



TRILLIUM™

TROJAN INTELLIGENT LITHIUM

USER'S GUIDE



CONGRATULATIONS

on your purchase from Trojan Battery Company, the manufacturer of the world's most trusted deep-cycle batteries. The battery you purchased was engineered by Trojan to deliver superior power, performance, durability, and reliability for use in a broad range of demanding applications. Our goal is to provide reliable energy storage solutions that enhance the way people live and work around the 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 Battery Company's technical support engineers at one of the following numbers, or send us an email through our website at www.trojanbattery.com/tech-support/.

www.trojanbattery.com



TECHNICAL SUPPORT

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1 TRILLIUM, THE INTELLIGENT LITHIUM BATTERY LINE

The Trillium battery line is a family of deep-cycle lithium ion batteries designed to provide exceptional cycle life in a variety of applications*. The line currently consists of three different models:

- ▶ Group 24 size 12.8V, 92Ah (with state-of-charge gauge)
- ▶ Group 27 size 12.8V, 110Ah (with state-of-charge gauge)
- ▶ U1 size 25.6V, 25Ah



TR 12.8-92 Li-Ion
Group 24



TR 12.8-110 Li-Ion
Group 27



TR 25.6-25 Li-Ion
Group U1

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

2 SAFETY

ALWAYS	NEVER
Always wear proper personal protective equipment (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 charge a battery when the temperature is below -4°F (-20°C)
Always keep sparks and flames away from batteries. This includes sources of static electricity	Never charge a battery when the temperature is above 140°F (60°C)
Always use short cables of appropriate size to minimize voltage drop	Never store batteries below 20% State-of-Charge
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
	Never use pressure-washers to clean the battery or immerse the battery in water
	Never short-circuit the battery terminals
	Never physically damage the battery (this includes, without limitation: puncturing, dropping, crushing, burning, penetrating, shaking, hammering, and misconnecting terminals)
	Never over-charge the battery
	Never over-discharge the battery



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 TRILLIUM BATTERIES ARE CO₂, DRY CHEMICAL (TYPE ABC), OR FOAM.

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
- ▶ Voltmeter
- ▶ Battery charger

4 BATTERY INSTALLATION

To ensure you install your batteries properly and safely, please use the following guidelines.

4.1 INSPECTION

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.

4.2 TERMINALS

Trillium batteries are equipped with the following terminal configurations:

- ▶ Group 24 size: M8-1.25 x 9 mm threaded hole
- ▶ Group 27 size: 1/4-20 x 0.23" threaded hole & 5/16-18 x 0.625" threaded stud
- ▶ U1 size: M6-1.0 x 8 mm threaded hole

4.3 CORRECT HARDWARE INSTALLATION

If using flat 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.

4.4 CABLE SIZE

Battery cables should be sized to handle the expected load. Refer to Table 1 for the maximum amperage based on the cable/wire gauge size.

TABLE 1

CABLE/WIRE GAUGE SIZE, AWG (mm ²)	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
4/0 (107)	230

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 (1829 mm) may require heavier gauge wire to avoid unacceptable voltage drop. In series/parallel battery banks, it is preferable for all series cables to be the same length, and all parallel 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.

4.5 TORQUE VALUES

Tighten all cable connections to the proper specification to make sure there is good contact with the terminals. Over-tightening terminal connections can cause terminal breakage and loose connections can result in terminal meltdown or fire. Refer to Table 2 for the proper torque values based on the type of terminal on your battery.

TABLE 2

BATTERY AND TERMINAL TYPE	DRY TORQUE (IN-LB)	DRY TORQUE (NM)
Group 24: M8-1.25 Threaded Hole	50	5.6
Group 27: 5/16-18 Stud	100	11.3
Group 27: 1/4-20 Threaded Hole	60	6.8
U1: M6-1.0 Threaded Hole	23	2.6



WARNING! USE AN INSULATED WRENCH WHEN MAKING BATTERY CONNECTIONS.

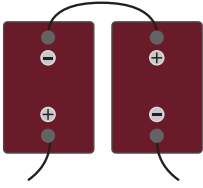
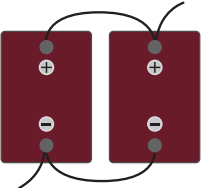
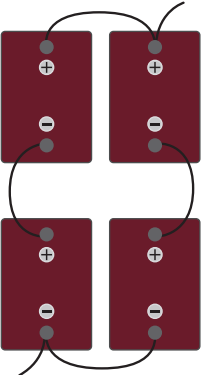
4.6 CONNECTING BATTERIES IN BANKS

You can increase capacity, voltage, or both by configuring your batteries as shown in Table 3.

Note: The Maximum Nominal Bank Voltage for Trillium Batteries is 51.2V.

(Group 24 & Group 27: 4 Batteries in Series. U1: 2 Batteries in Series.)

TABLE 3

	SERIES CONNECTION	PARALLEL CONNECTION	SERIES/PARALLEL CONNECTION
			
	To increase voltage, connect batteries in series. This will not increase the system capacity.	To increase capacity, connect batteries in parallel. This will not increase the system voltage.	To increase both voltage and capacity, connect additional batteries in series and parallel.
EXAMPLE	Two Group 27, 12.8V batteries rated at 110Ah. Connected in series	Two Group 27, 12.8V batteries rated at 110Ah. Connected in parallel	Four Group 27, 12.8V batteries rated at 110Ah.
	System Voltage: $12.8V + 12.8V = 25.6V$ System Capacity: 110Ah	System Voltage: 12.8V System Capacity: $110Ah + 110Ah = 220Ah$	System Voltage: $12.8V + 12.8V = 25.6V$ System Capacity: $110Ah + 110Ah = 220Ah$
CALL TECH SUPPORT FOR ADDITIONAL CONFIGURATIONS			

4.7 VENTILATION

Trillium batteries do not release gas during normal use. There are no specific ventilation requirements for Trillium installations, although sufficient airflow should be provided to prevent excessive heat build-up.

4.8 BATTERY ORIENTATION

Batteries may be installed in any horizontal or vertical orientation except with the terminals facing downward.

4.9 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%.

4.10 TEMPERATURE

The recommended operating temperature range for Trillium batteries is -4°F (-20°C) to 140°F (60°C). Note that battery life diminishes as temperature increases, while capacity increases with temperature.

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" (12.7 mm) of space between them to allow for adequate airflow.

4.11 BATTERY START-UP

The start-up instructions below apply only to the Group 24 and Group 27 batteries. The U1 battery is fully automatic and no user action is required to place it in operating mode.

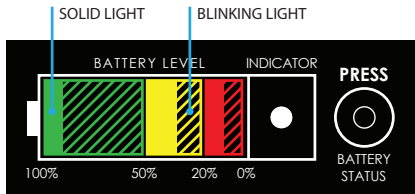
- ▶ Verify that the battery is either completely disconnected or correctly connected to the equipment it will be powering.
- ▶ Be sure you are able to see the blinking green and red indicator light, then press and hold the status button.
- ▶ After five seconds, the indicator light will change to solid green.
- ▶ Release the status button. You may hear a 'click' as the output of the battery is engaged. (If the button is not released after fifteen seconds, the light will turn off and the battery will not start).

If the battery is 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 ["Automatic Safety Shutdowns"](#) for specific explanations of shutdown causes.

4.12 INDICATOR LIGHT (GROUP 24 AND GROUP 27 ONLY)

The Group 24 and Group 27's built-in smart battery features include a battery status push button and indicator light on the top of the case. After the button is pressed, the indicator light will show one of the following color patterns for five seconds:



LIGHT COLOR PATTERN BATTERY CONDITION

Solid Green	90% - 100% Capacity Remaining
Blinking Green	50% - 90% Capacity Remaining
Solid Yellow	35% - 50% Capacity Remaining
Blinking Yellow	20% - 35% Capacity Remaining
Solid Red	10% - 20% Capacity Remaining
Blinking Red	0% - 10% Capacity Remaining
Blinking Green and Red	Battery is shut off

The light will display this color pattern for five seconds after the button is pressed, and whenever the condition changes during use.

When the battery is charging, the light will indicate the state of charge with a color pattern. If the indicator light is off while charging the battery then it is not charging or it is almost fully charged.

4.13 CAN BUS

The Trillium Group 24 battery is equipped with a CAN bus interface to allow communication with other CAN-based devices. The battery side connector information is as follows:

	QUANTITY	PART DESIGNATION	MANUFACTURER
DTM AWG 20 Solid Pin	3	0460-202-20141	Deutsch
DTM Receptacle	1	DTM04-3P	Deutsch

The user is responsible for selection and procurement of mating hardware and cabling, including the specified 120 Ω termination between the CAN-H and CAN-L wires at each end of the CAN cable. Details on the functionality of the CAN bus are contained in the Trillium CAN User's Guide, available at <https://www.trojanbattery.com/literature>. If required, technical support is available as outlined at the front of this manual.

5. PREVENTIVE MAINTENANCE

5.1 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 4.5, 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.

- ▶ 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. INITIAL CHARGING

Due to shipping laws and regulations, your battery may be received at a partial state-of-charge. Batteries should be given a full charge prior to first use.

6.2. CHARGING

14.4 VDC

Trillium Recommended Charger Range

14.8 VDC

Chargers which charge at lower voltages will not harm the battery, but will not provide a full charge to maximum capacity and may affect range and usable lifespan of the battery.

Chargers which charge at higher voltages will not harm the battery, but may not provide a full charge because the battery will shut off as soon as the voltage gets too high and your charger may not continue to charge the battery once it turns back on.

Most deep-cycle battery chargers will charge the battery, but many will shut off prior to the Trillium battery reaching 100% SOC. Chargers which utilize an automatic desulfation or equalization mode are not recommended. Consult the appropriate data sheet for limits on charging current, particularly at temperatures below 32°F (0°C).

While the battery is being charged, the display indicator on Group 24 and Group 27 batteries will usually be on, displaying a pattern and color indicating the state of charge **(See “Indicator Light” for a List of Display States)**.

To protect against potential damage, if the battery is shut off due to excessive charge current or high voltage, it will not turn on when a charger is detected. **(See “Automatic Safety Shutdowns”).**

For batteries connected in series (24V to 48V systems), each of the batteries can be charged individually for best results or the batteries can be charged with a multi-bank charging system. Bulk 48V chargers may not charge all series connected batteries and may require individual battery maintenance charging at periodic intervals to fully charge the set.

STEPS TO CHARGE YOUR BATTERY TO RECOMMENDED CAPACITY:

- ▶ Verify that the battery is correctly hooked up to the charger with the positive wire on the **red (+)** terminal and the negative wire on the **black (-)** terminal.
- ▶ If the charger has multiple settings, set it to a “bulk charge” mode (constant voltage / constant current) followed by a “float” mode (constant voltage) such as “AGM”.
- ▶ If the charger will not run until it detects battery voltage, be sure that Group 24 or Group 27 batteries are turned on. If the charger provides charge without detecting battery voltage, and the battery is shut off, the battery will turn on automatically as soon as the charger starts.
- ▶ Start charging, following the charger manufacturer’s instructions.
- ▶ After charge has completed, the charger may be shut off and disconnected, or if it remains in a “maintenance mode” at less than 14.6 VDC, it can remain connected to the battery indefinitely.

7. STORAGE AND SHIPPING

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

- ▶ Store in a cool and dry location, protected from the elements.
- ▶ Disconnect from equipment to eliminate potential parasitic loads that may discharge the battery.
- ▶ Prior to long-term storage of the battery, Trojan Battery recommends that the battery be charged to at least 30% state-of-charge. Storing a discharged battery can result in permanent damage or decreased run time.
- ▶ On Group 24 and Group 27 batteries, in order to turn the battery off for shipping or extended storage (3 months or more), press and hold the status button. The status light will initially show the current state of the battery, and after five seconds it will change to a solid red. At that point, release the button to turn the battery off. If the button is not released after being held for fifteen seconds, the light will turn off and the battery shutdown process will not be completed.

Note: If the Battery is Attached to a Charger When It is Shut Down, It May Turn Back On.



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



- ▶ When batteries are taken out of storage they should be given an initial charge as outlined in Section 6 prior to use.

8. MAXIMIZING THE PERFORMANCE OF YOUR TRILLIUM 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 Battery Company'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 TRILLIUM BATTERY

- ▶ Your Trillium 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.

10. AUTOMATIC SAFETY SHUTDOWN

The battery will automatically shut down under any excessive use conditions in order to prevent damage to the battery and connected equipment. Specified limits for excessive current, high voltage, and low voltage are provided in each battery's data sheet.

The User is Responsible for Any Damages Resulting from a Failure to Properly Monitor and Control the Charging or Discharging of the Battery.

CAUSE OF SHUTOFF	CONDITIONS FOR RESTART
<p>LOW VOLTAGE The battery is designed to automatically shut off to avoid damage if voltage falls below specified limits.</p>	<ul style="list-style-type: none"> › During cutoff, the battery voltage will slowly climb back up, and when it reaches the specified restart voltage, it will turn back on. › If the battery shuts itself off for low voltage, it will restart when a charger is attached (See Charging - Section 6). › Group 24 and Group 27 batteries can also be manually restarted. (See Battery Start-up - Section 4.11). If the battery is still at low voltage it will shut off again in a few seconds.
<p>HIGH VOLTAGE The battery is designed to automatically shut off to avoid damage if voltage increases to a level that would be harmful over the long term.</p>	<ul style="list-style-type: none"> › During cutoff, the battery voltage will slowly decrease, and when it reaches the specified restart voltage it will turn back on. › Group 24 and Group 27 batteries can also be manually restarted. (See Battery Start-up - Section 4.11). If the battery is still at high voltage it will shut off again in a few seconds.
<p>EXCESSIVE DISCHARGE CURRENT The battery is designed to operate in a safe discharge range and will shut off to avoid damage if discharge current is detected above specified limits.</p>	<ul style="list-style-type: none"> › After cutoff, the battery will restart after 30 seconds. › If the battery shut off for high current, it will restart when a charger is attached (See Charging - Section 6). › Group 24 and Group 27 batteries can also be manually restarted (See Battery Start-up - Section 4.11). If the battery detects high discharge current it will shut off again in a few seconds.
<p>EXCESSIVE CHARGE CURRENT The battery is designed to shut off to avoid damage if charge current exceeds specified limits.</p>	<ul style="list-style-type: none"> › After cutoff, the battery will restart after 30 seconds. › Group 24 and Group 27 batteries can also be manually restarted (See Battery Start-up - Section 4.11). If the battery detects high charge current it will shut off again in a few seconds (See Charging - Section 6).
<p>TEMPERATURE CONDITIONS The battery is designed to shut off to avoid damage if the internal temperature is beyond the following temperature limits:</p> <ul style="list-style-type: none"> › Lower than -13°F (-25°C). › Higher than 140°F (60°C). 	<ul style="list-style-type: none"> › The internal temperature of the battery must be brought to between -4°F (-20°C) and 140°F (60°C). › Group 24 and Group 27 batteries can also be manually restarted (See Battery Start-up - Section 4.11). If the battery detects excess temperature it will shut off again in a few seconds.
<p>SHORT CIRCUIT The battery is designed to shut off to avoid damage if a short circuit condition is detected.</p>	<ul style="list-style-type: none"> › If the battery shuts itself off due to a short circuit, it will restart itself when a charger is attached (See Charging - Section 6). › Group 24 and Group 27 batteries can also be manually restarted (See Battery Start-up - Section 4.11). If the battery detects a short circuit it will shut off again.

Except in the case of a short circuit, the battery will normally reset itself after the condition that caused the cutoff has cleared. If the battery is not shut off for overcharge, it will restart when it detects a charger.

If Group 24 or Group 27 batteries do not automatically restart, then follow the “Battery Start-up” section. If you have any difficulty getting a Trillium battery to provide power, contact your dealer or Trojan Technical Support for assistance.

11. BATTERY RECYCLING

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

12. BATTERY ABBREVIATIONS

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

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.

TROJAN BATTERY COMPANY

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Call **800-423-6569 Ext. 3045** or **+1-562-236-3045**
or visit **www.trojanbattery.com**



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