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# TROJAN<sup>®</sup> GC2 SERIES LITHIUM-ION BATTERIES

## USER'S GUIDE



# CONGRATULATIONS

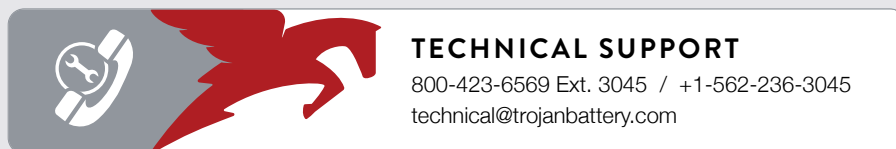
on your purchase from Trojan Battery Company, LLC (“Trojan”), manufacturers of the world’s most trusted batteries. GC2 Lithium-Ion batteries are engineered for safety and performance—delivering faster charge times and longer runtimes with virtually zero required maintenance. It’s the next innovation in battery power backed by 100 years of expertise. We’re proud to continue our tradition of delivering clean, long-lasting and reliable batteries to power your world.

TROJAN BATTERY  
COMPANY WITH  
QUALITY SYSTEM  
CERTIFIED BY DNV  
= ISO 9001:2015 =

# THIS USER'S GUIDE

was created by Trojan's application engineers and contains vital information regarding proper care and maintenance of your new battery. Please read through this User's Guide carefully and completely before using your battery. It will help you achieve optimum performance and long life from your new investment. If you have any questions concerning safety precautions or for any assistance in installing or using the battery in your system, contact Trojan's technical support engineers at one of the following numbers, or send us an email through our website at [www.trojanbattery.com/tech-support/](http://www.trojanbattery.com/tech-support/).

[www.trojanbattery.com](http://www.trojanbattery.com)



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# 1 YOUR TROJAN LITHIUM-ION BATTERY

The TR GC2 Series battery is a deep-cycle lithium-ion battery. Key attributes of the battery include:

KEY ATTRIBUTES			
Nominal Voltage	24V	36V	48V
Case Size	BCI Group Size GC2		
Battery Voltage	25.6	38.4	51.2
Capacity*	65Ah	45Ah	30Ah
Terminal Configuration	M8-1.25 threaded studs		
Communication Port	CAN Bus SAW J1939		



- A. Status Button
- B. Negative Terminal (M8 size)
- C. Battery Status Indicators (SOC)
- D. Positive Terminal (M8 size)
- E. Communications Port I/II
- F. Lifting Brackets

\*Temperature, load, state of charge, and battery age can affect battery performance and capacity.

## 2 SAFETY

ALWAYS	NEVER
Always wear proper personal protective equipment (PPE) (eye protection and gloves).	Never wear jewelry or other metal objects when working on or around batteries.
Always use insulated tools when working on batteries.	Never place objects on top of batteries.
Always check connections for proper torque.	Never attempt to charge a battery when the temperature is below 32°F (0°C) or above 113°F (45°C).
Always keep sparks and flames away from batteries. This includes sources of static electricity.	Never store batteries below 30% State of Charge.
Always use short cables of appropriate size to minimize voltage drop.	Never exceed maximum charging currents for the battery's temperature.
Always make sure charger is set as recommended.	Never dispose of batteries as household waste. Use recycling channels in accordance with local, state and federal regulations.
Always charge batteries before installing.	Never connect or disconnect terminals from batteries without first disconnecting loads.
Always make sure chargers are off or disconnected while working on batteries.	Never attempt to open the battery case.
Always add additional TR GC2 Series batteries in parallel.	Never use pressure washers to clean the battery or immerse the battery in water.
Always use battery lifting strap.	Never short-circuit the battery terminals.
Always review product warning labels and Trojan® GC2 Series Lithium-Ion User's Guide.	Never physically damage the battery (this includes, without limitation): Puncturing, dropping, crushing, burning, penetrating, shaking, hammering, and misconnecting terminals.
Always install batteries while powered off.	Never lift by the battery terminals.
	Never over-charge or over-discharge the battery.
	Never attempt to connect TR GC2 Series batteries in series.



**WARNING! RISK OF FIRE, EXPLOSION OR BURNS. DO NOT DISASSEMBLE, HEAT ABOVE 140°F (60°C) OR INCINERATE.**



**THE MOST EFFECTIVE FIRE EXTINGUISHER TYPES FOR TROJAN LITHIUM-ION BATTERIES ARE CO<sub>2</sub> OR WATER. SEE SAFETY INSTRUCTIONS.**



### **DANGER!**

UNLIKE LEAD-ACID BATTERIES, LITHIUM-ION BATTERIES, INCLUDING THE TROJAN® GC2 SERIES LITHIUM-ION BATTERY, WILL DISCONNECT FROM THE HOST SYSTEM UNDER A VARIETY OF CONDITIONS IN ORDER TO AVOID INTERNAL DAMAGE ("AUTOMATIC DISCONNECTION"). FOR A FULL LIST OF CONDITIONS PLEASE SEE SECTION 10.3: "PROTECTION LIMITS: AUTOMATIC DISCONNECTION". WHEN AUTOMATIC DISCONNECTION OCCURS IN EQUIPMENT POWERED BY GC2 BATTERIES, ALL POWER WILL BE LOST. IN EQUIPMENT WITH ESSENTIAL SYSTEMS THAT RELY ON BATTERY POWER (FOR EXAMPLE, LOW-SPEED VEHICLES WITH ELECTRONIC BRAKING SYSTEMS) (EACH AN "AFFECTED APPLICATION"), AN ABRUPT INTERRUPTION OF POWER CAN CAUSE UNDESIRABLE, UNEXPECTED AND POTENTIALLY DANGEROUS EQUIPMENT BEHAVIOR, INCLUDING BUT NOT LIMITED TO BRAKING LOSS OR SUDDEN BRAKING. USERS AND INSTALLERS OF THE GC2 MUST UNDERSTAND THE CONSEQUENCES OF AUTOMATIC DISCONNECTION. WHEN THE GC2 BATTERY IS USED IN AN AFFECTED APPLICATION, THE USER AND/OR INSTALLER OF THE GC2 BATTERY ("USER AND/OR INSTALLER") ASSUMES ALL RISK AND LIABILITY FOR ANY DAMAGES, INJURIES TO PERSONS OR PROPERTY (INCLUDING BUT NOT LIMITED TO DEATH), OR ACCIDENTS ARISING OUT OF OR RELATED TO SUCH USE OR INSTALLATION. USERS AND/OR INSTALLERS MUST FAMILIARIZE THEMSELVES WITH THE CONDITIONS CAUSING AUTOMATIC DISCONNECTION AS DESCRIBED IN THIS USER GUIDE, SECTION 10.3, "PROTECTION LIMITS: AUTOMATIC DISCONNECTION". USERS AND/OR INSTALLERS SHOULD CONSULT THE MANUFACTURER OF ANY AFFECTED APPLICATION FOR RISK MITIGATION OPTIONS RELATED TO THE AUTOMATIC DISCONNECTION BY EXCEEDING THE PROTECTION LIMITS OF THE BATTERY, WHICH MAY INCLUDE BUT NOT BE LIMITED TO HIGH VOLTAGE, LOW VOLTAGE, HIGH CURRENT, EXTERNAL SHORT CIRCUIT, HIGH TEMPERATURES, LOW TEMPERATURES, SELF DIAGNOSTICS, AND/OR AFTER MARKET MOTOR CONTROLLERS.



## DANGER!

LITHIUM-ION BATTERIES, INCLUDING THE TROJAN® GC2 SERIES LITHIUM-ION BATTERY, WEIGH SUBSTANTIALLY LESS THAN LEAD-ACID BATTERIES OF COMPARABLE CAPACITY. MANY TYPES OF EQUIPMENT ARE DESIGNED TO UTILIZE THE WEIGHT OF LEAD-ACID BATTERIES TO ACHIEVE THE MANUFACTURER'S INTENDED WEIGHT DISTRIBUTION. IF GC2 BATTERIES ARE INSTALLED AS REPLACEMENT BATTERIES IN EQUIPMENT DESIGNED TO USE LEAD-ACID BATTERIES AS BALLAST, THE WEIGHT DISTRIBUTION OF THE EQUIPMENT COULD BE IMPACTED. THE USER AND/OR INSTALLER OF THE GC2 BATTERY IN SUCH EQUIPMENT MUST UNDERSTAND THE CONSEQUENCES OF MODIFIED WEIGHT DISTRIBUTION AND ENSURE THAT STABILITY REMAINS WITHIN A SAFE RANGE FOR THE INTENDED USE. THE PROPER INSTALLATION OF GC2 BATTERIES MAY REQUIRE ADDITIONAL BALLAST WEIGHTS OR OTHER ADJUSTMENTS OR EQUIPMENT MODIFICATIONS TO ENSURE STABILITY AND SAFE WEIGHT DISTRIBUTION. THE IMPROPER INSTALLATION AND/OR USE OF GC2 BATTERIES COULD COMPROMISE THE WEIGHT BALANCE AND PHYSICAL STABILITY OF THE EQUIPMENT LEADING TO UNSAFE CONDITIONS. THE USER AND/OR INSTALLER OF THE GC2 BATTERY IN SUCH EQUIPMENT ASSUMES ALL RISK AND LIABILITY FOR ANY DAMAGES, INJURIES TO PERSONS OR PROPERTY (INCLUDING BUT NOT LIMITED TO DEATH), OR ACCIDENTS ARISING OUT OF OR RELATED TO DEGRADED STABILITY RESULTING FROM IMPROPER INSTALLATION AND/OR USE OF THE GC2 BATTERY.

## 3 EQUIPMENT NEEDED

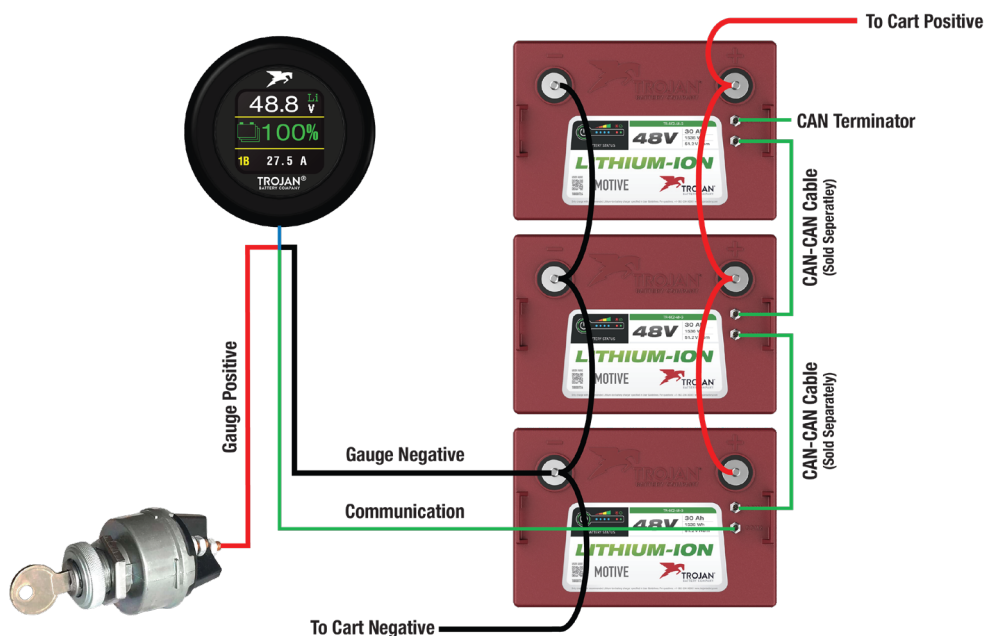
Before installation or maintenance of your batteries, have the following equipment available:

- ▶ Proper personal protective equipment (eye protection and gloves)
- ▶ Insulated tools
- ▶ Battery charger
- ▶ Voltmeter (optional)
- ▶ 13mm socket
- ▶ Cables

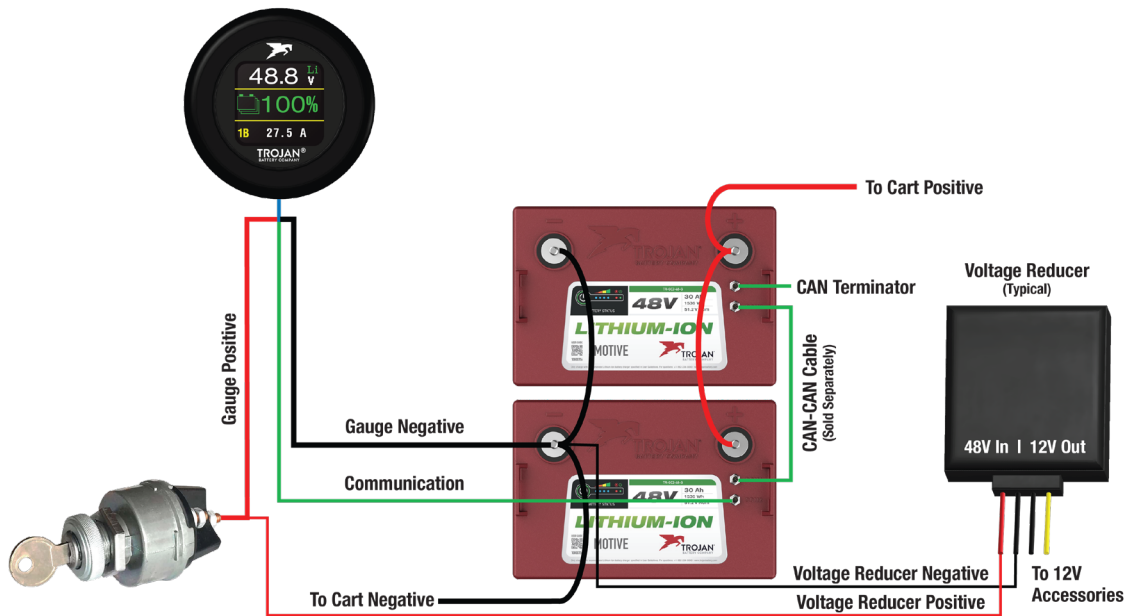
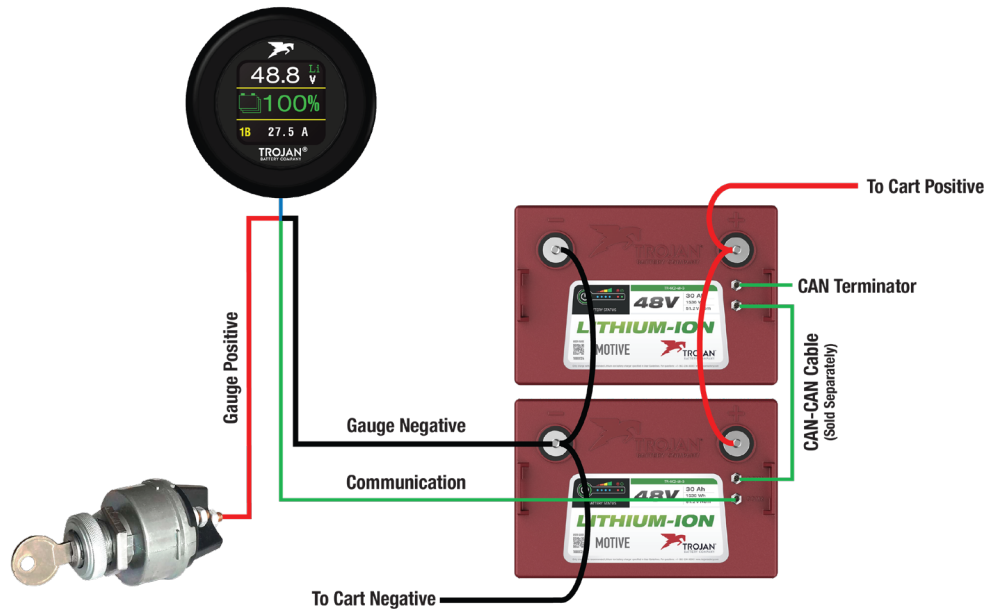
The TR GC2 weighs 37 lbs. Use of a battery lifting strap to aid installation is recommended. Lifting strap must be designed and rated for lifting batteries and able to securely engage integrated lifting brackets.

## 4 BATTERY INSTALLATION

The Lithium-ion battery voltage must be matched to the vehicle where it is installed. Connect batteries in parallel electrically when installing more than one battery in your vehicle. Be sure to follow the instructions for parallel installation. Installing multiple batteries in parallel (See Section 4.5: "Connecting Batteries in Banks") increases the available capacity and may be required to match the power requirements of your vehicle.



## 4 BATTERY INSTALLATION (CONTINUED)



**DO NOT CONNECT BATTERIES IN A SERIES.** Series connection may pose danger to user and/or installer and cause damage to the battery. The installer should verify every battery is off before performing the installation procedure. See Section 4.9: "Battery Start-Up." For operation and use, turn the battery back ON using the status button on each battery.



## 4.1 INSPECTION AND 12V ACCESSORIES

Check for visible damage including cracks, dents, deformation and other visible abnormalities. The tops of the batteries and terminal connections should be clean, free of dirt and corrosion, and dry. If any problems are detected with the batteries, contact Trojan technical support or your battery distributor. If damage occurred in transit, contact your freight carrier. To prevent damage to 12V accessories in the vehicle, first verify the voltage requirement of accessories like lights or others items in the vehicle. Never connect accessories directly to the battery. Lithium-ion batteries are more susceptible to permanent damage from parasitic loads than other battery types. If a continuous load such as a light, USB charger, voltage reducer, GPS or battery state of charge indicator is left connected to the battery for an extended period of time, a low voltage fault will occur. If left in this condition, the battery could become unrecoverable. All accessories should be wired through the vehicle key switch or another method of disconnecting the equipment from the battery when not in use. Then, if needed, the installer can use a voltage reducer to reduce the battery voltage to 12V or as required. To ensure you install your batteries properly and safely, please use the following guidelines.

## 4.2 TERMINALS AND TORQUE VALUES

Both the positive and negative terminals of the battery are M8-1.25 x 15mm threaded studs. Ensure that the nuts are tightened to the **proper dry torque of 80-90 in•lbs (9-10Nm)**. OVER-TIGHTENING TERMINAL CONNECTIONS CAN CAUSE TERMINAL BREAKAGE, AND LOOSE CONNECTIONS CAN RESULT IN TERMINAL MELTDOWN OR FIRE.

## 4.3 CORRECT HARDWARE INSTALLATION

If using flat or lock washers, it is very important to ensure the battery cable lug is contacting the top surface of the terminal, and the washer is placed on top of the lug. DO NOT PLACE A WASHER BETWEEN THE BATTERY TERMINAL AND THE LUG, AS THIS WILL CREATE HIGH RESISTANCE AND CAUSE EXCESSIVE HEATING OF THE CONNECTION, WHICH CAN RESULT IN FIRE. If assistance is needed in determining the appropriate hardware configuration, contact Trojan Battery technical support.

## 4.4 CABLE SIZE

Battery cables should be sized to handle the expected load and be of sufficient length and flexibility to avoid applying undesirable mechanical loads on the battery terminals. Refer to Table 1 for the maximum amperage based on the cable/wire gauge size.



**WARNING! SHOCK HAZARD – DO NOT TOUCH UN-INSULATED BATTERY, CABLES, OR TERMINALS. ALL TOOLS SHOULD BE ADEQUATELY INSULATED TO AVOID THE POSSIBILITY OF SHORTING CONNECTIONS. DO NOT LAY TOOLS ON THE TOP OF THE BATTERY.**

CABLE/WIRE GAUGE SIZE, AWG (mm <sup>2</sup> )	AMPACITY (Amps)
14 (2.08)	20
12 (3.31)	25
10 (5.26)	35
8 (8.36)	50
6 (13.3)	65
4 (21.1)	85
2 (33.6)	115
1 (42.4)	130
1/0 (53.5)	150
2/0 (67.4)	175

**TABLE 1**

Table values are from NEC Table 310.15(B)16 for copper cables rated at 167°F (75°C), operating at an ambient temperature of no more than 86°F (30°C). Lengths in excess of 6 feet (1829mm) may require heavier gauge wire to avoid unacceptable voltage drop. In parallel battery banks, it is preferable for all cables to be the same length.

For more information refer to the National Electrical Code for correct cable/wire size, which can be located at [www.nfpa.org](http://www.nfpa.org).

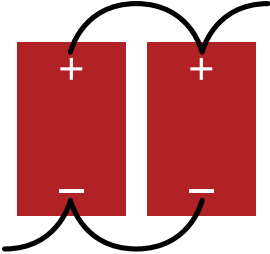
## 4.5 CONNECTING BATTERIES IN BANKS

You can increase the vehicle range and battery power capability by connecting multiple batteries together in parallel electrically as shown in Table 2.



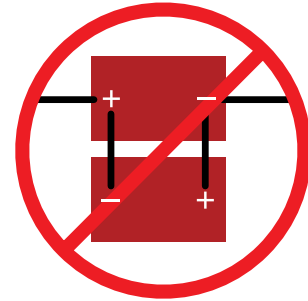
**WARNING! SHOCK HAZARD; RISK OF FIRE.** ATTEMPTING TO USE THIS BATTERY IN HIGHER VOLTAGE SYSTEMS OR CONNECTING IN SERIES MAY BYPASS INTERNAL BATTERY SAFETY FEATURES AND CREATE A HAZARDOUS SITUATION. PERSONAL PROTECTIVE EQUIPMENT RECOMMENDED IN THIS USER GUIDE MAY BE INADEQUATE IF BATTERY IS MISUSED IN THIS WAY. REFER TO NFPA 70E OR LOCAL ELECTRICAL SAFETY GUIDELINES FOR ADDITIONAL INFORMATION RELATED TO PERSONAL PROTECTIVE EQUIPMENT AND SAFETY PROTOCOLS.

**TABLE 2**

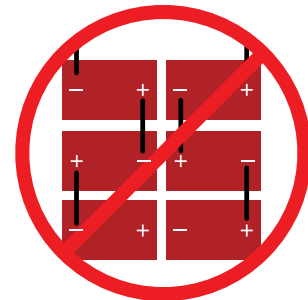
PARALLEL CONNECTION
To increase capacity, connect batteries in parallel. This will not increase the system voltage.
Two 51.2V batteries rated at 30Ah connected in parallel

<p>System Voltage: 51.2V System Capacity: 30Ah + 30Ah = 60Ah</p>
<b>CALL TECH SUPPORT FOR ADDITIONAL CONFIGURATIONS</b>



**WARNING! SHOCK HAZARD; RISK OF FIRE – DO NOT INSTALL BATTERIES IN REVERSE POLARITY. THIS MAY PERMANENTLY DAMAGE THE BATTERY**



**WARNING! SHOCK HAZARD; RISK OF FIRE – DO NOT INSTALL BATTERIES IN SERIES. THIS MAY PERMANENTLY DAMAGE THE BATTERY**



## 4.6 VENTILATION

Trojan® GC2 Series Lithium-Ion batteries do not release gas during normal use. There are no specific ventilation requirements for TR GC2 Series installations, although sufficient airflow should be provided to prevent excessive heat build-up.

## 4.7 BATTERY ENVIRONMENT

Batteries should be stored and installed in a clean, cool and dry place, keeping water, oil and dirt away from the batteries. If any of these materials are allowed to accumulate on the batteries, tracking and current leakage can occur, resulting in self-discharge and possible short-circuits. Battery chargers should also be installed in well-ventilated, clean areas that are easily accessible. Relative humidity should be <90%.

## 4.8 TEMPERATURE

The operating temperature range for discharging TR GC2 batteries is -4°F to 140°F (-20°C to 60°C). Charging batteries below 32°F (0°C) is prohibited, and charging currents must be reduced below 68°F (20°C). See the product data sheet for more information on charging current constraints.

Attempting to charge the battery at temperatures below 32°F (0°C) will cause the battery to disconnect from the charger and enter an under-temperature alarm, charging will be disabled while the alarm is active.

Refer to Section 10.1: “Charging” for charging current limitations.

Note that battery life diminishes as temperature increases, while capacity diminishes as temperature decreases.

It is important to minimize temperature variations between the batteries. Therefore, avoid restricting airflow by tightly packing batteries together. The batteries should have a minimum of 0.50” (12.7mm) of space between them to allow for adequate airflow.

## 4.9 BATTERY START-UP

Your battery may be shipped at 50% state of charge or lower.

Prior to installation, follow the instructions in Section 6.2: “Initial Charging.”

To prevent imbalance between parallel batteries, when bringing batteries out of storage mode, all batteries should be powered on within minutes of each other. It is not recommended to leave a single battery in storage mode while others in parallel are powered on unless instructed to do so for troubleshooting purposes.

Perform the following steps to turn the battery on:

Verify that the battery is either completely disconnected or correctly connected to the equipment it will be powering.

- ▶ Be sure that you are able to see the LEDs, then **press and hold** the status button.
- ▶ The LEDs will successively turn on from left to right until they are all on.
- ▶ **Once all LEDs are on, wait another 2 seconds, then release the status button.**  
(Batteries with firmware 1.3 or higher will also blink all six LEDs to indicate the operation was successful)
- ▶ The battery will perform a self test for about 10 seconds and turn on. Press and release the status button to verify the green LED is on and the battery is ready to be used.

Perform the following steps to turn the battery off and place it in storage mode:

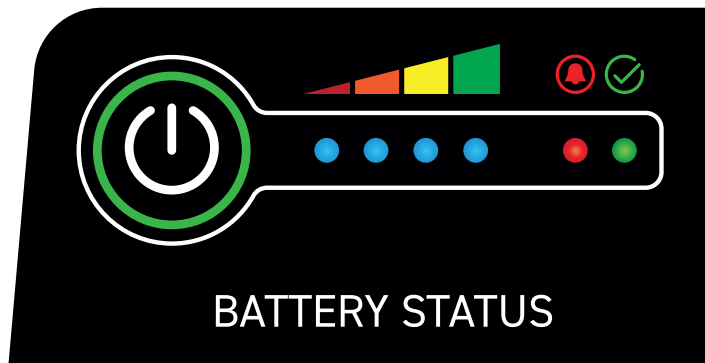
- ▶ **Press and hold** the status button.
- ▶ All LEDs will turn on, then successively turn off, starting with the green LED.
- ▶ **Once all LEDs are off, wait another 2 seconds, then release the status button.**  
(Batteries with firmware 1.3 or higher will also blink all six LEDs to indicate the operation was successful)

## 4.9 BATTERY START-UP (CONTINUED)

If the battery has been intentionally turned off for shipping or because of a shutoff condition, you can restart it by the above steps. However, if a condition that causes a shutoff has not been corrected, the battery will shut off again. See Section 10.3: “Protection Limits: Automatic Safety Shutdown,” for specific explanations of shutdown causes.

## 4.10 INDICATOR LEDs

The Trojan® GC2 Lithium-Ion battery features a status push button and indicator LEDs on the top of the case as illustrated below. After the status button is momentarily pressed, the indicator LEDs will operate as follows:



LED COLOR	DEFINITION
Blue	Each blue LED represents 25% State of Charge (SOC) as shown in the legend. During charging, they will flash the SOC once each second.
Red	Active alarm (battery disabled)
Green	Battery OK

The light will display this color pattern while the button is pressed.

When the battery is charging, the blue LEDs will blink to indicate charging and the increasing state of charge percentage. When the charging stops, all the LEDs turn off.

## 4.11 CAN BUS

The battery includes a Controller Area Network (CAN) bus communications interface. The two circular M8 DIN connectors are on the top of the battery to enable one battery to connect to another battery using CAN bus cables in a simple daisy chain wiring scheme. For normal battery operation, the CAN bus feature is not required. The battery operates and protects autonomously; it does not require any CAN bus communication or external devices such as external controllers, or other CAN bus-connected batteries to function. Keep the two black caps installed on the two M8 connectors to protect them from the environment when not used. Trojan’s field service can retrieve the battery usage history and view status over the CAN bus interface to help resolve issues or questions. A certified field service technician can update the battery firmware over the CAN bus to add features or enhancements. The CAN bus interface is galvanically isolated from the internal battery voltages. Therefore, an external power source is required to turn on and power the field side of the isolated CAN bus. Contact Trojan’s technical support engineers if you have any questions about the CAN bus interface and its use.

See Section 8: “Maximizing the Performance of Your Battery” for technical support information.

## 5. PREVENTATIVE MAINTENANCE

### 5.1 INSPECTION

- ▶ Power off battery before inspection.
- ▶ Examine the outside appearance of the battery. The tops of the batteries and terminal connections should be clean, dry and free of corrosion.
- ▶ Check battery cables and connections. Replace any damaged cables and tighten any loose connections. Refer to Section 4.2: "Terminals and Torque Values."

### 5.2 CLEANING

Check the battery for cleanliness at regular intervals and keep terminals and connectors free of corrosion. Terminal corrosion may adversely affect the performance of the battery and present a safety hazard.

- ▶ Power off battery before cleaning.
- ▶ Disconnect the battery from the charging source and the load.
- ▶ Clean the top of the battery, terminals and connections with a damp cloth or non-metallic brush. If the battery is extremely soiled, a household cleaner may be used.
- ▶ Dry with a clean cloth.
- ▶ Keep the area around batteries clean and dry.

## 6. Charging

### 6.1 BACKGROUND

Trojan® GC2 Lithium-Ion batteries may be used in applications where lead-acid batteries have previously been utilized. Best charging results are obtained by using an appropriate Trojan-recommended charger and charging profile (algorithm). Refer to documentation on your specific charger for more information. Charging due to regenerative braking should also be reduced in environments below 68°F. Vehicles that use regenerative braking at cold temperatures may force the battery to shut off if too much current is applied back into the battery.

### 6.2 INITIAL CHARGING

Unless your dealer has charged your battery prior to delivery, it will be received at partial state of charge. If your system uses more than one battery, follow the steps below:

1. Prior to installation, turn each battery on, then measure and record each battery's voltage.
2. If all voltages are within 0.5 volts of each other, turn them off, proceed with the installation, then follow the normal charging procedure.
3. If the voltages differ by more than 0.5 volts, each battery should be individually charged, then the installation can proceed.

### 6.3 BALANCING

One function of a lithium-ion battery BMS is to maintain balance between each group of cells within the battery. This allows the battery to deliver full capacity without any cells experiencing an over or under-voltage condition. Balancing is performed when a parallel group of cells reaches a specified threshold voltage corresponding to nearly 100% state of charge (SOC). At that point, the highest-charged cells “bleed down” a small amount to enable the remaining groups of cells to “catch up.”

### 6.4 INITIAL CHARGING CYCLES

In systems using more than one (1) battery, new batteries will be slightly unbalanced when they are unpacked and initially installed. Interruption of individual battery charging current and charge cycling may occur during the first charging cycle and is considered normal. Allow some extra time during first charging cycle to allow the batteries to come into balance.

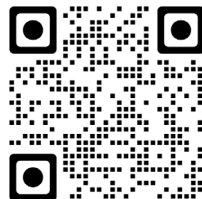
Using a charger not designed for use with a lithium-ion battery may result in an imbalance between cells over time that requires charging maintenance to recover. Recovery of an imbalance condition requires one or more charging cycles to 100% state of charge using a lithium-ion specific charger or charging algorithm. Failure to do so may result in a battery lockout condition.

### 6.5 CHARGING PROFILES

Trojan GC2 Lithium-ion Series batteries should be charged using a lithium-ion charging profile with a voltage setting matching the battery pack voltage as shown in the table below. Use of a compatible charging profile is strongly recommended to obtain a fully balanced battery pack. Using charging profiles designed for lead-acid or other battery types may result in a sudden voltage increase that will cause permanent damage to the battery BMS and render the battery inoperative. For a list of compatible chargers and charging profiles, visit [www.trojanbattery.com](http://www.trojanbattery.com).

Batteries regularly charged with equipment not optimized for lithium-ion batteries may become imbalanced and is not recommended. See Section 6.3: “Balancing” for additional information.

**Use Only With Compatible  
Lithium-Ion Chargers  
Scan For the Approved List**



BATTERY VOLTAGE	RECOMMENDED CHARGER RANGE
24V	27.36 - 28.0
36V	41.0 - 42.0
48V	54.7 - 56.0

Chargers which charge outside of the recommended range will result in battery faults and lead to slower charging, reduced performance or cell imbalance. Failure to fully charge the battery using the recommended charging profile may lead to reduced lifespan. See section 6.3 for additional information.

### 6.6 CHARGING AT TEMPERATURES BELOW 68°F (20°C)

Maximum charging currents must be reduced at temperatures below 68°F (20°C). Measures need to be taken to ensure that charging currents do not exceed the values shown on the product datasheet. As mentioned previously, charging is prohibited below 32°F (0°C). Charging due to regenerative braking should also be reduced in environments below 68°F. Vehicles that use regenerative braking at cold temperatures may force the battery to shut off if too much current is applied back into the battery.

## 6.7 CHARGING PROCEDURE

- ▶ Verify that the battery is correctly hooked up to the charger with the positive wire on the positive (+) terminal and the negative wire on the negative (–) terminal.
- ▶ Ensure the charger is set to run the appropriate profile.
- ▶ If the charger will not run until it detects battery voltage, be sure that the batteries are turned on.
- ▶ Start charging, following the charger manufacturer's instructions.
- ▶ After the charge has completed, the charger may be shut off and disconnected, or if it remains in a “maintenance mode” within the recommended charging range, it can remain connected to the battery indefinitely.

## 6.8 OTHER CHARGING INFORMATION

- ▶ **Chargers which utilize an automatic desulfation or equalization mode are not recommended.**
- ▶ **While the battery is being charged, the blue LEDs will flash the current state of charge once each second.** See Section 4.10: “Indicator LEDs,” for interpretation of LED information.
- ▶ *If a battery shuts off due to low state of charge, it should be recharged as soon as possible. Failure to do so may render the battery permanently unusable.*
- ▶ *Depending upon the initial state of charge and the size of the load, even small quiescent loads such as motor controllers and on-board chargers can fully discharge batteries in as little as a few days. For instance, a 25mA load amounts to 0.6Ah discharge per day. Be sure to understand the quiescent loads in your application and set an appropriate charging interval. If the batteries will not be used for extended periods of time, turn them off.*
- ▶ *It is not recommended to use power outlets controlled by switches, peak shaving controllers or that rely solely on non-continuous power sources such as solar or wind generation to charge batteries. Interruption of the charge cycle may prevent the battery from reaching full state of charge or prolong charging times.*

## 6.9 CHARGING FROM 0% STATE OF CHARGE

If the battery is discharged to 0% state of charge, voltage to the battery terminals will be disabled. This may interfere with the operation of battery chargers with voltage-sensing protection and prevent the charge cycle from starting. If the battery is at 0% state of charge and will not charge, use the following steps to recover the battery:

- ▶ Plug in the charger and connect it to the battery.
- ▶ Press the power button on the battery momentarily. If neither of the red or green status lights illuminate, the battery is in storage mode. If the battery is not in storage mode, it will need to be placed into storage mode using the procedure in section 4.9.
- ▶ Power on each battery following the procedure in section 4.9. All parallel connected batteries should be powered on as close to each other as possible.
- ▶ The charging cycle should begin within 1 minute of powering on the first battery. If it does not begin, verify power to the charger and the connection to the battery and repeat this process.

## 7. STORAGE AND SHIPPING

A fully charged TR GC2 can be safely stored in climate controlled conditions for up to one year (12 months) while in sleep mode. It is recommended that the battery state of charge is checked every 4-6 months. Temperatures exceeding 77°F (25°C) will cause the battery to self-discharge faster and will require more frequent checks.

Never put the battery into prolonged storage if the state of charge is below 30%.

The following tips will help ensure that your batteries emerge from storage in good condition:

- ▶ Prior to long-term storage of the battery, fully charge the battery. Storing a discharged battery can result in permanent damage or decreased run time.
- ▶ Store in a cool and dry location, protected from the elements.
- ▶ Place the **battery in storage mode** to eliminate potential parasitic loads that may discharge the battery.

Perform the following steps to turn the battery off and place it in storage mode:

- ▶ Press and hold the status button for the entire sequence below.
- ▶ All LEDs will turn on, then successively turn off, starting with the green LED.
- ▶ Once all LEDs are off, release the status button after 2 more seconds.
- ▶ When batteries are taken out of storage they should be given an initial charge prior to use as outlined in Section 6.



**IF YOU SHIP THIS BATTERY, YOU MUST COMPLY WITH STATE, FEDERAL AND INTERNATIONAL LAWS, RULES, REGULATIONS AND REQUIREMENTS REGARDING LITHIUM BATTERIES. YOU MUST UTILIZE A QUALIFIED SHIPPING AGENT PROPERLY CERTIFIED FOR HAZARDOUS MATERIALS (“HAZMAT”) SHIPMENTS.**



## 8. MAXIMIZING THE PERFORMANCE OF YOUR BATTERY

- ▶ Follow all the procedures in this User’s Guide for proper installation, maintenance and storage.
- ▶ If you have any questions or concerns about battery care, please contact Trojan’s technical support engineers at 800-423-6569 Ext. 3045 or +1-562-236-3045 before a problem develops.

## 9. WHAT TO EXPECT FROM YOUR TROJAN LITHIUM-ION BATTERY

- ▶ Your Trojan® GC2 Series Lithium-Ion battery will deliver rated capacity when it is new. No “break-in” period is required.
- ▶ When operating batteries at low temperatures, they will deliver less than the rated capacity.
- ▶ When operating batteries at high temperatures, battery life will be reduced.
- ▶ The life of a battery is difficult to predict and will vary by application, frequency of usage and load characteristics.

### 9.1 QUIESCENT LOADS

Some vehicles, especially those with voltage reducers, radios and GPS units installed will continue to drain a small amount of power from the battery, even when with the key switch in the Off position or the vehicle placed in Tow Mode. This is called a quiescent load and can consume 5-10% of the battery’s capacity per day even when not in use.

Quiescent loads will vary from vehicle to vehicle.



## 9.1 QUIESCENT LOADS (CONTINUED)

To limit these types of loads, it is important that all accessories are wired through a switched power source that is disconnected with the vehicle's key-switch. If your vehicle has a quiescent load, after multiple days of inactivity, the battery may have less than 100% state of charge, even if it was plugged in prior to being stored.

For installations with a quiescent load, it is recommended that the battery is disconnected from the vehicle or placed into storage mode before extended periods of inactivity. To prevent over-discharge Trojan GC2 Series lithium-ion batteries will enter storage mode after 4 days of inactivity and disconnect itself from the vehicle. If the battery capacity drops below 25% while inactive, it will enter storage mode in 7 hours. To wake the battery from storage mode, simply press and hold the power button until all 6 LEDs have illuminated, plus an additional 2 seconds. See Section 4.9 Battery Startup for additional information.

# 10. ELECTRICAL SPECIFICATIONS

## 10.1 CHARGING

The charging and discharging current limits in the tables below are for one battery. Installing and electrically connecting batteries in parallel increases the current limits. For example, two batteries connected in parallel effectively doubles the current values in the tables below. Adding more batteries increases the driving range, current, and power capability.

CHARGING INFORMATION			
Battery Voltage	24V	36V	48V
Recommended Charging Voltage	27.36 - 28.0V	41.0 - 42.0V	54.7 - 56.0V
Charge Voltage Cutoff	29.12V	43.68V	58.4V
Peak Charge Current (max.)	74A for 0.5 seconds	74A for 0.5 seconds	74A for 0.5 seconds
Charge Current (max. continuous) @ Temperature			
< 32°F (0°C)	0A	0A	0A
32°F to 50°F (0°C - 10°C)	20A	13A	10A
50°F to 68°F (10°C - 20°C)	34A	23A	17A
68°F to 113°F (20°C - 45°C)	68A	45A	34A
> 113°F (45°C)	0A	0A	0A

## 10.2 DISCHARGING

DISCHARGING INFORMATION			
Battery Voltage	24V	36V	48V
Discharge Current (max. continuous)	<90A	<60A	<45A
Discharge Current (time < 30 Seconds)	150A	133A	100A
Discharge Current (time < 4 Seconds)	155A	155A	155A
Discharge Current (time < 0.2 Seconds)	174A	174A	174A

### 10.3 PROTECTION LIMITS: AUTOMATIC DISCONNECTION

As outlined in the following table, Trojan® GC2 Lithium-Ion batteries will automatically shut down under excessive use conditions in order to prevent damage to the battery and connected equipment. This will generally result in total loss of power to equipment. Systems must be implemented and precautions must be taken to ensure that sudden loss of power does not result in hazardous system behavior.



**AS NOTED IN SECTION 2: “SAFETY,” THE SYSTEM INSTALLER/USER ASSUMES ALL RESPONSIBILITY AND LIABILITY FOR ANY DAMAGES THAT MAY OCCUR DUE TO SUDDEN LOSS OF POWER.**

PROTECTIVE SHUTOFF AND RESTART CONDITIONS					
	SHUTOFF		RESTART		OTHER RESTART CONDITIONS
Over Voltage	Any cell voltage > 3.74V	24V Battery Voltage>29.9V	All cell voltages < 3.64V	24V Battery Voltage>29.1V	Load attached and discharging
		36V Battery Voltage>44.9V		36V Battery Voltage>43.7V	
		48V Battery Voltage>59.9V		48V Battery Voltage>58.2V	
Low Voltage	Any cell voltage < 2.53V	24V Battery Voltage>20.2V	All cell voltages > 2.63V	24V Battery Voltage>21.0V	Charger attached and charging
		36V Battery Voltage>30.4V		36V Battery Voltage>31.6V	
		48V Battery Voltage>40.5V		48V Battery Voltage>42.1V	
Short Circuit Current	660A instantaneously		No automatic restart		Push and hold the status button to clear red LED
Over Temperature Discharge	140°F (60°C)		131°F (55°C)		
Over Temperature Charge	113°F (45°C)		104°F (40°C)		
Under Temperature Discharge	-4°F (-20°C)		14°F (-10°C)		
Under Temperature Charge	32°F (0°C)		41°F (5°C)		
Automatic Sleep/Storage Mode	No use for 4 days or 7 hours if the battery state of charge is lower than 25%		No automatic restart		Push and hold the status button to manually wakeup the battery

## 11. BATTERY RECYCLING

Trojan® GC2 Lithium-Ion batteries are recyclable and should not be disposed of as household or landfill waste. If you need assistance in recycling your battery, contact your dealer or Trojan’s technical support engineers as outlined at the front of this manual.

## 12. BATTERY ABBREVIATIONS

A	Ampere	°F	Degrees Fahrenheit
Ah	Ampere-hour	M6/M8	6mm/8mm terminal
AWG	American Wire Gauge	SOC	State of Charge
BMS	Battery Management System	T	Temperature
°C	Degrees Celsius	V	Volt
DOD	Depth of Discharge	VDC	Volts DC



# TROJAN BATTERY COMPANY

would like to thank you for selecting our battery. With close to 100 years of experience, Trojan Battery is the world's most trusted name in deep-cycle battery technology backed by our outstanding technical support. We look forward to serving your battery needs.



**TECHNICAL SUPPORT**  
800-423-6569 Ext. 3045 / +1-562-236-3045  
technical@trojanbattery.com



**Do not mix with lead-acid batteries when recycling**

FAILURE TO ABIDE BY THE CARE AND MAINTENANCE REQUIREMENTS OUTLINED HEREIN MAY RESULT IN VOIDING THE WARRANTY, AS APPLICABLE.

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