Discover®

DRY CELL

Traction Valve Regulated Battery

Operating Manual

DRY CELL
BATTERY BLOCKS

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Overview

The manual includes information about safety instructions, installation considerations, and other valuable topics to help you install, operate and maintain your Discover® Dry Cell 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

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1. SAFETY

1.1 Warnings, Cautions, Notes and Symbols

▲ WARNING
Important information regarding possible personal injury.

▲ CAUTION
Important information regarding possible equipment damage.

▲ NOTE
Additional information concerning important procedures and features of the battery.

1.2 General Warning

▲ CAUTION
It is important to operate the battery with care to avoid undesirable consequences.


Do not throw batteries in the garbage. Do not dispose in fire.


Use personal protective equipment when working with batteries.


Additional information concerning important procedures and features of the battery. Read all the instructions before installation, operation and maintenance.


This product must be recycled and is made of recycled products.

▲ CAUTION
Do not disassemble or modify the battery. If the battery housing is damaged, do not touch exposed contents.

1.3 Fire Risk

▲ WARNING
Risk of fire - Do not expose batteries to flames, or sparks, as it may cause an explosion.

1.4 Electric Shock Risk

▲ WARNING
Battery terminals and connector are always under voltage. Do not place tools or other metal objects on the battery. Avoid short circuits!

1.5 Chemical Risk

▲ WARNING
Electrolyte is highly corrosive. Lead acid batteries are a chemical risk if misoperated, mishandled or abused.

1.6 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 handle battery carefully
- Do secure battery safely

1.7 Do Not's

- Do not add water to the battery
- 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 and Inspection

- Inspect for missing components.
- Check against the shipping/packing documents.
- Inspect each package or pallet for integrity and electrolyte leakage.
- 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, cool and frost-free location.
- 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

▲ WARNING

Read Safety Section 1 before handling the battery.

- Never lift batteries by the terminal posts, use carry handles.
- Do not short circuit.
- Check for damage. All batteries with visible defects should be reported.
- It is recommended to check the OCV (Open Circuit Voltage) on arrival.

3. Installation and Commissioning

▲ WARNING

Read Safety Section 1 before handling the battery.

3.1 Tools

- Insulated tools
- Voltmeter
- Post cleaner and wire brush
- Personal protective equipment

3.2 Battery Compartment

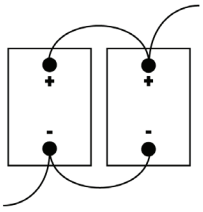
- Battery performance and service life will be optimized when they are operated in an ambient temperature of 15°C to 25°C (59°F to 77°F).
- All electrical protective measures, devices, accommodation and ventilation of the battery installation area must be in accordance with all local rules and governmental 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.
- 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 the batteries should have a minimum of 0.50" (12.7mm) of space to ensure adequate air flow around each battery.

3.3 Parallel Connections

Discover® Traction Dry Cell 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 3 strings parallel: The following steps should be fulfilled to have battery string in parallel without reducing battery life or batteries getting out of balance:

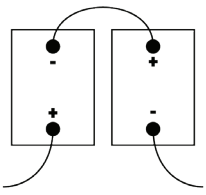


Parallel Connection

- 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.
- Same length connector cables for positive and negative terminals for each string.
- Manually operated switching device that also automatically opens or breaks the circuit in the event of an over current (circuit breaker) for each string.
- Same number of batteries for each string.
- Same heat or temperature potential for each string.
- Always connect the individual series strings first and then check that the different strings are at the same potential before connecting them in parallel.

3.4 Series Connections

Discover® Traction Dry Cell 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.

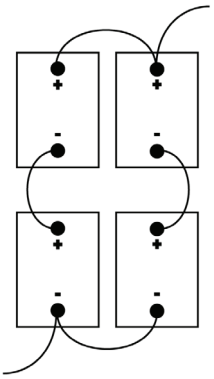


Series Connection

- Same cables or connector bar resistance for each string e.g. same cross-section, same length and same conductor type (copper, aluminum)
- Disconnect capabilities (breakers) on each string for maintenance and safety.

3.5 Series/Parallel Connections

To increase both voltage and capacity, Discover Dry Cell may be connected in series and parallel. Refer to diagram for series/parallel connections.



Series/Parallel Connection

3.6 Electrical Connections

Battery cables must be sized to the specifications required by the charger and application, 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.

Terminal Type	Terminal Torque
(F13) M5 Button	4 ft-lbs / 5 Nm
(F11) M6 Button	6 ft-lbs / 8 Nm
(F10) M8 Button	7 ft-lbs / 10 Nm
(F27) M8 Button	11 ft-lbs / 15 Nm
(F10) M10 Button	12 ft-lbs / 16 Nm
(F4) 5mm Nut & Bolt	3 ft-lbs / 4 Nm
(F4) 6mm Nut & Bolt	3 ft-lbs / 4 Nm
(F5) 8mm Nut & Bolt	8 ft-lbs / 11 Nm
(F7) 6mm Nut & Bolt	3 ft-lbs / 4 Nm
(F9) 7mm Nut & Bolt	8 ft-lbs / 11 Nm
(F16) 8.5mm Nut & Bolt	8 ft-lbs / 11 Nm
SAE Auto Post	6 ft-lbs / 8 Nm
AM Dual Terminal (AP and 5/16” threaded stud)	9 t-lbs / 13 Nm
AT Dual Terminal (AP and 3/8” threaded stud)	10 ft-lbs / 14 Nm

▲ NOTE

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

4. Operation

▲ CAUTION!

Read Safety Section before installing the battery.

Before charging the battery make sure to read and understand the instructions that come with the Power Conversion device. Never attempt to charge a battery without first reviewing and understanding the instructions for the Power Conversion device being used.

4.1 Charging

▲ CAUTION!

Always make sure the charger is in the correct setting and compatible with the battery's charging requirements; never charge a visibly damaged battery; never charge a frozen battery.

4.1.1 Charge Curve

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 finishing 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.

There are various charge algorithms to charge Discover® Traction Dry Cell Batteries.

1. Voltage regulate (IUU) charging
2. Current controlled (IUI) charging
3. Current controlled (IUI) charging with pulse termination. Discover recommends IUI charge algorithm for traction applications i.e. floor scrubber and material handling with deep discharges (~80% DoD) and high discharge current (I1-I5).

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

▲ WARNING!

Do not equalize charge DRY CELL batteries! Equalizing is an "over voltage-over charge" performed on flooded leadacid batteries after they have been fully charged.

Voltage regulate (IUU) charging

To maximize battery life, a voltage regulated charger with temperature compensation is strongly recommended. The voltage settings displayed in charge algorithm graph and 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.

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

▲ 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 AGM type batteries, verify that these settings follow recommended charge settings.

IUU CHARGE PROFILE

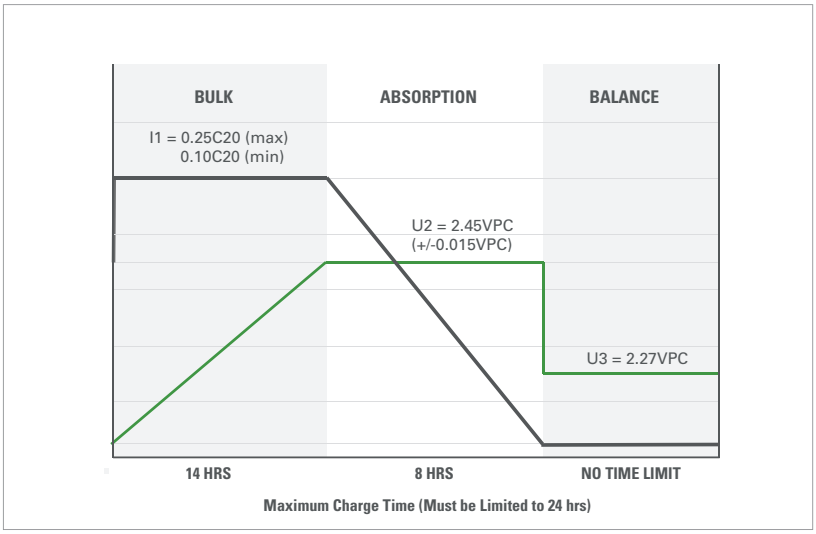


Figure 1: Voltage Regulated Charge profile (IUU charger) at 25°C (77°F)

	6 VDC	8 VDC	12 VDC	24 VDC	36 VDC	48 VDC
Bulk & Absorption Charge Voltage U2	7.4V	9.8V	14.7V	29.4V	44.1V	58.8V
Recommended Charge Current I1	I1 = Min 10% C20 to Max 25% C20					
Float Voltage U3	6.8V	9.1V	13.6V	27.2V	40.9V	54.5V

Table 1: Voltage Regulated Charger - Charge settings at 25°C (77°F)

▲ WARNING!

Charge Profile graph, 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). If a sensor is not used, you must manually adjust charging voltages based on the battery temperature when in use.

Current controlled (IUI) charging

Some chargers that claim to have an equalize mode or stage should not be used on AGM or Gel batteries. Discover's approved chargers may have "Balance Charge" modes included in their "single cycle" charge algorithms. Balance Charging is similar to an equalize charge but it is performed using specific temperature adjusted current, voltage and time data.

If a "Balance Mode" is included in the charging algorithm it would typically happen after the "Absorption Stage." This would become the third stage and the "Float Stage" would then become the fourth stage. A balance mode is similar to an Equalize function for flooded batteries but is performed against tightly controlled current, voltage and time. Balance charging is available with or without pulse termination.

IUI CHARGE PROFILE

An indefinite float phase may be added at 2.27VPC

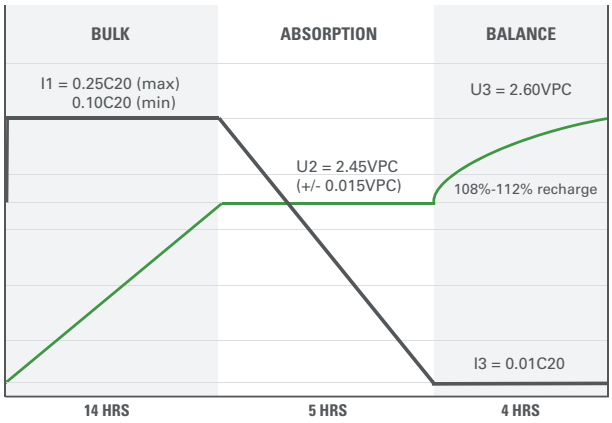


Figure 2: Current Controlled Charging

	6 VDC	8 VDC	12 VDC	24 VDC	36 VDC	48 VDC
Bulk & Absorption Charge Voltage U2	7.4V	9.8V	14.7V	29.4V	44.1V	58.8V
Charge Current I1	I1 = 10% to 25% C20					
Balance Voltage U3	7.8V	10.4V	15.6V	31.2V	46.8V	62.4V
Charge Current I3	I3 = 1% C20					
Float Voltage U4 (Optional)	6.8V	9.1V	13.6V	27.2V	40.9V	54.5V

Table 2: Current controlled charge settings at 25°C (77°F)

Current controlled charging (IUI) with pulse termination

For IUI charging with pulse termination, as a safety precaution during the Finish phase, if the average battery voltage exceeds U3max and the charger output has been on more than 30 seconds the output is shut off until the voltage falls to U3min. The Finish phase then resumes and this "pulsing" continues until the target overcharge is reached.

IUI WITH PULSE TERMINATION CHARGE PROFILE

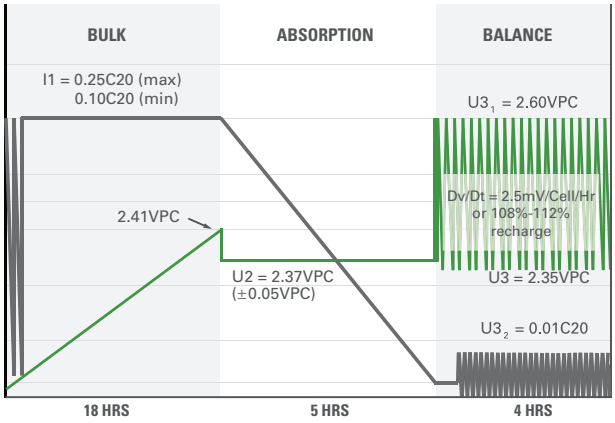


Figure 3: Current controlled charging with pulse termination.

	6 VDC	8 VDC	12 VDC	24 VDC	36 VDC	48 VDC
Bulk Charge Voltage	7.2V	9.6V	14.5V	28.9V	43.4V	57.8V
Absorption Charge Voltage U2	7.1V	9.5V	14.2V	28.4V	42.7V	56.9V
Recommended Charge Current I1	I1 = 10% to 25% C20					
Balance Voltage Pulsing max U3	7.8V	10.4V	15.6V	31.2V	46.8V	62.4V
Balance Voltage Pulsing min U3	7.1V	9.4V	14.1V	28.2V	42.3V	56.4V
Charge Current I3	I3 = 1% C20					

Table 3: Current controlled charge settings with Pulse Termination at 25°C (77°F)

4.1.2 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. Allow the charger to go through a full charge cycle before they are used.

During commission, measure the battery voltage and after commissioning, measure the battery voltage and surface temperature of each battery and log this data. Commissioning Logs are online available online

4.2 Discharging

No restriction on the discharge current up to the maximum allowable is required as long as the connections are properly sized and the battery temperature stays within the allowable limits.

Some industrial equipment have a built-in low-voltage disconnect (LVD) to prevent the battery bank from over-discharging. When the programmed low voltage setting is reached, the equipment may stop working or slows down allowing the user to recharge the battery bank. By default, this may be set by industrial equipment manufacturer at 1.75 volts per cell (Vpc). To prolong the battery life, Discover recommends setting the LVD to 1.90 Vpc to be discharged no more than 80%. After all, LVD is a personal preference. Preventing the battery to discharge to a lower voltage will increase cycle life expectancy.

		6 VDC	8 VDC	12 VDC	24 VDC	36 VDC	48 VDC
Reference LVD / I5	20% DOD	6.30V	8.40V	12.60V	25.20V	37.80V	50.40V
	50% DOD	6.15V	8.20V	12.30V	24.60V	36.90V	49.20V
	80% DOD	5.70V	7.60V	11.40V	22.80V	34.20V	45.60V

Table 4: Reference Low-Voltage-Disconnect / I10

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 45°C/113°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:

Electrolyte Freezing Point

State of Charge (SOC)	0%	25%	40%	75%	100%
Freezing point	-23°C / -9°F	-27°C / -17°F	-37°C / -35°F	-48°C / -54°F	-59°C / -74°F

4.4 Charge Current Limits

Charging current in general should not exceed 30A/100Ah C20 rating.

5. Battery Maintenance

VISUAL INSPECTION
Check for any visible defects such as cracks, 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 online.

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. Faults

Should faults be detected in the battery or the charging device, contact your servicing dealer immediately. Keeping records of all measured data will simplify fault detection and corrective action. A service contract with your servicing Discover® dealer will help to detect faults in time.

7. Storage

If filled lead acid batteries are to be taken out of operation for extended periods of time, they must be placed fully charged in a dry, frost-free room. To avoid damage, perform periodical balance charging or permanent float charging.

8. Transport

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

9. 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?
- Some case 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 50°C (122°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 1% of the battery C20 capacity, the charge is essentially complete.

WHY DOES THE VOLTAGE RISE QUICKLY CAUSING THE CHARGER TO SHUT OFF WHEN I BEGIN TO 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.
- If the battery bank is heavily sulphated, a balance charge may be necessary.

WHY DOES THE BATTERY BANK NOT REACH THE 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 IF THE BATTERY TEMPERATURES ARE VERY HIGH?

If at or nearing 50˚C (122˚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.

Updated: September 2019