Lithionics Battery®

GT Series Installation Manual

*Model Numbers

GT12V450A-F24
GT12V525A-F24
GT12V600A-F24
GT24V300A-F24
GT48V150A-F24
GT51V150A-F24
GT12V600A-F27
GT24V300A-F27
GT48V150A-F27
GT51V150A-F27

*See Table 1 for model number details

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Important Safety Guidelines

This guide contains important safety instructions for the GT Series Battery System that must be followed during installation procedures. Completely read this manual and become familiar with all system components before attempting installation. **Save this installation manual for future reference.**

The following symbols and messages are used to identify potential hazards or to clarify the procedure.

The CAUTION symbol indicates a hazardous situation which, if not avoided, could result in moderate or minor injury.

The DANGER symbol indicates a hazardous situation which, if not avoided, will result in death or serious injury.

Safety Information

1. The information in this manual is intended for qualified personnel. Qualified personnel have training, knowledge, and experience in:
    - Selecting and using Personal Protective Equipment (PPE).
    - Installing electrical equipment.
    - Applying all applicable local and national installation codes.
    - Analyzing and reducing the hazards involved in performing electrical work.
2. Use of accessories not recommended or sold by the manufacturer may result in a risk of fire, electric shock, or injury to persons.
3. To avoid a risk of fire and electric shock, make sure that existing wiring is in good condition and that wire is not undersized. Do not operate the battery system with damaged or substandard wiring.
4. Do not operate the battery system if it has been damaged in any way.
5. This unit does not have any user-serviceable parts. Do not disassemble the battery system except where noted for connecting wiring and cabling. Attempting to service the unit yourself may result in a risk of electrical shock or fire. Internal cells remain charged after all power is disconnected.
6. To reduce the chance of short-circuits, always use insulated tools when installing or working with this equipment.
7. Remove personal metal items such as rings, bracelets, necklaces, and watches when working with electrical equipment.

CAUTION

HAZARD OF ELECTROLYTE VAPOR

- The battery module may emit a *non-toxic* pressurized electrolyte vapor if punctured.
- Electrolyte vapor may cause temporary minor breathing congestion.
- Electrolyte vapor can decrease visibility in closed compartments.

CAUTION

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH

- Apply appropriate personal protective equipment (PPE) and follow safe electrical work practices.
- Always turn OFF all equipment connected to the system in addition to turning OFF the power switch provided on the system to isolate the batteries from other electrical circuits, before performing any repairs or maintenance on the system.
- Do not operate the system if it has received a sharp blow, been dropped, has cracks or openings in the enclosure.
- Do not disassemble any part of the system. Internal cells remain charged after all power is disconnected.
- Do not operate the system with damaged or substandard wiring.
- Always use proper wire sizes to connect the system to inverters, chargers or other equipment.
- Voltage is present at the connector and output terminals. Always ensure that the BMS output terminals have the insulated protective boots in place.
- Always use crimped connections to connect to the output terminals.
- Always use a properly rated voltage sensing device to confirm all circuits are de-energized.

CAUTION

HAZARD OF HEAVY EQUIPMENT

- Use two people to lift and mount the battery module.
- Always use proper lifting techniques during installation to prevent injury.
- Do not lift the battery module by its power or signal wires as they will become damaged.

If the system is operated outside of its limits and/or used in combination with non-original components without authorization, the warranty is void.

Do not expose this unit to direct sunlight, external heat sources or submersion in any liquid. This product is designed for closed compartment use only. Damage to any part of the battery system caused from direct sunlight, external heat sources or submersion in any liquid will not be covered by the product warranty.

The Battery Module and BMS is tested to comply with UN DOT 38.3, the testing requirement for Lithium Batteries per Part III; of the UN Recommendations on the TRANSPORT OF DANGEROUS GOODS (Manual of Tests and Criteria, Fifth revised edition); [ST/SG/AC.10/11/Rev.5].

This Battery Module contains no mercury and Is RoHS Compliant. Please consult your local municipal authority for proper disposal.

1. System Specifications

1.1 Operating Specifications

Table 1

System Model:	GT12V-450A-F24-CTRL300 External BMS	GT12V-525A-F24-CTRL300 External BMS	GT12V-600A-F24-CTRL300 External BMS	GT24V-300A-F24-CTRL300 External BMS	GT48V-150A-F24-CTRL300 External BMS	GT51V-150A-F24-CTRL300 External BMS	GT12V-600A-F27-CTRL300 Internal BMS	GT24V-300A-F27-CTRL300 Internal BMS	GT48V-150A-F27-CTRL300 Internal BMS	GT51V-150A-F27-CTRL300 Internal BMS
Capacity	450Ah	525Ah	600Ah	300Ah	150Ah	150Ah	600Ah	300Ah	150Ah	150Ah
Nominal Voltage	12.8V	12.8V	12.8V	25.6V	48.0V	51.2V	12.8V	25.6V	48.0V	51.2V
Recommended Charging Voltage	14.4V	14.4V	14.4V	28.8V	54.0V	57.6V	14.4V	28.8V	54.0V	57.6V
Overcharge Voltage Protection	14.8V	14.8V	14.8V	29.6V	55.5V	59.2V	14.8V	29.6V	55.5V	59.2V
Over-discharge Voltage Protection	11.6V	11.6V	11.6V	23.2V	43.5V	46.4V	11.6V	23.2V	43.5V	46.4V
Standard Charging Current	150A (C/3)	200A (C/3)	200A (C/3)	100A (C/3)	50A (C/3)	50A (C/3)	200A (C/3)	100A (C/3)	50A (C/3)	50A (C/3)
End of Charging Current	15A (C/30)	20A (C/30)	20A (C/30)	10A (C/30)	5A (C/30)	5A (C/30)	20A (C/30)	10A (C/30)	5A (C/30)	5A (C/30)
Maximum Charging Current	300A @ 14.2V Charging Voltage	300A @ 14.2V Charging Voltage	300A @ 14.2V Charging Voltage	288A @ 28.4V Charging Voltage	144A @ 53.25V Charging Voltage	144A @ 56.8V Charging Voltage	300A @ 14.2V Charging Voltage	288A @ 28.4V Charging Voltage	144A @ 53.25V Charging Voltage	144A @ 56.8V Charging Voltage
Maximum Charging Voltage	14.6V @ Standard Charging Current	14.6V @ Standard Charging Current	14.6V @ Standard Charging Current	29.2V @ Standard Charging Current	54.75V @ Standard Charging Current	58.4V @ Standard Charging Current	14.6V @ Standard Charging Current	29.2V @ Standard Charging Current	54.75V @ Standard Charging Current	58.4V @ Standard Charging Current
System Impedance at BMS Power Terminals	**2.03 mΩ**	**1.77 mΩ**	**2.11 mΩ**	**1.92 mΩ**	**5.39 mΩ**	**5.11 mΩ**	**2.11 mΩ**	**1.92 mΩ**	**5.39 mΩ**	**5.11 mΩ**
Ibf Bolted Fault Current at Nominal Voltage (N4)	**6,305A**	**7,232A**	**6,066A**	**13,333A**	**8,905A**	**10,020A**	**6,066A**	**13,333A**	**8,905A**	**10,020A**
Standard Discharging Current/Load	300A	300A	300A	288A	144A	144A	300A	288A	144A	144A
Maximum Discharge Current/Load	300A									
Maximum Charging Temperature Range (N1)	32 to 113°F (0 to 45°C)									
Maximum Discharging Temperature Range (N1)	-4 to 131°F (-20 to 55°C)									
Module Dimensions	24.0" x 13.0" x 11.1" (610 x 330 x 282mm)						27.0" x 16.0" x 11.1" (686 x 406 x 282mm)			
Module Weight (N2)	128lb (58.0kg)	150 (68.2kg)	160lb (72.5kg)	160lb (72.5kg)	152lb (68.9kg)	160lb (72.5kg)	178lb (80.7kg)	178lb (80.7kg)	170lb (77.1kg)	178lb (80.7kg)
BMS Case Dimensions (N3)	11.25" x 6.96" x 4.1" (286 x 177 x 104mm)						N/A			
BMS Weight (N2)	7.7lb (3.5kg)						N/A			

Notes for Table 1:
(N1) Maximum charging and discharging rates apply depending upon the ambient temperature and duty cycle of the system. UL1973 tests of maximum charge and discharge current were performed at 25°C/77°F.
(N2) Does not include 4/0 power cable's weight as its length varies per application.
(N3) Does not include 4/0 power cable, main power connector, or terminals. Please see www.lithionicsbattery.com for dimensions.
(N4) "Bolted Fault Current" per NFPA-70E.

1.2 Arc Flash Energy Specifications

- An arc flash is the light and heat produced from an electric arc supplied with sufficient electrical energy to cause substantial damage, harm, fire, or injury.
  - An example of an arc flash event could be a direct short circuit caused by a metallic object such as a tool bridging between the positive and negative of an energized circuit.
  - Table 2 below quantifies the hazard level of arc flash energy that each battery system is capable of producing.

Per NFPA 70E D.5.1 "Maximum Power Method"
Iarc = 0.5 x Ibf
IEm = 0.01*Vsys* Iarc*Tarc/D^2 (Arc Flash Energy)
Calculations are for a maximum of six modules in parallel connection.

Table 2

	Configuration	Vsys	Impedance mΩ	Ibf, calc.	Iarc	IEm cal/cm^2	3x IEm cal/cm^2	Distance where IEm=1.2 (Arc Boundary), inches.	Hazard level
Tarc= 70mS fuse clearing time	GT12V450	12.8	0.34	37833	18916	0.082	0.246	4	0
	GT12V525	12.8	0.3	43390	21695	0.094	0.282	5	0
	GT12V600	12.8	0.35	36398	18199	0.079	0.236	4	0
	GT24V300	25.6	0.32	80000	40000	0.346	1.039	9	0
	GT48V150	48	0.9	53432	26716	0.434	1.301	10	0
	GT51V150	51.2	0.85	60117	30059	0.52	1.561	11	0

Hazard/risk classification as per NFPA 70E-2000

Category	Energy Level	Typical PPE Examples
0	N/A	Non-melting, flammable materials (e.g. untreated cotton, wool, rayon, etc.)
1	5 cal/cm²	FR shirt and FR pants
2	8 cal/cm²	Cotton underwear plus FR shirt & pants
3	25 cal/cm²	Cotton underwear plus FR shirt & pants plus FR coverall
4	40 cal/cm²	Cotton underwear plus FR shirt & pants plus double layer switching coat and pants

1.3 Manufacturing Date Code Format

- MMDDYYYY001
  - MM: Month of Manufacture
  - DD: Day of that Month
  - YYYY: Year of Manufacture
  - 001: Sequence of Battery Produced on That Day
- Example: 01012018001 = manufactured on January 1, 2018 and it was the first battery produced on that day.

2. System Installation

2.1 Short Circuit Protection

- The battery system must be protected by a DC fuse. The models listed in this document were evaluated and tested by Underwriter Laboratories with external fuses as noted. UL Listed (JDDZ) Class J Fuse, rated 300A, 450Vdc or UL Listed (JDDZ) Class T fuse rated 350A, 125Vdc. The fuse is to be provided downstream of the BMS before the load or supply in all cases. The fuses should be used with a fuse holder, UL Listed (IZLT), suitable for single-pole, Type J or Type T fuses, rated 600V, 400A. The use of any other fuse or non-fuse voids the UL Listing of the models.
- Examples of approved:
  - Fuse: Littelfuse JLLN-350 or Eaton DFJ-300
  - Fuse holder: Littelfuse LFT30400 or Eaton JM60400-1CR-1
  - Fuse placement must be directly after the positive power terminal on the BMS. (Fuse placement may be controlled by other industry standards such as ABYC or RVIA.)

2.2 Disconnect Device Protection (only applies to GT51V150A system)

- Per UL1973 Revision 2 Section 7.8.1.4, the GT51V150A system must have 2 additional disconnect devices, one located on the positive pole and one on the negative pole.
  - The disconnect devices shall not require the use of special tools or equipment to be operated.
  - Recommended disconnect device: Gigavac HBD41 Hermetic Battery Disconnect.
  - Please see Figure 1 for the disconnect devices placement.

2.3 Battery Module and NeverDie BMS Unit Environment and Mounting orientation

- The Battery Module and BMS Unit should be mounted in an environment that does not receive direct sunlight, pressurized water or road debris.
- To avoid power interruption, your installation may need to consider controlling the ambient operating temperature.
- Mount the Battery Module in an upright position, i.e. black lid faces up.
  - Other orientations are NOT permitted and will void the warranty.
- The BMS Unit can be mounted in any orientation as long as all its features are accessible.
- Ensure that the BMS Unit is located in close proximity to the Battery Module so that all connectors can be mated in the following steps.

2.4 Temperature Sensor Connector

- The temperature sensor cable and connector exiting the battery module must be connected to the BMS.
- Connect the two M8 circular connectors together by first aligning their pins and pressing them together, then rotate the securing nuts until they stop snugly.
- **Do not use the temperature probe from the inverter-charger manufacturer.**

2.5 Main Power Connector

- The battery module has a large black female main power connector that must be inserted into the BMS' male main power connector. This is the connector with the large 4/0 red and black wires and single small gauge gray cable.
- Align the connectors and insert them together.
- Use 2 zip ties to bind the connectors together so that they may not separate during use.

2.6 NeverDie BMS Unit Power Terminals

- Connect the BMS Unit Power Terminals to your DC bus, both Positive (Red) and negative (Black).
  - Use correctly sized wire conductors for the application.
  - Torque to 80 INCH pounds
  - Never stack ring terminals.
  - Never place the stainless-steel washer between the Power Terminal and ring terminal lug (see Figure 1 on Page 7).

2.7 Pressure Vent

- It is recommended to install a ventilation hose onto the pressure vent barb when the Battery Module is in a location with poor ventilation.
  - The hose shall direct the gases to the atmosphere.

2.8 BMS Unit I/O Connector

- Some systems have a rectangular I/O connector to extend the BMS Unit features remotely such as remote Power/Reset switch, LED indicator, or serial datalogging. Be sure to connect the I/O connector if so equipped.

2.9 Initial Charge Cycle

- Initially the system must be FULLY charged once to calibrate the BMS Unit to the Battery Module. Please read and follow the next section to perform this.

3. System Operation

3.1 Powering the System On

- Press the momentary Power/Reset switch for 1 second.
  - The switch will illuminate once power is enabled.
  - You may notice an audible “thunk” noise of the internal contactor switching on.
  - Check that there is voltage at the Power Terminals with a voltmeter.

3.2 Powering the System Off

- Press and hold the momentary Power/Reset switch for 3 seconds.
  - The switch will cease to illuminate once power is disabled.
  - You may notice an audible “thunk” noise of the internal contactor switching off.
  - Check that there is 0V at the output terminals with a voltmeter.

3.3 Charging

- The charging device(s) connected to the GT Series Lithium Battery System must be programmed as per Table 1.
- Charging may be performed at any time the system is powered On.
  - ***NOTE*** - The GT Series Lithium Battery System will disconnect power if the voltage, amperage, or temperature limits are exceeded during charging.
  - Only use a Lithionics Battery approved charging source. Please contact Lithionics Battery for charger approval.

3.4 Initial Charging Cycle

- The initial charging cycle is required as it calibrates the NeverDie BMS to the Battery Module for accurate State of Charge percentage (SoC) monitoring.
- During the initial charging cycle the system must reach a voltage level that is equal to the Standard Full Charging Voltage indicated in Table 1.
- Enable the charging device(s) so that they may complete a charge cycle. It is recommended to not have any discharge loads active during the initial charging cycle, especially towards the end of charging.

3.5 Discharging

- Discharging may be performed at any time the system is powered On.
  - ***NOTE*** - The GT Series Lithium Battery System will disconnect power if the voltage, amperage, or temperature limits are exceeded during discharging.
- The NeverDie feature allows the system to have a “reserve” amount of energy left in the battery. Once the system is discharged to 12.0V or 10% State of Charge (SoC), whichever comes first, power will be disabled to leave a “reserve” amount of energy still left in the battery.
- To enable the remaining reserve energy of the system, press the momentary Power/Reset switch for 1 second.
  - ***NOTE*** - Once the reserve range is enabled the battery should be charged as soon as possible.
  - ***WARNING*** - If the reserve energy is used and the battery module is left in a deeply discharged state without immediate charging, the battery module will become permanently damaged.

3.6 System Storage Procedure

- Storing your battery at the correct specifications is important as it keeps the battery in the healthiest state possible for the fastest deployment when needed.
- If the GT Series Lithium Battery System will not be in use for greater than 2 weeks, it is recommended to enable system storage.
- Storage mode is simply a fully charged system in the Powered Off state.
- To enable System Storage:
  - Perform a full charge cycle, ensure that the System voltage reaches the Standard Full Charging Voltage indicated in Table 1.
  - Power off the System, press and hold the Power/Reset switch for 3 seconds. Check that the switch is no longer illuminated. Check that there is 0V at the Power Terminals with a voltmeter.

Table 3

Storage Temperature & Humidity Range	< 1 Month	-4~95°F (-20~35°C), 45~75%RH
	< 3 Months	14~86°F (-10~30°C), 45~75%RH
Long Term Storage	If the battery needs to be stored for > 3 months the voltage should be 13.2V for a 12V battery (or 3.3V x number of cells in series) (~50%SOC) and stored at the recommended storage specifications shown above. Additionally, the battery needs at least one charge-discharge-recharge to 50% SOC cycle every six months.	
Self-discharge rate	≤3% per month	

Storage conditions < 3 months:

1. Fully charge the battery.
2. Turn the battery **OFF** by the Power/Reset switch.
3. Store the battery in an environment according to the specifications shown above.

Storage conditions > 3 months:

1. Reduce the battery SOC to 3.3V/cell which is 50% ±10% SOC.
   NOTE - See table 4 below for voltage calculation.
2. Turn the battery **OFF** via the Power/Reset switch.
3. Store the battery in an environment according to the specifications shown in table 3 above.
4. Every 6 months charge the battery to 100% SOC, then discharge the battery to LVC, then charge it to 50% ±10% SOC.

Table 4

Battery Voltage	Number of Cells	~50% SOC Voltage
12V	4	13.2
24V	8	26.4
48V	15	49.5
51V	16	52.8

NOTE – For further system installation and operation please refer to the *Advanced Series User Guide* available at: http://www.lithionicsbattery.com/user-guides/

Figure 1: System Example