Discover®

ENERGY STORAGE

SOPzV Gel Tubular Plate Battery

Operating Manual

TUBULAR GEL SOPzV
12V BLOCK

REV A

106 - 4105 Hickory Hill Rd Memphis, TN 38115, USA + 1.888.819.4044 @ info@discoverbattery.com

Overview

The manual includes information about safety instructions, installation considerations, and other valuable topics to help you install, operate and maintain your Discover®Tubular Gel Battery. Please read through this guide completely before using your batteries, this will help protect your new investment and ensure the batteries are operating to maximum performance.

Certain configuration, installations, service, and operating tasks should only be performed by qualified personnel in consultation with local utilities and/or authorized dealers. Qualified personnel should have training, knowledge, and experience in:

- Installing electrical equipment
- Applying applicable installation codes
- Analyzing and reducing hazards involved in performing electrical work
- Installing and configuring batteries

No responsibility is assumed by Discover for any consequences arising out of the use of this material.

Visit discoverbattery.com for the most recent version of published documents.

Read instructions carefully and place them close to the battery.

Use protective glasses, gloves and clothing when working on batteries. Always make safe working practices a priority.

No smoking. Do not expose batteries to flames, or sparks, as it may cause an explosion.

Clothing contaminated by acid should be washed in water.

Batteries with this symbol can be recycled.

Risk of explosion and fire. CAUTION: Battery terminals and connector are always under voltage. Do not place tools or other metal objects on the battery. Avoid short circuits!

Electrolyte is highly corrosive.

Batteries and cells are heavy. Ensure secure installation! Use only suitable handling equipment and lifting gear.

Dangerous Voltage!

Do not mix with other industrial or household waste. Contact your servicing Discover® dealer for proper battery return and recycling!

1. Safety

1.1 Do's

- Do protect terminals from short circuit before, during, and after installation
- Do wear electrically insulated gloves
- Do use electrically insulated tools
- Do wear eye protection
- Do wear safety toe boots / shoes
- Do read user manual for battery handling instructions
- Do secure battery safely
- Do have first aid kits and fire extinguishers easily accessible

1.2 Do Not's

- Do not immerse battery in water
- Do not lift or carry the battery during usage or operation
- Do not operate or store battery outside of operating limits
- Do not short circuit battery
- Do not puncture battery
- Do not expose battery to flames, or incinerate
- Do not open battery case or dissemble battery
- Do not wear rings, watches, bracelets or necklaces when handling or working near battery
- Do not drop or crush battery
- Do not lift battery by the terminal cables
- Do not vibrate battery
- Do not expose battery to water or other fluids
- Do not expose battery to direct sunlight
- Do not dispose of battery
- Do not connect with other types of batteries
- Do not expose battery to high temperatures
- Do not install with other battery types or brands

2. Delivery and Storage

2.1 Receiving Inspection

- Inspect for missing components.
- Check against the shipping/packing documents.
- Inspect each package or pallet for integrity.
- Record receipt date and inspection data results, and notify your servicing dealer of any damage. Take photographs if necessary.

2.2 Storage

- Store in a dry, clean, ventilated and cool location.
- Winter storage in sub-freezing temperatures as low as -35 °C / -31°F possible as long as they are fully charged prior to storage.
- Do not expose to direct sunlight as damage to the container and cover may occur.
- Do not stack pallets on top of each other and on sharp-edged supports.
- Storage on a pallet and wrapped in plastic material (shrink wrap) is permitted except when room temperature fluctuates significantly, or when high relative humidity can cause condensation under the plastic. Condensation can cause a whitish hydration on the terminals to form and result in current leakage and self-discharge.
- Protect against any risk of electric shock from short- circuiting poles/terminals with conductive objects or from the buildup of conductive dust.

- Maintain the same storage conditions for all batteries within the same batch. Depending upon storage conditions and temperature, storage time may be limited.
- If lead acid batteries are to be stored for extended periods of time, they must be placed fully charged.
- To prevent over discharge during storage, do not store batteries for more than 6 months at 20°C/68°F or 3 months at 30°C/86°F before performing a re-fresh charge. Failure to observe these conditions may result in significantly reduced capacity and service life.
- Record dates and conditions for all charges during storage.

2.3 Unpacking and Handling

- Never lift battery by the terminal posts. Lifting batteries heavier than 25 kg/55 lb should be made with lifting belts
- Never drag or roll the battery!
- The batteries are fully charged before shipment. Do not short circuit.
- Check for evidence of leakage. All batteries with visible defects should be rejected.

3. Installation and Commissioning Charge

3.1 Installation and Battery Room Design

- All electrical protective measures, devices, accommodation and ventilation of the battery installation area must be in accordance with all local rules and governmental regulations.
- The battery should be installed in a clean and dry area and protected against dropped items and dirt.
- Avoid placing the battery in a hot place or in direct sunlight.
- The location or arrangement of batteries should result in no greater temperature difference than 3°C/5°F between batteries within a connected string at any given time.
- Avoid conditions that result in spot heating or cooling, as temperature variations will cause electrical imbalances in the battery. For better cooling and temperature management ensure the installation allows for adequate air flow around each battery. Keep 10mm/0.5in distance between batteries.
- The layout of the battery room or installation area must allow for easy access to the batteries. The recommended minimum distance between battery rows is 1.5 times the depth of the row.
- Racks or cabinets shall be located 100mm/4in from the wall.
- Be sure to provide adequate space and lighting for inspection, maintenance, testing, and battery replacement. Space should also be provided to allow the operation of lifting equipment and for taking measurements (battery voltage and temperature) during service.

3.2 Batteries in Parallel Strings

Discover® Tubular Gel batteries may be connected in parallel to increase capacity, current capability and/or discharge durations. In the case of each parallel connected string, only use batteries of the same voltage, capacity, design and age.

The resistance and ampacity of the cables or connector bars in each string must be the same, e.g. same cross-section, same length and same conductor type (copper, aluminum). In addition, each string should be equipped with disconnect capabilities (circuit breakers) for maintenance and safety purposes.

Discover® recommends a maximum of 4 strings parallel. If the following steps are fulfilled it is possible to have more strings in parallel without reducing battery life or batteries getting out of balance if the following requirements are fulfilled:

- The same voltage drop must be realized from each string to the end connection (load and ground). This can be achieved by proper choice of cable lengths, cable diameters and arrangement for crosswise connection configurations
- The connector cables for positive and negative terminals of each battery string must have the same length
- It is a must that each string has a manually operated switching device that also automatically opens or breaks the circuit in the event of an over current (circuit breaker).
- Each string must have the same number of batteries
- Each string must be exposed to the same heat or temperature potential.
- Always connect the individual series strings first and then check that the different strings are at the same potential before connecting them together on the bus.

3.3 Batteries in Series Strings

Discover® Tubular Gel batteries may be connected in series to increase system voltage. In the case of each series connected string, only use batteries of the same voltage, capacity, design and age.

- The resistance of the cables or connector bars in each string must be the same, e.g. same cross-section, same length and same conductor type (copper, aluminum).
- Each string should be equipped with disconnect capabilities (breakers) for maintenance and safety purposes.

3.4 Electrical Connections

Battery cables must be sized to the specifications required by the inverter charger and must be installed in accordance with the standards set by the authority having local jurisdiction.

- Ensure that the battery is installed and connected in the correct polarity
- If the battery circuit has a disconnect - open the disconnect to isolate battery
- Check that all contact surfaces are clean. If required, clean poles/terminals with a brass brush/pad.
- When using a washer to connect a battery cable to a battery terminal, it is very important to ensure the battery cable is contacting the lead surface of the terminal and that the washer is placed on top of the cable. Do not place the washer between the battery terminal and the battery cable, this creates high resistance and can cause terminal meltdown.
- Do not ground the terminals to any metal mounting, fixture, or body part
- Connect battery cables. Connect the ground cable last to avoid sparking
- Tighten terminal screws using the terminal torque values as in the table below and thinly coat connections and terminals with dielectric grease or silicone to prevent corrosion
- If the battery circuit has a disconnect - close disconnect to reconnect the battery

Note: All cable ends must be connected to battery terminals without any washers between terminal bushing and cable ends.

Terminal Torque	9 - 11 Nm / 6.64 – 8.11 Ft-lbs

4. Operation

4.1 Charging

A battery charge profile (also known as an algorithm) contains all of the logic used to execute a multi-stage charging process, including the bulk, absorption and float phases. Charge profiles differ depending on the battery type, capacity, battery manufacturer, and even the application. It is extremely vital that a battery is charged with an appropriate charge profile. Not doing so, may cause the battery pack to be chronically under- or over- charged, resulting irreversible damage and premature end-of-life.

The Bulk charge accounts for charging the battery from anywhere between 0% up to 80% state of charge. The absorption phase charges the battery from 80% to nearly 100% state of charge. Lastly, a float charge supplies a controlled voltage and amperage to bring the battery to a complete full charge. Without a float charge, recharge can be terminated based on time (this will need to be determined as it will vary with depth of discharge and charge current) or until the battery voltage has not risen for a period of 3 hours.

The battery temperature must be monitored during charge. It should never exceed 55°C/131°F. If the upper temperature limits are reached, the charge shall be interrupted or the charge voltage should be reduced to float voltage for a period of time sufficient enough to allow the battery to cool down. Operation can continue once the temperature stabilizes below 45°C/113°F.

SUPERIMPOSED ALTERNATING CURRENTS

Depending on the charger type and charging characteristic curve, alternating currents flow through the battery during charging and are superimposed onto the charging direct current. These superimposed alternating currents and the reaction of the loads lead to additional heating of the battery or batteries and create a cyclical strain on the electrodes. This might result in premature aging of the battery. These alternating currents (AC ripple current) must not exceed 1-2A per 100 Ah of C10 nominal capacity.

TEMPERATURE-RELATED ADJUSTMENT OF THE CHARGE VOLTAGE

To maximize battery life, a voltage regulated charger with temperature compensation is strongly recommended. The voltage settings displayed in charge setting tables, corresponds to the set points at 25°C (77°F). For temperatures below 25°C, adjust +0.005VPC/°C (or 0.003VPC per °F). For temperatures above 25°C, adjust -0.005VPC/°C (or 0.003VPC per °F). As the temperature decreases, the voltage should increase and vice versa.

$$\Delta V = (T - 25°C) \times \left(\frac{-0.005VPC}{°C} \right)$$

Note: If a temperature sensor is not used, you must manually adjust charging voltages based on the battery temperature when in use.

If the charger has a preset charge profile for GEL type batteries, verify that these settings follow recommended charge settings.

4.1.1 Charge Parameters

The charge voltage should be set as shown in the table below.

Nominal System DC Voltage	12V	24V	48V
Maximum Charge Current	0.2 C10		
Maximum Absorption Time	4 hours		
Bulk & Absorption Charge Voltage	14.2V	28.4V	56.8V
Float Voltage	13.8V	27.6V	55.2V
Balancing Voltage	14.8V	29.6V	59.2V

Voltage Regulated Charge profile (IUU charger) at 25°C / 77°F

4.1.2 Balancing charge

To avoid permanent capacity loss and sulphation in cycling operation the goal is to achieve a complete recharge (100% SoC) after every discharge. Capacity loss and sulphation will threaten the battery's state of health.

The less complete the daily recharge is, the more frequently a balance charge will be required to protect the battery from sulphation and lagging batteries. Depending on the cycling frequency, a balancing charge is recommended every 60 to 180 days. When short charging times are used then balancing charges are required at frequent intervals, preferably every month.

Balancing charges are also required after incidents of excessive stress for the battery (deep discharges with inadequate charges) or when the individual battery voltages show excessive deviation from the average (lagging batteries and sulphation problems). Should the voltage in individual batteries deviate from the average value more than the following limits, perform a balance charge. Balance charge is generally required when the total spread between batteries is greater than 0.04V.

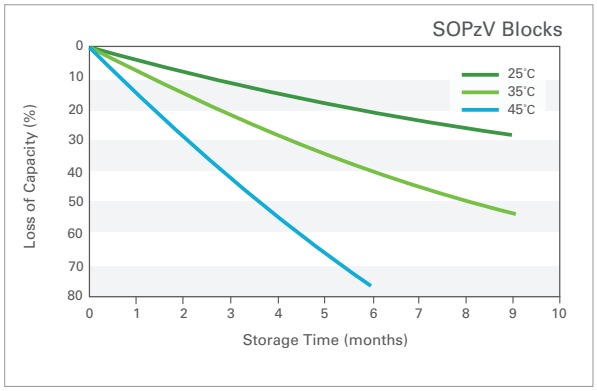
4.1.3 Commissioning Charge

Batteries lose charge while in transit or during storage. For this reason, a refresh charge should be given before putting the battery into service. The battery should be considered fully charge when individual battery voltages have not risen for a period of 4 hours. The surface temperature must not exceed 55°C (131°F). Recommended charge settings are as follows:

Nominal System DC Voltage	12V	24V	48V
Bulk & Absorption Charge Voltage	14.2V	28.4V	56.8V
Current Limit	10A per 100Ah C10 rating		
Time Limitation	Max. 6hrs		

Commissioning / Refresh charge settings (25°C/77°F)

SELF-DISCHARGE CHARACTERISTICS



During commission, measure the battery voltage before and after commissioning, measure the battery voltage and surface temperature of each battery and log this data. Discover Commissioning Logs are available online at discoverbattery. com/en/resources/

4.2 Discharging

It is recommended for a system to be sized for no greater than 50% Depth of Discharge (DOD). A deep discharge will provide more capacity to operate loads but exposes the battery to sulphation and reduces the service life. After a deep discharge, it is recommended to charge a battery back to full State of Charge (SOC) as soon as possible to preserve capacity life.

The longer the battery stays at a low Depth of Discharge, the greater the exposure to sulphation and capacity loss. If the battery is left at a low Depth of Discharge for extended periods of time, sulphation damages may become unrecoverable.

OVER-DISCHARGE PROTECTION

Maximum Depth of Discharge limits should not be managed solely based on Ah-counters (counting the ampere- hours into and out of the battery). Monitoring the battery voltage against the low- voltage disconnect setting (LVD) should always be included.

- The system designer or installer shall adjust and confirm the LVD settings based on the actual conditions of the system.
- For systems where the voltage is measured at the controller and not on the battery, the voltage drop on the connections to the battery shall be considered.

Reference LVD / I10	20% DOD	12.30 V
	50% DOD	11.90 V
	80% DOD	11.10 V

4.3 Temperature Limits

The battery is designed to perform optimally at temperatures between 15-25 °C. At lower temperatures the battery capacity is lower and at elevated temperatures the life is reduced. A maximum ambient operating temperature of 55°C / 131°F must not be exceeded.

Sub-zero temperatures may cause electrolyte freezing and irreversible damage when the battery's state of charge (SoC) is low.

State of Charge (SOC)	0%	25%	50%	75%	100%
Freezing Point	-23C / -9°F	-27°C / -17°F	-37°C / -35°F	-48°C / -54°F	-59°C / -74°F

Discover Tubular Gel batteries can be stored in sub-freezing temperatures as low as -35°C / -31°F as long as they are fully charged prior to storage. The self-discharge rate of fully-charged batteries is very low in these conditions and they will not require charging for many months.

4.4 Charge Current Limits

The maximum charging current during bulk charging in general should not exceed 30A/100Ah C10 rating. Using a charging current during bulk/absorption of 10A to 20A per 100Ah C10 rating is recommended.

5. Battery Maintenance

VISUAL INSPECTION

Check for any visible defects such as cracked jars, loose terminal posts and oxidized connectors. To avoid leakage currents and the associated risk of fire, keep the battery dry and clean. Do not use any solvents or detergents. Avoid electrostatic charges. Discover Maintenance Logs are online available at discoverbattery.com/en/resources/

QUARTERLY MAINTENANCE

- Check/record battery voltage
- Deviation testing of battery voltages (deviations signal imbalance batteries)
- Deviation testing of battery temperatures (deviations signal short circuit cells)
- Check if connectors are firmly tightened
- Confirm DOD per battery does not exceed the allowed limit
- Confirm that charge settings correspond to recommendations

BI-ANNUAL MAINTENANCE

Further to the bi-annual maintenance, do the following:

- Inspect racks/cabinets for corrosion or loss of integrity
- Check/record if ventilation is sufficient.
- Check/record battery room temperature
- Check battery for cracks
- Check ground connections

6. Transport

Be sure that all cells are protected against short-circuit. Be sure to document and transport all cells or batteries according to local department of transportation rules and regulations.

7. Recycling

Discover's lead acid batteries are recyclable products. All Discover Factory Warehouses and servicing dealers are qualified to accept and handle all used lead acid batteries. Contact Discover® or your servicing dealer for details.

8. Troubleshooting and Frequently Asked Questions

The following is a list of common concerns and questions regarding system setup, battery charging and maintenance procedures. Please refer to these as general guidelines. For further assistance with your specific system setup, please contact your installer.

WHAT CAUSES THE BATTERY TERMINAL TO MELT?

Battery terminals melting is most common because of improper connections causing high resistance and heat generation.

- Loose connections
- Over-tightened connections
- Improper sized cables (too small).
- Corroded connections
- Improper use of washers/lock washers.
- Too many connections on the same terminal

WHY DO THE BATTERIES BULGE?

In some cases bulging can happen and is normal during battery charging.

- If case bulging is a concern upon receipt of a new product, please notify your Distributor immediately
- In the case of excessive bulging- your batteries may have been exposed to temperatures of over 50°C (122°F) or may have been overcharged. Both conditions may cause the plates/chassis to swell and expand. If this occurs, the batteries may fail prematurely.
- The batteries may have frozen due to excessive exposure to cold temperatures.

To prevent bulging, you need to take the following precautions:

- Use the right type of charger and charge algorithm that is fully compatible with the battery
- Ensure proper polarity when connecting the charger to the battery
- Don't short-circuit the battery
- Don't expose battery to temperatures of over 55°C (131°F) and prevent battery from freezing

WHAT CAUSES A BATTERY TO LOSE CAPACITY?

Every lead acid loses capacity over its lifetime. A loss of capacity may indicate the battery is cycled out and reached its end of life. Capacity loss may also occur due to sulphation, overheating, or over-discharging. If there is capacity loss, the battery bank may no longer support an increase in load. To prevent premature capacity loss:

- Use the right type of charger and charge algorithm that is fully compatible with the battery.
- Verify the temperature sensors are properly mounted and the operation settings are adjusted to the appropriate battery temperature.

WHY IS THE CHARGING CURRENT TO THE BATTERY BANK SO LOW?

The charging current will decrease as the batteries become fully charged. If the charge current is low, the end of charge cycle may have been reached. Verify that the charger is near the end of the Absorption phase or in Float voltage phase. If so, low current is normal at this stage of charging.

- The battery bank self-regulates charge current. The voltage can be controlled and adjusted to a high or low setting, however the amp output to the battery bank cannot be controlled and will drop as the batteries reach a full state of charge.
- When the charge current decreases to 2% of the battery C20 capacity, the charge is essentially complete.

WHY DOESTHEVOLTAGE RISE VERY QUICKLY CAUSINGTHE CHARGERTO SHUT OFF WHEN I BEGINTO CHARGE MY BATTERY BANK?
This is often an indication of sulphated batteries which can be confirmed by completing a load test

- An increase in Absorption time may be necessary to sufficiently charge the battery to full SOC.

WHY DOESTHE BATTERY BANK NOT REACHTHE BULK VOLTAGE SETTING WHEN CHARGING?
If the system is not reaching the Bulk voltage, the charger voltage and/or Amp output to the battery bank may be too low. To ensure sufficient charge, the output should be approximately 10%-25% of the C20 capacity rating of the battery bank. Another cause may be from DC loads running on the system during the charge cycle and reducing the current supplied to the battery bank.

- Verify that the charging settings meet the recommended charging parameters and that the charger output (Amps) is sufficient to meet the capacity requirements of the battery bank.

WHAT DO I DO IFTHE BATTERYTEMPERATURES ARE VERY HIGH?
If at or nearing 55˚C (131˚F), shut off the charger and allow the batteries to cool. If a single battery or cell in a string is hot, this may indicate a cell failure or short. Verify the voltage readings from each battery, and perform a load test to identity any cell failures.

9. Definitions and Abbreviations

- Ampacity: The allowable current-carrying capacity of a conductor measured in amps. Ampacity is the current, in Amperes, that a conductor can carry continuously under the conditions of use without exceeding its temperature rating.
- Battery Capacity: The power a battery can deliver from full charge at standard temperature, and at a specified (usually C10) discharge rate.
- Circuit Breaker: Is an automatically operated electrical switch designed to protect an electrical circuit from damage caused by overload or short circuit. Its basic function is to detect a fault condition and interrupt current flow. Unlike a fuse which operates once and then must be replaced, a circuit breaker can be reset (either manually or automatically) to resume normal operation.
- DoD: Depth of Discharge or how deeply the battery has been dis-charged. Like the fuel gauge of your car, DoD is the measure of how much fuel you have used.
- I10: The constant current (I) discharge rate that can be maintain for 10 hours (10).
- MDDoD: Maximum Daily Depth of Discharge allowable
- MDoD: Maximum allowable Depth of Discharge
- OCV: Open Circuit Voltage: The voltage across the cell/ block or battery terminals with no load applied. The maximum possible voltage across a PV array, module, or cell with no load.
- SoC: State of Charge or how much energy is still available to be discharged. Like the fuel gauge of your car, SoC is the measure of how much gas you have left.
- V: The unit of measure for voltage. Voltage is the electrical pressure which forces the current to flow in a conductor such as a wire.
- VPC: Volts per Cell. The voltage of each individual cell, each cell in a block or each cell in a battery. The system voltage of your battery is the sum of the individual volts per cell.
- 100AH C10: Battery has a capacity (C)of 100 amp hours (AH) when rated at the 10 hour (C10) rate.