failure is not frequently occurring.

2. Confirm the discharge environment, including the temperature and ensure that the battery is in a fully charged state.

3. Ensure all pre-inspection checks have been performed before any testing.

4. Turn on the discharge circuit and start the discharge until the battery reaches the discharge termination voltage. Record all data in the testing process including the battery voltage, current and other information.

Instructions after Testing

Constant monitoring is needed if the system is online for the first time to avoid leakage or thermal runaway.

Please confirm the following information and operation before proceeding with power up and installation. Confirm the following conditions after installation and powering up:

• Disconnect the test equipment and clean thoroughly.

• Confirm the system operation is functioning correctly.

SYSTEM RUNNING

ATTENTION

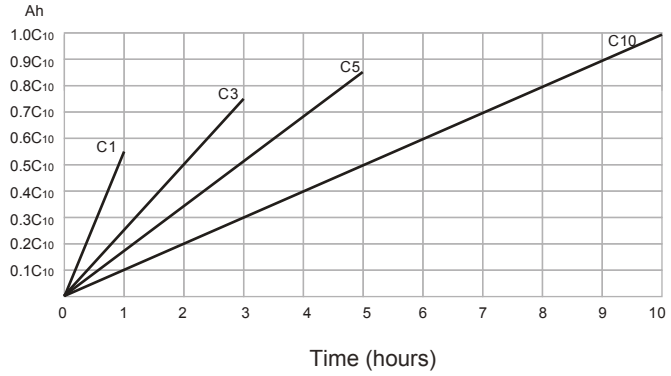
Attention

Battery management parameters should be set by the parameters such as battery quantity, capacity etc. These parameters are the base data source for the BMS module of the system. If the battery parameters are configured incorrectly, it will affect the battery charge, discharge and service life.

Discharging

Discharge Current

The battery cannot be discharged at any current or damage will occur. The manufacturer has set the constraint rules for discharge to ensure safety. The figure below shows the capacity increase with the decrease of the discharge current. For example, a 1000Ah (C_{10}) battery can discharge for 100A for 10hrs but only 550A for 1hr therefore it's capacity becomes 550Ah.



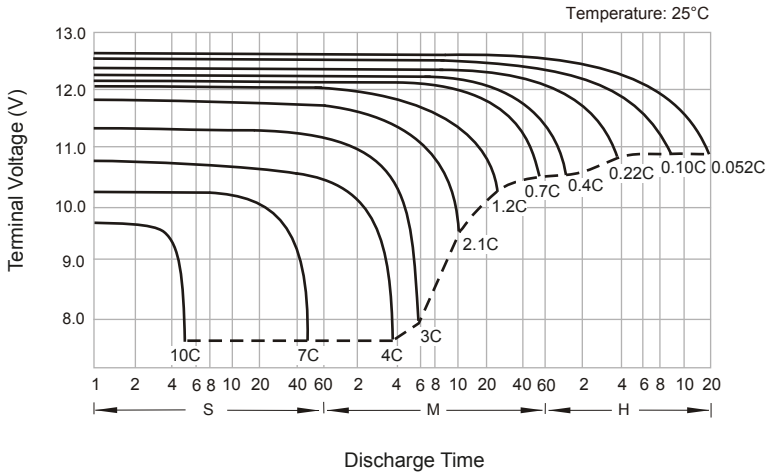
Final Voltage

The final voltage drops rapidly when it reaches the critical level and little energy can be harvested. If discharging of the battery continues, this will cause a negative impact so it is vital that discharge is stopped at the critical voltage level. The critical voltage is called the final voltage.

Lead sulfate is generated when the battery is charged under too low a current and it will cause damage to the battery. The volume will increase $0.57x10^{-3}$ (litre/Ah) at the negative plate and $0.43X10^{-3}$ (litre/Ah) at the positive plate and cause active material to erode.

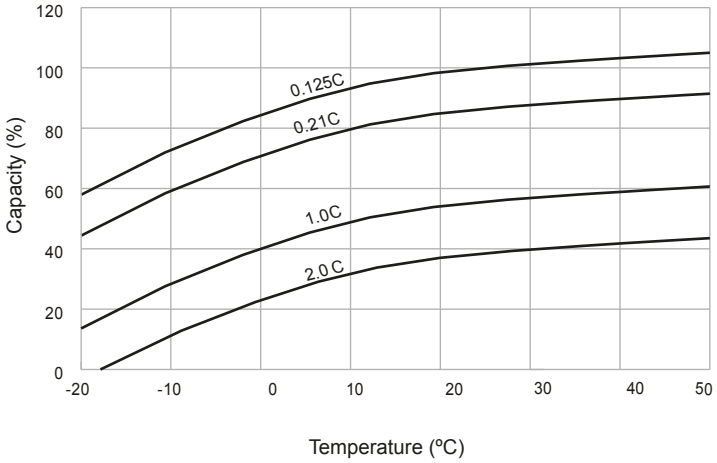
When the battery is discharged to the final voltage stage. Discharge by a small current is prohibited as damage to the battery will occur.

The graph below shows the final voltage under different discharge rates:



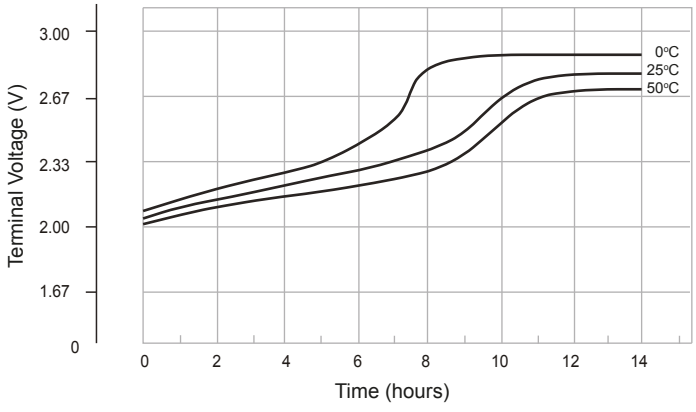
Temperature Effect

Capacity increases with the temperature and can be affected by the discharge current. The figure below shows the effects of different temperatures in relation to battery capacity.

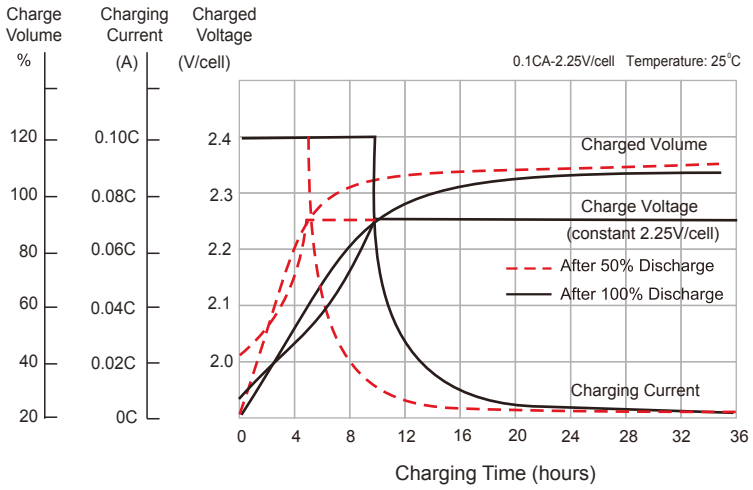


Charge Characteristics

The graph below shows the constant current charge characteristics. The charge voltage increases with the charge time. However, at the final stage, the charge voltage will rise rapidly as the oxygen is produced on the positive plate and $PbSO_4$ becomes lead dioxide. The charge voltage should increase with the decrease of ambient temperature.



The graph below shows the constant voltage charge characteristics. The default setting is 2.25V/cell, the max initial charge current is 0.1C10. The charge current decreases with the charge time and will reach a minimum current at the final stage of charge.



Charge Voltage

Batteries will naturally self-discharge, the charge voltage should be set accordingly so the battery can be fully charged. The table below shows the three modes for constant voltage charge. Float charge is the required mode to keep the batteries fully charged. Equalisation charge is another mode to charge every cell in the string to the same charge status. It is recommended to increase the charge voltage to fully charge the batteries rapidly under cycle use.

Charge Modes for Batteries

Type	Float Charge (V/Cell)	Equalising Charge (V/Cell)	Cycle Use (V/Cell)
≥38Ah/12V	2.25	2.35	2.35~2.30
2V	2.25	2.35	2.35~2.40

NOTE

Please Note

The maximum initialise charge current of Ultracell's UCG Solar Series batteries cannot exceed 0.25C10.

Equalising Charge

Equalisation charge is required when the battery meets the below conditions:

- Discharge capacity is above 20% or according to the power supply setting.
- Shelf life can last from approx 3 - 6 months.
- In the 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 mode yet.
- Float charge usage for more than one year.

Temperature Compensation

- To prolong battery life, consider the temperature compensation (deviated from 25°C).
- When temperature compensation is used, the batteries can be charged in different temperature conditions. When the temperature increases, the current will decrease at the end of the charge time.
- In float charge state, temperature compensates using 25°C as a datum mark and the coefficient is -3mV/cell/°C.
- Decrease -5mV/cell for every 1°C increment (compensation -5mV/cell/°C) on cycle use.

Ripple

Due to the charge equipment's characteristics, there will be some AC component overlay on the DC. This AC component and load feedback will cause the battery temperature to rise and cause lead plate stress and distortion. Normally the limit for ripple voltage and ripple current is 0.5% of the float charge Root Mean Square (RMS), which is a common formula method to define AC ripple or current. Ripple current Root Mean Square (RMS) should not exceed 5A/100Ah rated capacity; during fast charge. The instantaneous value will be allowed to reach 10A/100Ah rated capacity.

MAINTENANCE

To get the optimal service life of the batteries, check and maintain regularly. Keep a record of the process of maintenance as this will help check the battery group's parameters.

Battery Maintenance

Please see the table below which shows the recommended monthly routine maintenance of the battery.

Monthly Maintenance

Item	Content	Standard	Maintenance
Battery temperature	Measure the temperature on the battery terminal and battery case.	Below 35°C.	When the temperature is above standard, please look for the cause, and resolve or consult with your supplier.
Float charge total voltage for battery group	Measure the output terminal voltage of the battery group.	The measurement value is the same as the equipment. The deviation does not exceed ±0.5%, and satisfies the set standards of float charge for the current temperature conditions.	If there is a deviation from the value, it should be based on the actual measurement value. If the equipment cannot meet the allowed error scope after adjustment, the equipment should be reported for repair.
Battery appearance	Check if the battery is inflated or has any leakage.	Appearance is normal.	If the appearance is abnormal, please replace the battery.
	Check for dust or dirt.	Clean appearance.	Wipe off the dust with a damp cloth.
	Examine the connector terminals and terminals for signs of rust.	No signs of rust on terminals or connectors.	If rust is present, wipe away, and change the connection line and cover with anti rust agent.
Connections	Use a wrench and ensure the connection is tight.	Torqued to the manufacturer specifications.	If the connection is loose, please tighten the connection to the correct torque specifications.
	Battery group connection, terminal clearance, no abnormallities.	No signs of rust.	When minor rust appears, remove the connection, clean the connections with clean water and a brush, then dry. If the rust worsens, replace the connection line.

Monthly Maintenance continued on the next page.

Item	Content	Standard	Maintenance
Safety valve examination (2V battery)	Gently move the safety valve and check the installation is secure.	The safety valve is secure and there is no movement.	If the safety valve moves, please tighten securely.
	Visual inspection of the safety valve with crystals present.	No crystals present.	Clean with a dry cloth. If this persists, contact your supplier.
Switch test	Break in the AC supply. Batteries will supply power. Follow the station's regulations.	No power down. The switch works well.	Check the battery if the output voltage drops too fast or site powers down.

Seasonal Maintenance

Item	Content	Standard	Maintenance
Bolt	If the bolt is tight.	Follow the manufacturer's guide.	Follow the manufacturer's guide.
Floating charge voltage	Checking floating charge voltage.	2V series the difference should be less than 90mV. 12V series the difference should be less than 480mV.	Discharge 10% then equalisation charge, then floating charge for 2-3 months. If the voltage still fails, replace the battery.
Failed Battery	Low voltage.	The floating charge voltage should meet the standard.	Equalisation charge the battery for 10h and then discharge. Repeat 3 times. If the battery still fails, contact your supplier.

Annual Maintenance

Item	Content	Standard	Maintenance
Bolt	If the bolt is tight.	Follow the manufacturer's guide.	Follow the manufacturer's guide.
Discharge Test	Discharge the batteries in 30% ~ 40% D.O.D.	The final voltage should be above the recommended voltage.	Equalisation charge then floating charge for 1-2 months. If the discharge fails, contact your supplier.

NOTE

Please Note

- Follow the guidance to maintain the batteries.
- Wear protection and insulate the tools to prevent any shock.

Checklist for Common Failure

Frequent failure and solutions are shown in the table below:

Specification	Service Life	Mark
Damage	Damage during transportation.	• Contact your supplier for further advice.
Floating charge voltage	Floating charge voltage is abnormal.	• Check the settings. • Equalisation charge the batteries.
	Too high or too low.	• Check if there are any short circuits or open circuited batteries then replace them.
Floating charge current	Zero charge current.	• Check the connection and voltage for each cell. • Ignore if the charge current is too low (beyond the tolerance).
	Floating charge current is bigger than $0.05C_{10}$ after being charged for 48 hours.	• Common causes of battery failure are overheating (+15°C above environment temperature) or the system settings are wrong. • If no error is found, replace the battery.
Leakage	Crystals present on terminals or battery.	• Clean with a dry cloth. If crystals persist, replace the battery. • If there is leakage from the terminal, clean and replace the battery.
Thermal runaway	Thermal runaway.	• Check and clean the valve. • Check for undercharged battery (<2.05V/Cell) in the circuit. • Check the system settings. • Replace only damaged batteries.
Cannot be charged	No power.	• Check the connections. • Check for any leakage, damage or thermal runaway. • If no errors are found, check the open circuit voltage. If it is below 2.05V/cell, replace the battery.
Capacity and voltage	Capacity or voltage drops quickly.	• Contact your supplier.

COMPONENT REPLACEMENT

Replace Batteries
A battery is a consumable product and has a service life. The usage conditions and ambient temperature should be taken into account for the service life of the batteries. Replace when service life has been reached to keep the system reliable.

Precondition
The battery should be replaced if the battery performance does not meet the requirements or standard after testing.

Confirm the risk of blackout and correct maintenance.

Operation Steps

• Remove the battery from the system.

• Dismantle the connectors from the batteries using insulated tools.

• Replace old, damaged accessories with new ones.

• Connect the battery connectors in order.

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

Attention
If there is space interference, unpack and mark the batteries following current flow sequence while maintaining insulation protection.

ENVIRONMENTAL PROTECTION

Toxic and Poison

Checklist for Toxic and Poison

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

Recycling

Ultracell's UCG Solar Series batteries contains a recycle mark. Please recycle in accordance with local laws and regulations to ensure any potentially harmful substances are not exposed to human health or the environment.

To recycle old equipment, please use the recycling system or contact your local authority to manage waste disposal.

Post Installation Checklist

No.	Item	Qualified	Note
1	Followed instructions.	☐ Yes ☐ No ☐ N/A	
2	All components were installed.	☐ Yes ☐ No ☐ N/A	
3	No damage.	☐ Yes ☐ No ☐ N/A	
4	All fixing bolts are installed.	☐ Yes ☐ No ☐ N/A	
5	Cables installed and are connected correctly.	☐ Yes ☐ No ☐ N/A	
6	Markers or signs are clean.	☐ Yes ☐ No ☐ N/A	
7	All bolts fastened.	☐ Yes ☐ No ☐ N/A	
8	Grounding and breakers are installed.	☐ Yes ☐ No ☐ N/A	
9	Cables installed correctly.	☐ Yes ☐ No ☐ N/A	
10	Communication cables installed correctly.	☐ Yes ☐ No ☐ N/A	
11	Output cables and communication cables are separated.	☐ Yes ☐ No ☐ N/A	
12	All strips are installed correctly.	☐ Yes ☐ No ☐ N/A	

Pre-Testing Checklist

No.	Item	Qualified	Note
1	All breakers have been cut off.	☐ Yes ☐ No	
2	Confirm that there is no short circuit.	☐ Yes ☐ No	
3	Check the colour and the label of the input cable to ensure that the positive and negative polarity is correctly connected.	☐ Yes ☐ No	
4	Check if the battery is correctly connected in accordance with the schematic diagram of the system, including the attachments.	☐ Yes ☐ No	
5	Check that the bolts are tightened in accordance with the recommended torque.	☐ Yes ☐ No	
6	Check all settings, including the battery management parameters, are correctly set up and in accordance to the user's manual and configuration requirements.	☐ Yes ☐ No	

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