

User Manual and Operating Instructions

TRUE BLUE POWER

TT28-12

TRUE BLUE
CHARGER PRO

Manual Number
LI-ACM1260-101



Revision 1.6 • January 23, 2025

NOTICE:

This Operator Manual applies to the TT28-12 True Blue Charger PRO.
These units are manufactured by Lamar Technologies LLC for True Blue Power.

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Precautions

Batteries store very large amounts of energy that can be dangerous.

- Do not wear loose jewelry such as necklaces or neck chains that might short the terminals of a battery. A ring that touches both sides of a battery circuit can easily turn red-hot almost instantly.
- Be very careful using metal tools around a battery. A wrench dropped across battery terminals can cause the battery to explode and can heat the wrench to red-hot in only a few seconds.

This unit has a user selectable AC input power switch. The user **MUST** select the correct setting (115V or 230V) prior to plugging in. Failure to do so may cause damage to the unit.

Always work in a well-ventilated area. Do not put batteries into closed containers while they are being charged or discharged.

A damaged battery may heat excessively during charging or discharging. True Blue lithium-ion batteries self-monitor battery temperature and will shut down if overheated. If the TT28-12 is used with batteries that do not self-monitor battery temperature an external temperature sensor should be used, or the battery must be monitored at least every 30 minutes to be sure it is not over-heating.

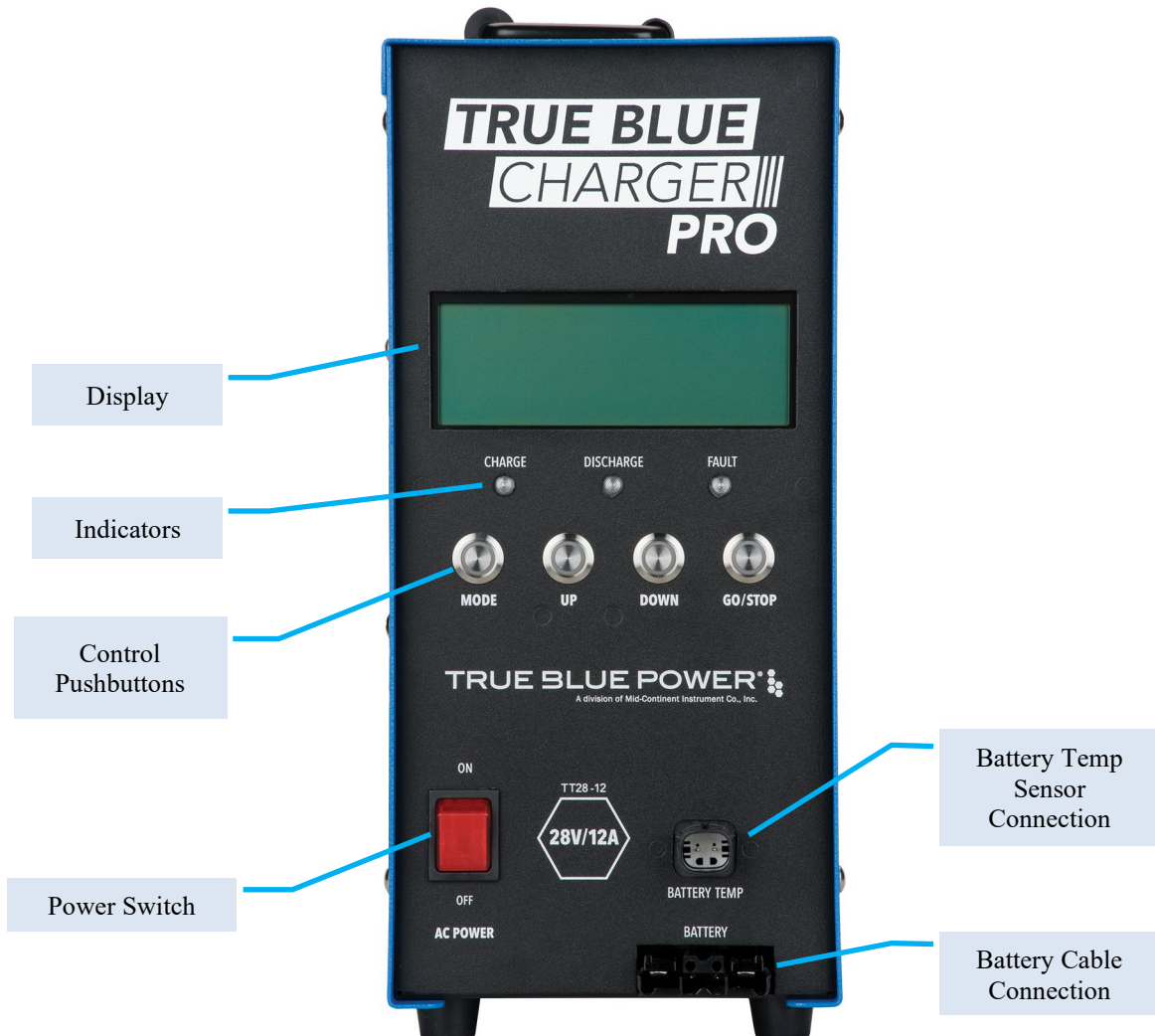
This unit creates a lot of heat when discharging and testing a battery. Be sure adequate ventilation is provided. Do not block the TT28-12 air inlets and outlets. Use caution when exposing yourself to the exhaust air when testing or discharging a battery.

Overview

The True Blue Charger Pro (TT28-12) is an automated and multi-functional power solution for shops needing to charge, test and prepare lithium-ion batteries for shipping. The Pro will charge and discharge 12 and 24 Volt lithium-ion batteries. It can automatically recharge a battery either to 100% state of charge or to an air-shipping state of charge (30% of capacity for lithium-ion). The TT28-12 can also perform a capacity check: charge, discharge at 1C rate, then recharge. The TT28-12, True Blue Charger Pro, is manufactured by Lamar Technologies LLC. You can contact them for accessories and support at:

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14900 40th Ave NE
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Controls and Indicators



Display

The four-line display shows the status of the Charger Pro. As appropriate, the display will show charging or discharging current, battery voltage, battery model, and battery temperature (if battery temperature sensor is connected).

Indicators

There are three lights that indicate the current operating mode.

- **CHARGE:** The left-most light will illuminate green while the battery is being charged.
- **DISCHARGE:** The middle light will illuminate white while the battery is being discharged.
- **ERROR:** If an error is indicated, the right light will illuminate red. The error description will show in the display.

Control Pushbuttons

There are four pushbuttons with lighted rings. Active buttons are lighted and pressing them will cause something to happen. A button that is not lighted is not active and pressing it will do nothing.

- **MODE** is used to select among Full Charge Mode, or Full Capacity Test, or 30% Charge - AirShip operations when the unit is idle. **GO** or **MODE** (as indicated in the display) are used to save a setting and move to the next setting.
- **UP**, **DOWN** buttons are used to scroll through a list of batteries, or to change settings for a custom battery.
- **GO / STOP** is used to begin an operation, or to manually stop the operation once it is started.

Power Switch

The power switch controls all power to the equipment.

Getting Started

Quick Start

- **CAUTION:** Verify that the correct input power is selected on the rear panel. Units are shipped from the factory set to 115VAC. To operate in areas with 230VAC power this setting must be changed (see DETAILED INSTRUCTIONS).
- Plug in AC power cord and connect charger to battery (see DETAILED INSTRUCTIONS).
- Turn on the front power switch.
- Press the **MODE** button to select the desired mode; Full Charge, Full Capacity Test, or 30% Charge – Air Ship. Then press **GO / STOP**.
- Press the **UP** or **DOWN** button to select the desired battery (see DETAILED INSTRUCTIONS if a custom battery setup is desired). Then press **GO / STOP**.
- The selected cycle will complete automatically. Press **GO / STOP** at any time if it is necessary to discontinue the operation.

Routine Operation

The last used battery settings and operation mode are automatically saved. When performing the same operation on many batteries of the same size, getting started can be as simple as connecting a battery and pressing the GO button twice – once to confirm that the correct mode is selected, and a second time to confirm that the correct battery is selected and begin the operation.

Detailed Instructions

Modes of Operation

There are three modes of operation, selected with the MODE button:

- *Full Charge Mode* will fully charge the battery with a two-stage charge: constant current (about 12.5 Amps) until the battery reaches 28.8 Volts (14.4 Volts for 12 Volt batteries); then constant voltage until the charge current tapers to the specified end-of-charge current for the selected battery; then shutting off all charge current.
- *Full Capacity Test* will fully charge the battery, then fully discharge it while measuring the discharge Amp-hours, and finally recharge it to full capacity. The measured battery capacity will be displayed at the end of the process.
- *30% Charge - AirShip* will fully discharge the battery and recharge the battery to 30% of its nameplate capacity as required for shipping some batteries.

The percentage charge number (30%) can be adjusted by the factory during system calibration. The percentage charge is calculated from the battery ratings associated with the battery model number. It is not calculated from measured charge.

Applying Power

CAUTION: Be sure that the power input selection switch on the back of the Charger Pro is set for the correct power voltage, either 115 VAC or 230 VAC nominal.

Turn on the front panel power switch. The internal fans will start at full speed for three seconds, then reduce to a very low speed. The display will light and will display the internal firmware and hardware revision numbers, then the manufacturer's contact information, and then the last used operation.



All indicators and all pushbutton lights will briefly light up. Observe that they are all functional.

Connecting a Battery

Connect a battery using either a dedicated battery connector, ring terminals, or red and black alligator clamps. Red always goes to the positive (+) battery terminal, and black to the negative (-) terminal. See SPECIFICATIONS section for cable and adapter part numbers.

Ensure the battery is between 0°C and 50°C before performing any operation (capacity check should be done at 23±3°C). If connected, the battery temperature sensor is used to display the battery temperature on the screen. If no sensor is attached, the display will show -40°C.

The Charger-Discharger has an internal relay to connect to the battery, and it will not connect to a missing or reversed battery.

Connecting the Battery Temperature Sensor

If available, use a cable to connect between this equipment and the battery communication connector. This reads battery temperature from its internal Resistance Temperature Detector (RTD).

If the battery does not have a communications connector, or the adapter cable is not available, tape an external temperature sensor to the middle of the battery side. Temperature sensors are available from Lamar Technologies.

The equipment automatically senses if it is connected to a battery RTD or to an external sensor.

It is possible to proceed without a battery temperature sensor. If the battery does not self-monitor temperature, the battery operations must be monitored at least once every half-hour to ensure the battery is not overheating. The battery temperature will show “-40C” when the sensor is not connected.

Selecting a Mode of Operation

The idle display will show the last used operation. Pressing MODE will switch to the next operation. Pressing GO will show the last-used battery model number. If this is the desired battery model, pressing GO again will start the selected operation.

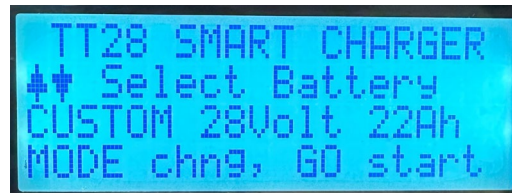
Changing Settings

Press **UP** or **DOWN** to select from a list of battery model numbers, or to select a **CUSTOM** battery that is not on the list.

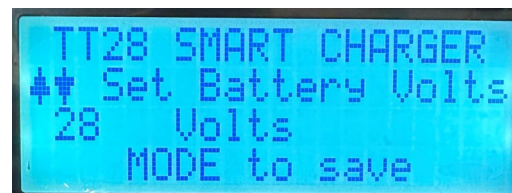


Press **GO** to start the process when the correct battery model is displayed.

If a **CUSTOM** battery is selected, custom setup screens are displayed. Press **MODE** to change this and review the **CUSTOM** battery A-h rating, discharge cutoff voltage, and terminating charge current, or press **GO** to begin the selected process on this battery.

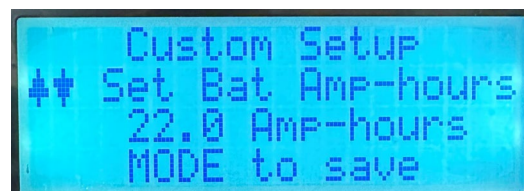


Setting Custom Battery Voltage



Use **UP** and **DOWN** buttons to switch the battery charge voltage between 14 Volts and 28 Volts. Press **MODE** to save.

Setting Custom Battery Amp-hour Rating



Use **UP** and **DOWN** buttons to adjust the Amp-hour rating as desired. The maximum Amp-hour rating is 65 A-h. Press **MODE** to save this rating.

Setting Custom Battery Discharge Cutoff Voltage



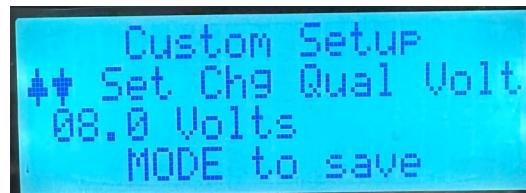
Use **UP** and **DOWN** buttons to adjust the discharge cutoff voltage as desired. When the battery voltage drops below this voltage, the discharging process is terminated. Press **MODE** to save.

Setting Custom Battery Charge Termination Current



Use **UP** and **DOWN** buttons to adjust the battery charging termination current (full charge Amps). When the battery charging current tapers below this, the charging process is terminated. Press **MODE** to save.

Setting Custom Battery Charge Qualification Voltage



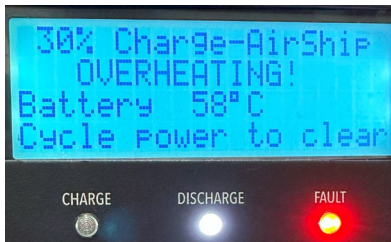
Use **UP** and **DOWN** buttons to adjust the battery charging qualification voltage. If the battery voltage is below this value when the start button is pressed, the cycle will not start. Press **MODE** to save. Green CHARGE and white DISCHARGE indicators will blink as the custom battery settings are saved to flash memory. Press **GO** again to start the selected process.

Stopping an Operation

An operation can be stopped at any time by pressing the GO – STOP button. Hold the button until the display changes.

Alarms

Excessive Temperatures

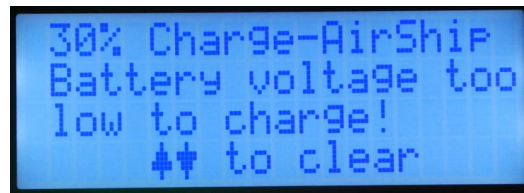


The battery temperature and five internal temperatures are monitored for overheating. If overheating occurs, operation stops. The red ERROR indicator will light, and the fans will all turn on at high speed. The display will show the six temperatures successively. Check the display to see which temperature is too high. Take appropriate corrective action.

- “Air 1”, “Air 2”, “Air 3”, “Air 4”, or “Heatsink”: This alarm may be caused by an internal fan failure or blockage of unit ventilation.
- “Bat”: If the alarm cause is the battery temperature, the battery may be defective. Let it cool down and retry the operation once. If it overheats again, the battery is not usable.

Cycle power to return to the idle operations screen.

Low Battery Voltage



It can be dangerous to charge a lithium battery that has been discharged too far and left in that state for more than a few days. The battery may develop internal dendrites that cause shorts in cells, leading to overheating when charging.

If the battery open circuit voltage is below 8 Volts (4 Volts for 14V batteries) when the **GO** button is pressed, operations cannot be performed. The red **ERROR** indicator will light, and the display will warn of low battery voltage.

If a battery is too low for operations, check with the manufacturer to see how a recovery may be attempted.

When the situation is corrected, press **UP** or **DOWN** to return to the idle operations screen.

Reversed Battery



If a battery is connected in reverse, the red **ERROR** indicator will light, and the display will warn of a reversed battery. This must be corrected before proceeding.

When the situation is corrected, press **UP** or **DOWN** to return to the idle operations screen.

Full Charge Mode

Reading the Display



A full charge completely charges the battery.

The second line of the display shows the selected battery model and temperature. The third line shows "Charging". The fourth line shows the battery voltage, the charging (plus sign) battery current, and the elapsed time in hours and minutes since the process was started.

The charge starts at about 12.5 Amps constant current, then the current tapers off when the battery nears 28.8 Volts (or 14.4 Volts). At the charge termination current, the charge is complete and the battery is disconnected. Charge termination current is set by the listed battery model number, or is set by the user for CUSTOM batteries. It is normally 5% of the battery Amp-hour rating, or as specified by the battery manufacturer.

NOTE: If a fully charged 24V lithium-ion battery (terminal voltage above 27.2) is connected and charged, the charger first applies a discharge of about 1.5 Amps. As the battery discharges slightly and its terminal voltage drops below about 27.0 Volts, the unit will begin charging and will terminate as usual when the current tapers to the charge termination current. This ensures a consistent full charge regardless of initial state of charge.

At the end of charge, a display indicates it is done and the CHARGE and DISCHARGE indicators flash. The battery is disconnected from the charger by an internal relay, so the battery may be left connected to the unit indefinitely without overcharging the battery.

Full Capacity Test

Reading the Display



Automatic Operation Steps

The battery will be fully charged. Then there is a full discharge down to the discharge cutoff voltage, at the 1C rate. Last, the battery is fully recharged. During the recharge phase the battery capacity will be displayed on line 2 alternating with the battery model number. When the recharge is complete, a final display shows the actual measured capacity.

For testing the airworthiness of a battery, there is a requirement that the battery demonstrate its capacity is at least 80% or 85% of the nameplate rating. Divide the displayed Amp-hours capacity by the nameplate Amp-hours capacity to get this percentage. For example, if the nameplate rating of the battery is 17 Amp-hours (TB17), and Capacity Test shows 20.8 A-h, the capacity is $20.8 / 17 = 1.22 = 122\%$. If the nameplate rating is 30 Amp-hours (TB30), and the Capacity Test shows 26.7 A-h, the true capacity is $0.89 = 89\%$.

30% Charge - AirShip

Reading the Display



The percent of charge for shipping is displayed on the top line.

This is usually 30%. Contact the factory if other charge levels are required.

The selected battery model number and battery temperature are displayed on the second line.

The third line shows “Discharging” or “Charging”, to show the exact operation that is going on now.

The fourth line shows the battery voltage, the discharge (minus sign) or charge (plus sign) battery current, and the elapsed time in hours and minutes since the process was started.

Automatic Operation Steps

Shipping Charge – Discharging

The battery is discharged at the 1C Amps rate. For the first few seconds, the discharge current will ramp up until it reaches the 1C rate. It is normal for the discharge current to drop 0.1 or 0.2 Amps for a second or two, as the unit changes the internal load to match the declining battery voltage.

Discharge current is smooth, not chopped or switched. Battery internal circuit breakers are not affected as they are with a pulsed discharge current.

Discharge continues until the battery reaches its discharge cutoff voltage (usually 15.0 or 20.0 Volts), which is pre-defined for listed battery models, or set by the user for *CUSTOM* batteries.

Shipping Charge – Recharging

Following the discharge, the battery is re-charged to 30% of its nominal 1C Amp-hour rating.

When the recharge is completed, the display shows that the operation is done and flashes the **CHARGE** and **DISCHARGE** indicators.

Completion of Operation

As any of the operations is completed, the **CHARGE** and **DISCHARGE** indicators will flash alternately. If the operation was for a Full Capacity Test, the measured capacity is displayed until removed by the operator. Log the capacity information if this is required.

After an operation, the battery is disconnected by an internal relay. Sitting in this mode indefinitely does not harm the battery.

To repeat the same operation with another battery of the same size, just change the battery. Then press **UP** or **DOWN** to return to the idle menu and **GO** twice to start the operation with another battery.

Operation with Custom Batteries

Smaller Battery Capacity

The charging current is fixed at a maximum of 12.5 Amps. A battery must be able to safely accept this level of charge to be used with the Charger-Discharger. Most batteries can safely charge at a 1C rate

(charging Amps equal to the Amp-hour rating of the battery.) Many modern batteries can safely charge at up to 10C rate (charging Amps equal to ten times the Amp-hour rating).

For a *CUSTOM* battery the charge termination current can be adjusted down to 0.1 Amps. The charge termination is usually set at 5% of the Amp-hour rating, so this corresponds to a 2.0 Amp-hour battery. Batteries smaller than 2.0 A-h may not be fully charged because the charge termination current is too high.

Check the battery manufacturer's information for maximum charge current and charge termination current.

Larger Battery Capacity

The maximum discharge rate of the Charger-Discharger is 60 Amps. A larger battery may be safely connected and charged or tested, but the discharge rate will be less than 1C. This equipment measures the actual Amps and calculates true Amp-hours at all times, so the Amp-hour reading will be correct. Be sure there are no regulatory requirements for a 1C discharge.

The maximum discharge current of 60 Amps is calculated for a battery with a discharge cutoff voltage of 20 Volts. For a battery with a discharge cutoff voltage of 15 Volts, the discharge current will taper down to about 48 Amps at cutoff. The correct Amp-hour value is still calculated even though final Amps are lower than the maximum 60 Amps.

The charge current is limited to approximately 12.5 Amps. Batteries require a constant voltage charge until the charge current tapers below about 5% of the battery capacity. Otherwise, the battery is not fully charged.

Lead-Acid and Ni-Cad Batteries

The charge profile has been optimized for lithium-ion batteries. The Charger Pro may be used with lead-acid batteries as long as the 28.8V (or 14.4V) charge voltage is acceptable per the battery manufacturer's requirements. The Charger Pro is not recommended for Ni-Cad batteries.

Changing AC Power Input Voltage

The Charger-Discharger can operate from 90 ~ 132 VAC or from 180 ~ 264 VAC power input, depending on the setting of an internal switch. The setting of the switch is visible on the upper rear of the equipment. Move the switch to the correct position (115 or 230) before applying power.



Troubleshooting

Fuses

There is a 70-amp fuse in the battery circuit to prevent fire in case of internal equipment failure. Normal operation cannot blow this fuse. If the battery fuse blows open, equipment repair action is needed. There is a circuit breaker in the AC power line entrance to protect against fire if the power supply fails. If the circuit breaker trips, equipment repair action may be needed.

Charge Voltage

Charging is done by measuring the battery current, while the charging voltage is set by the internal power supply and is displayed but not actively monitored. A misadjusted power supply will lead to improperly-charged batteries. Early termination of a charge cycle may indicate a inoperative charging power supply (possibly caused by application of 230V power with the rear panel setting at 115V).

High Temperature Alarm

A high battery temperature alarm while charging is a likely indicator of a bad battery.

A high Air or heatsink temperature alarm is an indicator of a defective fan, a blocked air inlet or outlet on the equipment, or an excessive ambient temperature.

Display Faded or Darkened

If the display is either very faded (low contrast) or has dark rectangles over each character, the display contrast may require calibration. This may be caused by a large change in the operating temperature compared to the original calibration temperature. Try re-calibration of the contrast using the calibration procedure.

Specifications

AC Input Power

Voltage: 90 ~ 132VAC or 180 ~ 264 VAC switch selected, 47 ~ 63 Hz.

Max Current: 8.4A @ 115VAC or 4.35A @230VAC

Operating Temperature and Altitude

Operating Temperature Range: 0°C to +55°C.

Operating Altitude Range: 0 ~ 3000m (10,000 ft). NOTE: Higher altitudes result in reduced cooling capacity, discharge rate may need to be reduced at altitudes above 1500m (5,000 ft).

Storage Temperature and Altitude

Storage Temperature: -40°C to +80°C. Storage Altitude: 0 ~ 6,000m (20,000 ft).

Dimensions and Weight

Weight: TT28-12 and power cord, 29.5 pounds (13.4 kilograms)

Size: Approx. 14.5" High, 6.5" Wide, 15" Deep (37cm x 16.5cm x 38cm)

Usable Battery

The smallest or lowest battery capacity that can be used with the TT28-12 is set by the maximum allowed charging rate of the battery. This equipment charges at a fixed 12.5 Amps until it reaches terminal voltage. A generally safe value is to charge at no more than 1C, so a battery as small as 12.5 Amp-hours capacity is acceptable. Be sure to check the battery manufacturer's recommendations.

The largest battery capacity may be set by a regulatory requirement to discharge at a 1C rate. For this equipment, that is 60 Amp-hours. If there is not a requirement to discharge at 1C, then batteries up to 250 Amp-hours can be safely charged and discharged.

When the equipment is idle or is turned off, there is a 164kΩ load on a connected battery. That is about 156 microAmps drain on the battery.

Accuracy and Resolution

Volts: 0.1 Volts resolution, ±0.2 Volts accuracy.

\\Amps: 0.1 Amps resolution, ±0.2 Amps accuracy.

Battery Connection Cables and Adapters

Part Number	Description
9012-1051	6' Long with MS3509 Compatible Quick Disconnect (Included)
9012-1052	6' Long with 5/16" Ring Terminals (Included)
9012-1053	6' Long with Alligator Clips (Included)
9012-1081	Charging Adapter, TS835 (Optional)

Battery Temperature Cables

Part Number	Description
9012-1061	6' Long with tape-on temperature sensor (Included)
9012-1062	6' Long with True Blue Power comm port connector (GEN5 batteries only) (Included)

Certificate of Calibration

Lamar Technologies LLC
14900 40th Ave.NE
Marysville, WA 98271
360-651-8869

CERTIFICATION OF FACTORY CALIBRATION
BATTERY CHARGER • MODEL TT28-12 • Lamar P/N: ACM-1260-101

SPECIFICATIONS: Refer to Operating Manual for Complete Specifications

NOTES: All Standards Used are Traceable to NIST
UNIT: 14/28 VOLT BATTERY CHARGER / ANALYZER
MODEL: TT28-12
DATE MANUFACTURED: _____
SERIAL #: _____
DATE CALIBRATED: _____
CALIBRATED BY: _____

Lamar Technologies LLC. certifies that the above listed instrument meets or exceeds all published specifications. It has been calibrated using standards whose accuracies are traceable to the National Institute of Standards and Technology.

Field Calibration Log

Date	Calibrated By	Pass/Fail	Notes

Field Calibration may be accomplished in accordance with Lamar Technologies Calibration Procedure Manual LI-0040 using ACM Calibration Module part number 9012-1071.

Warranty

1 YEAR WARRANTY

Lamar Technologies LLC. warrants its products to be free from defects in workmanship and material for a one-year period from the date of shipment to the distributor, original equipment manufacturer (OEM), or original end user. If any product shall prove to be defective during the warranty period, Lamar Technologies LLC. will repair or replace such part.

There are no warranties, which extend beyond the description on the face hereof. This warranty is in lieu of all other warranties, express or implied. Lamar Technologies LLC. excludes liability for incidental and consequential damages.

An action for breach of this warranty must be commenced within one year after the breach is or should have been discovered. Lamar Technologies LLC. specifically disclaims all other representations to the first user/purchaser, and all other obligations or liabilities. No person is authorized to give any other warranties or to assume any liabilities on Lamar Technologies LLC. behalf.



Revisions

Revision	Date	Description
1.0	October 26, 2020	Original issue
1.1	November 23, 2020	Updated Cover Art and Specifications
1.2	April 19, 2021	Corrected max discharge current, page 17
1.3	June 3, 2021	Added GEN5 Series note to 9012-1062 Temp Cable, page 17.
1.4	July 21, 2021	Added caution notes regarding input power switch.
1.5	February 1, 2024	Updated manual to cover firmware version 6.1 and the addition of 14 volt charging capability.
1.6	January 23, 2025	Provided additional detail about battery cables, adapters, and calibration module.