PROTRXion™

Battery User Manual

M-24V60-TRX

M-24V80-TRX

M-24V90-TRX

M-48V60-TRX

Designed & Manufactured by

INVENTUS™ POWER

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Applicable Models

Model	Part No. (CANopen)
M-24V60-TRX (w/ heater)	58692-302
M-24V80-TRX (w/ heater)	58571-002
M-24V90-TRX (w/ heater)	57481-002
M-48V60-TRX (w/ heater)	58560-202

Document Information

Release Date	Revision	Scope of Change
2021-08-01	V1.0	1st Release

Environmental Regulations

The battery pack is compliant with the following environmental regulations:

- EU Directive 2002/95/EC for Restriction of Hazardous Substances (RoHS)
- EU Directive 2006/66/EC on batteries and accumulators and waste batteries and accumulators
- EU Directive 1907/2006 on the Registration Evaluation Authorization and Restriction of Chemicals (REACH)
- Management Methods for Controlling Pollution Caused by Electronic Information Products Regulation (China RoHS)

Please read all contents of this User's Manual prior to the installation of Inventus Power PROTRXion™ Batteries.

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Technical Support: For any issues, please email tech_support@inventuspower.com

Abbreviations

CANOpen	Controller Area Network Bus communication	**CCCV**	Constant Current Constant Voltage
J1939	Higher-layer CANbus protocol for data logging	**OTC**	Over Temperature Charging
OCV	Over Charge Voltage	**OTD**	Over Temperature Discharging
AFE	Analog Front End	**TCO**	Thermal Cutoff
BMS	Battery Management System	**SOT**	Safety Over Temperature
CC	Constant Current	**SOC**	State of Charge
CID	Current Interrupt Device	**OCV**	Open Circuit Voltage
COV	Cell Over Voltage	**RT**	Room Temperature
DOD	Depth of Discharge	**Ah**	Ampere Hour
OCC	Over Current Charge	**CUV**	Charge Under Voltage
LED	Light Emitting Diode		

Contents

Product Overview

The Inventus Power PROTRXion™ Series is a proprietary modular battery system featuring an Intelligent Battery Management System (BMS) that offers optimal safety protection for over/under voltage, overcharge/discharge current, short circuit and over/under temperature conditions for all harsh environments. This product provides incredible reliability, long cycle-life, and efficiency to maximize your power, performance, and runtime.

Please record both the serial number and date of purchase and store this in a safe place for future reference.

Serial Number		**Date of Purchase**	
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Safety Information

DO	DO NOT
• Always wear proper personal protective equipment • All installation should be performed by a qualified service technician • Use only insulative tools required for assembly • Charge the battery prior to installation • Dispose of the battery properly in accordance with local, state, and federal regulations • Extinguish any flames with a carbon dioxide, dry- powder fire extinguisher, and cover with copious amounts of water • Consult with Inventus for recommended smart chargers to use with battery	• Do not use with other types of batteries connected with the PROTRXion™ products • Do not short circuit the battery terminals • Do not operate or store the battery beyond the operating limits • Do not over-charge or over-discharge the battery • Do not crush, puncture, or drop the battery • Do not immerse battery in water • Do not burn or expose battery to fire • Do not charge battery near flammable materials, liquids, and surfaces • Do not alter, disassemble, modify, or open battery • Do not wear jewelry (i.e. rings, watches, bracelets, necklaces) when handling or working near the battery • Do not lift battery by the terminal cables • Do not operate if battery has been damaged in any way during shipping

Symbol	Definition
	Important safety information will follow.
	DO NOT dispose of battery in fire.
	RECYCLE! Battery may require recycling in accordance with local laws. Regardless, recycling is encouraged. Contact local regulatory authorities for more information. DO NOT include battery with lead acid battery recycling.
	DO NOT dispose of battery in the trash.
	Shock Hazard - Labels may be located on or inside the equipment to alert people that dangerous voltage may be present.
	Burn Hazard - Labels may be located on or inside the equipment to alert people that surface temperature may be dangerous.

Emergency and First Aid Procedures

Emergency Procedures for a Smoking Battery

- If a battery begins to smoke or melt, remove charging source immediately.
- If possible, move the battery to a well-ventilated area, preferably outside.
- Submerse in water or douse with copious amounts of water.

First Aid Procedures for Human Contact/Exposure to Battery Content

In the event of exposure to battery contents, the following could occur:

- Vapor or mist could irritate eyes, mucous membranes and/or respiratory tract
- Irritation to eyes and skin
- Exposure can cause nausea, dizziness or headache.

In case of contact with the battery's electrolyte:

- Immediately flush eyes with copious amounts of water for at least 15 minutes
- Assure adequate flushing of the eyes by separating the eyelids with fingers
- Flush skin with water
- Remove and wash contaminated clothing promptly
- If inhaled, remove oneself to fresh air
- If swallowed, wash out mouth with water
- If not breathing or having difficulty breathing, seek first aid

Personal Protective Equipment / Installation Tools

Before installation or maintenance of your batteries, the following equipment is required:

- Rubber gloves
- Safety goggles or other eye protection
- Insulated Torque Wrench / Philips Screwdriver
- Voltmeter

Battery Installation

Before You Start

Please read all the safety and warranty information provided in this document prior to installing and/or operating the battery.

IMPORTANT: Remove all jewelry or other metallic objects from your hands and body during the installation and removal of the battery packs and peripherals.

PROTRXion™ batteries should be professionally installed and handled. Please contact Inventus Power Technical Support (tech_support@inventuspower.com) for a free consultation if you have any questions about the handling, operation or safe use of this battery before proceeding further.

Unpacking

- If possible, do not discard the packaging, both the cardboard box and interior inserts for the battery. This packaging is specifically designed for the safe transportation per the approved IATA regulations and can be used if the battery must be transported to a new location. (In case new packaging is required, please contact Inventus Power Support for proper packaging instructions).
- Remove the protective battery terminal covers from the terminals. Retain these covers in the event that you need to remove or move the battery at some future time.

Visual Inspection

- Please inspect each battery carefully. Report any damage from shipping to Inventus Power immediately.

Installation Requirements

- Do not connect other batteries in series. Connecting in series exceeds the voltage limit of the integrated protection circuitry, leaving the module without critical safety features such as over-voltage and over-temperature protection. (Special applications may require factory application consultation)
- Remove jewelry and other metal objects from your hands and body during installation of the battery.
- Do not install a PROTRXion™ Battery where liquid is likely to contact battery terminals or signal communication ports.

Connecting the Battery

CAUTION: Failure to follow proper connection sequence can damage the battery and void the warranty.

- Remove power to the vehicle/device prior to installation of the PROTRXion™ battery.
- Remove all other batteries from the system prior to replacing them with PROTRXion batteries.
- Attach the negative cable from the device to the negative terminal on the battery.
- Attach the positive cable from the device to the positive terminal on the battery.
- Attach the signal communications cable (M12 SIGNAL CONNECTOR) if needed.
- If the battery charger is integrated with the device drawing power from the PROTRXion battery, then please follow manufacturers recommended sequence for each battery connection.
- Please contact Inventus Technical Support if the system requires more than 10 batteries.

Torque Rating

Model	Terminal Type	Wrench Size	Torque (Nm)
M-24V60-TRX	ISO M8 x 1.25 x 16mm Threaded Hole	13mm	17 ± 1
M-24V80-TRX M-24V90-TRX M-48V60-TRX	ISO M8 x 1.25 x 16mm Threaded Hole (Negative Terminal)	13mm	17 ± 1
	ISO M10 x 1.5 x 20mm Threaded Hole (Positive Terminal)	17mm	22 ± 1

CAUTION: When using bolts to engage the battery's threaded holes, use the appropriate number of flat and lock washers to allow for as much thread engagement as possible without bottoming out the bolt. Over-tightening battery terminal bolts could result in damage to battery terminals. Under-tightening battery terminals could result in excessive heating of the terminals.

Power Cables

Choose the appropriate power cable size based on the system load requirements. Cables are rated at ambient temperature of 30°C (86°F) per the table below. When connected in parallel configuration, it is preferable for all cables to be the same length size.

Copper Wire Gauge (AWG)	Ampacity (A)
14	20
12	25
10	30
8	50
6	65
4	85
3	100
2	115
1	130
0 (1/0)	150
00 (2/0)	175

Communication Cables

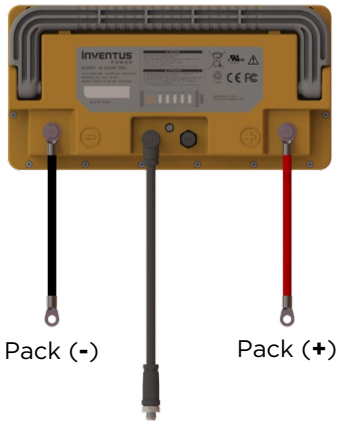
If your application requires communication, please connect a CAN cable to the battery signal connector and respective system or chargers. See wiring diagram on pages 11-12.

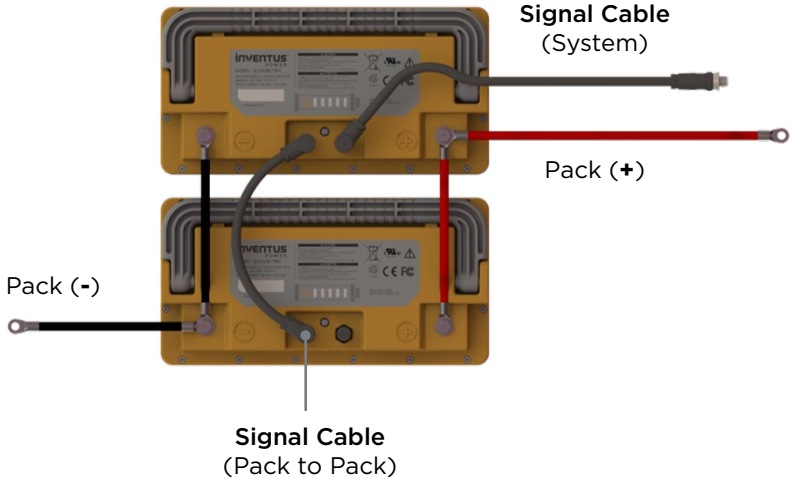
Item	Mfg Part No.	Cable Length	Where to Purchase
Pack to Host	T4161120008-001	0.5 meter (1.64′)	Digikey
Pack to Pack	M12A08MR-12AMR-SBA05	0.5 meter (1.64′)	Digikey

Parallel connections

Connecting two or more batteries together to increase the capacity of the battery system. The positive terminal of 1st battery is connected via jumper cable to the positive terminal of the 2nd battery. Use another set of jumper cables with same wire gauge to connect the negative terminals of both batteries together. Use another set of power cables with same wire gauge to connect the open positive and negative terminals from the 1st and last battery respectively to the host system until the desired capacity is reached.

Single Install	Parallel Connection





Note: For parallel battery configurations, a 120Ω termination resistor is recommended to be installed across Pins 6 & 7 on the unused connector of the battery stack.

Disconnecting the Battery

CAUTION: Failure to follow proper disconnection sequence can damage the battery and void the warranty.

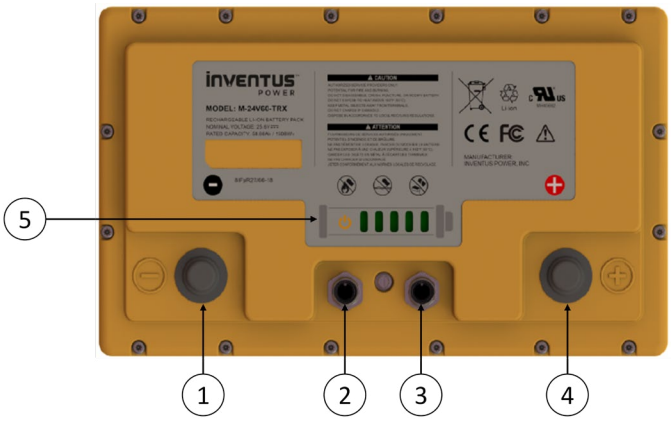
- Power off the machine/device prior to the removal of the PROTRXion battery.
- If the battery charger is integrated with the device drawing power from the PROTRXion battery, then please follow manufacturers recommended sequence for battery disconnect.
- Disconnect the communications cable (M12 SIGNAL CONNECTOR) if one is attached.
- Disconnect the positive cable from the positive terminal on the battery.
- Disconnect the negative cable from the negative terminal on the battery.

Battery Specifications

Specification	M-24V60-TRX	M-24V80-TRX	M-24V90-TRX	M-48V60-TRX
Cell Chemistry	Lithium Iron Phosphate			Nickel Manganese Cobalt
Voltage	25.6V / 28V	25.6V / 28V	25.6V / 28V	50.8V / 58.1V
Energy	1.5kWh / 60Ah	2.0kWh / 80Ah	2.3kWh / 90Ah	3.1kWh / 60Ah
Continuous Current *(per module)*	75A	80A	90A	60A
Peak Pulse Discharge *(@ 25°C)*	240 Amps < 10secs	200 Amps < 10secs	200 Amps < 10secs	140 Amps < 10secs
Cycle Life *(@ 25°C)*	3,000 @ 80% DoD	3,000 @ 80% DoD	4,000 @ 80% DoD	2,000 @ 80% DoD
Charge Operating Temperature	0°C to +55°C			0°C to +45°C
Charge Operating Temperature *(w/ heater)*	-35°C to +55°C			-35°C to +45°C
Discharge Operating Temperature	-20°C to +60°C	-20°C to +55°C		
Discharge Operating Temperature *(w/ heater)*	-35°C to +60°C	-35°C to +55°C		
Operating Humidity	5% to 95%			
Scalability	Parallel: 10 max	Parallel: 15 max	Parallel: 15 max	Parallel: 10 max
Weight	18.2kg (40lbs)	20.5kg (45.2lbs)	21kg (47lbs)	18.7kg (41.1lbs)
Communication	J1939 / CANopen			
Certifications	UN38.3, FCC Class B, UL1642, UL2271 IEC62133, IEC62619, CE, RoHS, WEEE			

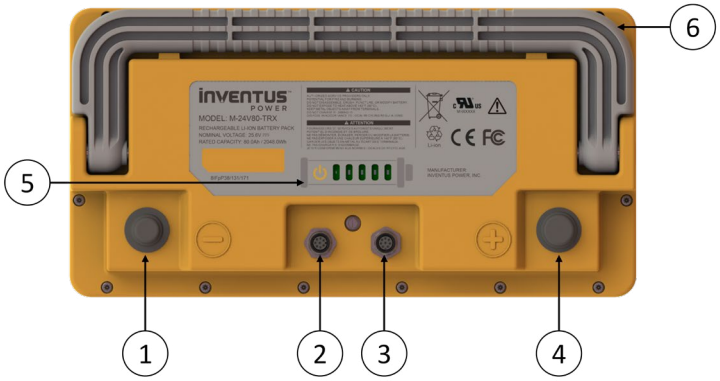
Mechanical Features

M-24V60-TRX



#	Description
1	Negative Terminal
2	Signal Connector #1
3	Signal Connector #2
4	Positive Terminal
5	Battery State of Charge Indicator

M-24V80-TRX / M-24V90-TRX / M-48V60-TRX



#	Description
1	Negative Terminal
2	Signal Connector #1
3	Signal Connector #2
4	Positive Terminal
5	Battery State of Charge Indicator
6	Retractable Pull Handle

Product Dimensions

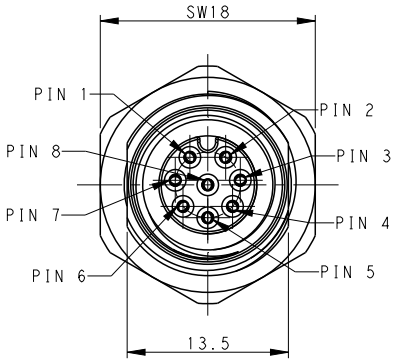
Specification	M-24V60-TRX	M-24V80-TRX	M-24V90-TRX	M-48V60-TRX
Length	297.0 ± 2.0mm	346 ± 2.0mm	346 ± 2.0mm	346 ± 2.0mm
Width	175.5 ±1.5mm	178 ± 2.0mm	178 ± 2.0mm	178 ± 2.0mm
Height	228.0 ± 2.0mm	258 ± 2.0mm	258 ± 2.0mm	258 ± 2.0mm

Battery Identifier Format

FF	**Factory Location** (TJ: Tijuana, MX; QX: QingXi, CN)
XXXXXXXX	**Work Order Number** (8 digits)
SSSSS	**Battery Serial Number** (00001-65535)
YYYYMMDD	**Mfg Date** (YEAR, MONTH, AND DAY)
	Restart each manufacture date

Communications

- Each PROTRXion battery uses two female Tyco Electronics M12 connectors to support signal communication with the host system.
- Communications are disabled until the battery is awakened by the charger applying a charge voltage.
- Voltage, current, temperature, capacity, cycle count, state of charge, and fault codes can be read from the battery using CANopen or J1939 communication.
- A signal interface is used as the communication interface between the battery and a connected device.



TE Connector P/N: T4131012081-000

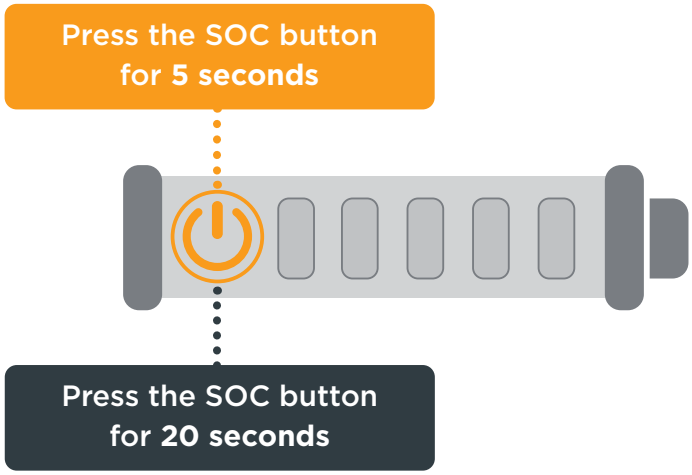
If in doubt, please consult with **Inventus Power Technical Support (tech_support@inventuspower.com)** on further instructions on the signal cable connections to the host system.

Wake-Up & Shutdown

TO **WAKE UP** THE BATTERY

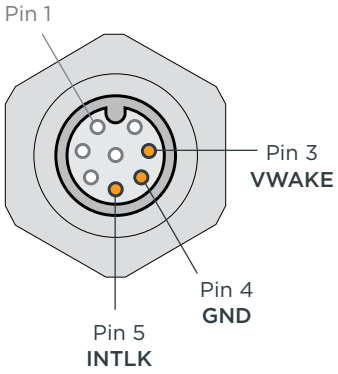
We recommend to shut down the battery when it is not used to prevent self-consumption current drain and extend storage life.

TO **SHUT DOWN** THE BATTERY



Installation

1. Remove power to the vehicle/device prior to installation of the battery.
2. For the M12 signal connector, short pin 4 (VGND) to pin 5 (VINTLK) to wake up battery from Ship Mode.
3. Attach negative cable from the device to the negative terminal on the battery.
4. Attach positive cable from the device to the positive terminal on the battery.
5. Attach M12 signal male to wire cable (T4161120008-001) only if the host system requires CANbus communication.



Battery Modes

Wake up	Sleep Mode	Charging Mode	Discharging Mode
1 2 3 **4** **5** 6 7 8	1 2 **3** **4** **5** 6 7 8	1 2 3 **4** **5** 6 7 8	1 2 **3** **4** 5 6 7 8
Connect pins 4 & 5 to exit ship mode	**Disconnect pins 3, 4 & 5 to put into ship mode**	**Connect pins 4 & 5 to enter charging mode**	**Connect pins 3 & 4 to enter Discharge Mode**

Pin Definition (M-24V60-TRX)

Pin #	Symbol	Description
1	VCANH	CAN High for communication to the vehicle/machine
2	VCANL	CAN Low for communication to the vehicle/machine
3	VWAKE	Wake up input pin – active low to enable Discharging
4	VGND	Pack signal ground used to pull Wake up and Interlock low
5	VINTLK	Interlock input pin – active low to enable charging
6	PACK_S_ID (-601)	Pack series configuration ID, leave floating for parallel
7	VCANL_BATT	CAN Low for module to module communications
8	VCANH_BATT	CAN High for module to module communications

Pin Definition (M-24V80-TRX / M-24V90-TRX)

Pin #	Symbol	Description
1	VCANH	CAN High for communication to the vehicle/machine
2	VCANL	CAN Low for communication to the vehicle/machine
3	VWAKE	Wake up input pin – active low to enable Discharging
4	VGND	Pack signal ground used to pull Wake up and Interlock low
5	VINTLK	Interlock input pin – active low to enable charging
6	VCANH_BATT	CAN High for module to module communications
7	VCANL_BATT	CAN Low for module to module communications
8	VSUPPLY_24V	Unregulated 24V output – 2A continuous max.

Note: VSUPPLY_24V is always on except for during Ship mode and, Over/Under Temperature and Cell Undervoltage Conditions.

Pin Definition (M-48V60-TRX)

Pin #	Symbol	Description
1	VCANH	CAN High for communication to the vehicle/machine
2	VCANL	CAN Low for communication to the vehicle/machine
3	VWAKE	Wake up input pin – active low to enable Discharging
4	VGND	Pack signal ground used to pull Wake up and Interlock low
5	VINTLK	Interlock input pin – active low to enable charging
6	VSUPPLY	Aux Power Supply (15V, <15mA current limit)
7	VCANL_BATT	CAN Low for module to module communications
8	VCANH_BATT	CAN High for module to module communications

Mode Selection

Machine Mode	Wake up	Interlock	Mode Name	Description	Module Mode
1	Off (High or Hi-z)	Off (High or Hi-z)	Off	Sleep, MOSFET's open	Sleep
2	Off (High or Hi-z)	**On (Low)**	Charge	Discharge prevented, MOSFET's closed	Normal (Charge)
3	**On (Low)**	**On (Low)**	Charge	Discharge prevented, MOSFET's closed	Normal (Charge)
4	**On (Low)**	Off (High or Hi-z)	Discharge	Discharge allowed, MOSFET's closed	Normal (Discharge)

Battery State of Charge Indicator

There are (5) LED and one button on each module to be used for SOC and fault indication. To the far left is the button followed by the LED to the right as shown in the figure below. The LED will capable of representing a range for the remaining SOC. The LED will remain lit for 5 seconds after the button is pressed before turning off unless the SOC is 10% or less than the first LED will blink on and off for 10 seconds. The LED will come on when the following conditions are detected:

LED Indicator Status	Battery State of Charge
	**81 – 100%**
	**61 – 80%**
	**41 – 60%**
	**21 – 40%**
	**11 – 20%**
	**1 to 10%**

Heater Operation

The PROTRXion™ batteries have an optional heater for each module for using during cold weather operation. The heater power will be drawn from charger during charge mode and from the cells during discharge mode. Always connect the charger to make sure the batteries can support operation of the battery heaters and recharge the batteries as needed.

For Charging: If the ambient temperature reaches below 0°C (32°F), the battery heater will activate to support charge mode until the battery pack temperature reaches above 5°C (41°F). Charging will be prohibited while the heater is activated.

For Discharging: If the ambient temperature reaches below -10°C (14°F), the battery heater will activate to support discharge mode until the battery pack temperature reaches above -5°C (23°F). The battery heaters will not operate when ambient temperature is below -35°C (-31°F).

Selecting a Battery Charger

Many types of existing lead acid chargers are compatible with our PROTRXion™ batteries. These can safely charge between -35°C to 55°C (-31°F to 131°F). However, at temperatures below 0°C (32°F) the charge current must be reduced until the temperature is >0ºC (32ºF).

After the charger has been selected, 1st connect the (+) terminal to the battery, then the (-) terminal. Once the terminals have been connected, connect the CAN communication to the battery to optimize the charger performance (preferred chargers recommended by Inventus Power).

Charger Voltage

The charger maximum voltage output should match the maximum charge voltage of the battery system and should not exceed constant voltage of 28VDC (58.1 VDC for M-48V60-TRX).

Charger Current

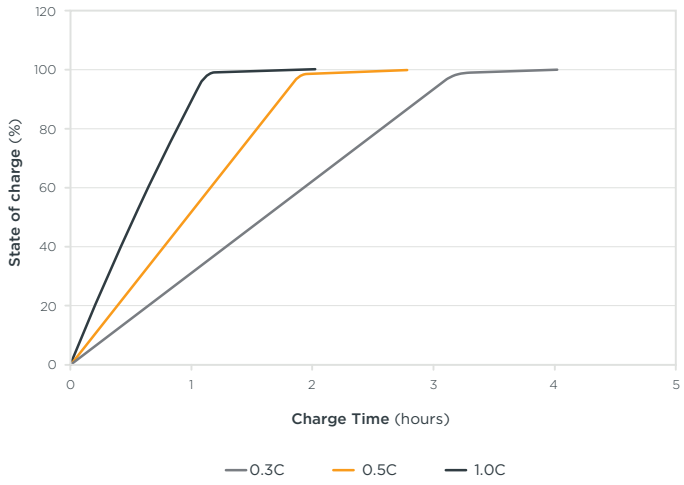
The recommend charge current rate is 0.5C for LFP cells (M-24V60/80/90-TRX) and 0.3C for NMC cells (M-48V60-TRX). The PROTRXion™ modules may be charged at higher C rates, however this may impact the battery cycle life.

When choosing an intelligent charger, please discuss with Inventus Technical Support on suitable off-the-shelf charger solutions.

M-24V60-TRX

Charging Performance

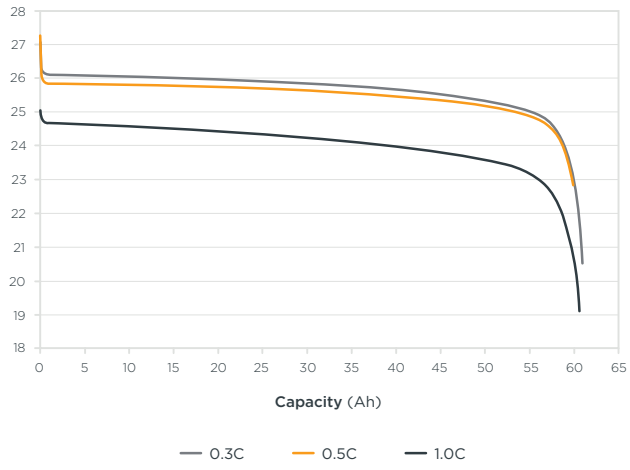
Test Condition: Ambient Temperature



M-24V60-TRX

Capacity vs Discharge Rate

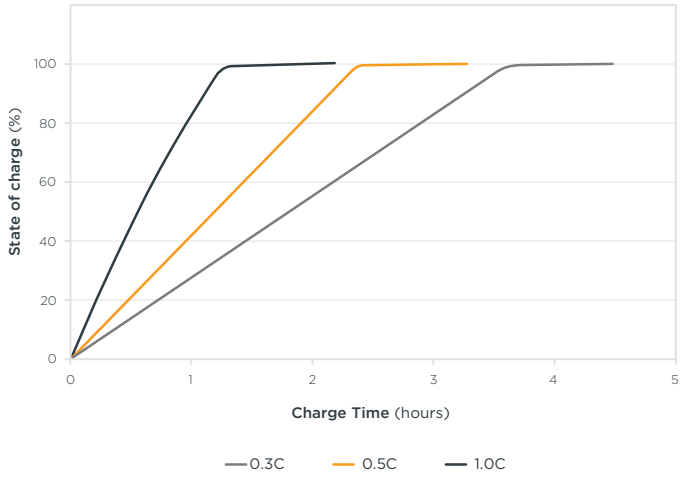
Test Condition: Ambient Temperature



M-24V80-TRX

Charging Performance

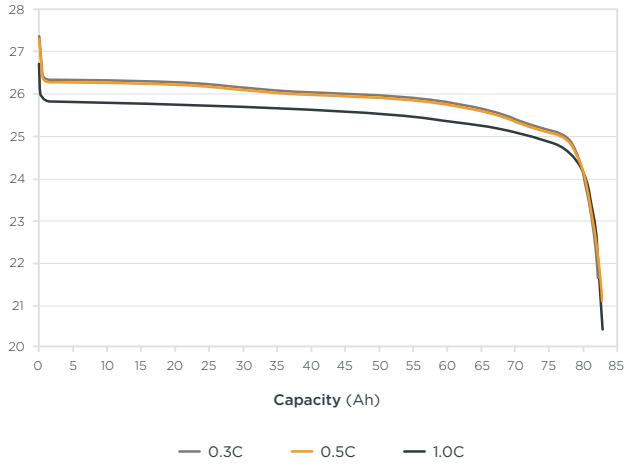
Test Condition: Ambient Temperature



M-24V80-TRX

Capacity vs Discharge Rate

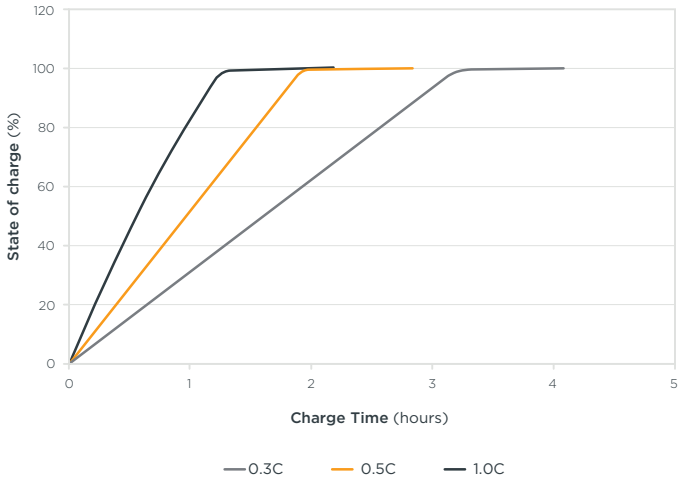
Test Condition: Ambient Temperature



M-24V90-TRX

Charging Performance

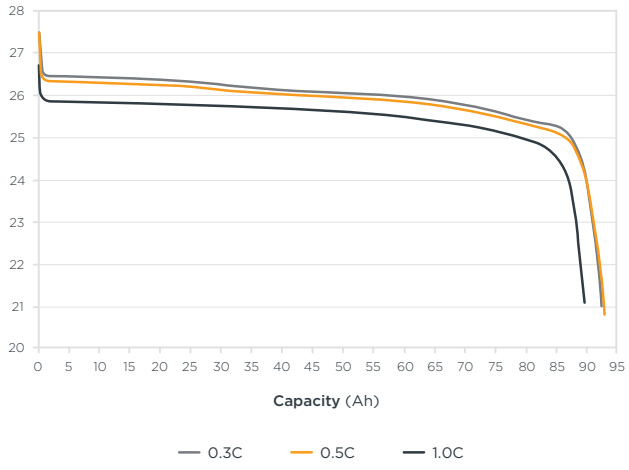
Test Condition: Ambient Temperature



M-24V90-TRX

Capacity vs Discharge Rate

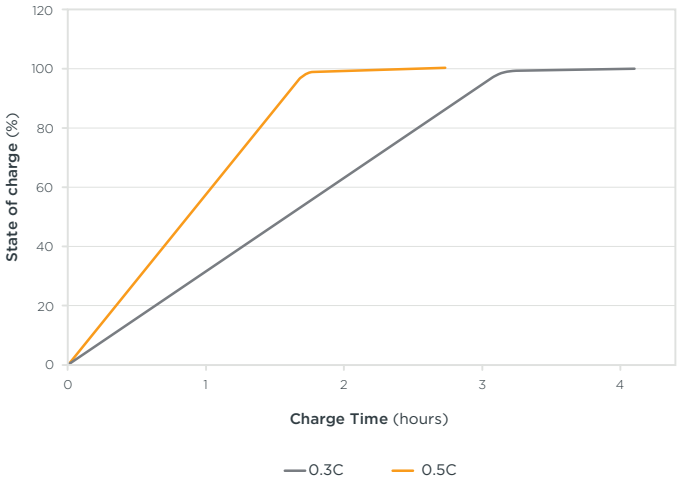
Test Condition: Ambient Temperature



M-48V60-TRX

Charging Performance

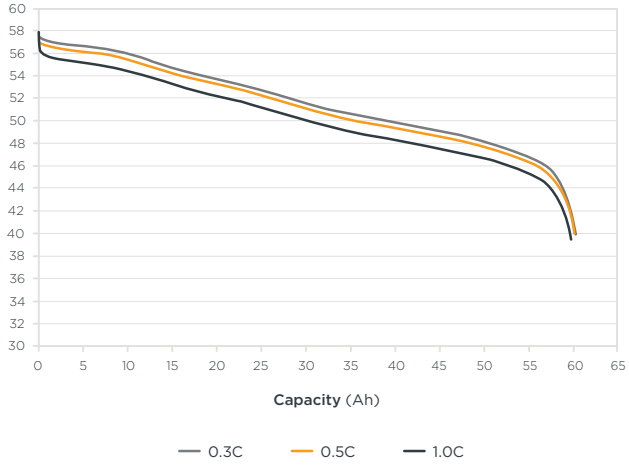
Test Condition: Ambient Temperature



M-48V60-TRX

Capacity vs Discharge Rate

Test Condition: Room Temperature



Maintenance Charging

PROTRXion™ batteries can be stored in an environment with temperatures between -20°C (-4°F) and +60°C (140°F) and between 5% and 95% relative humidity, non-condensing. For long storage periods at 25°C (77°F), charge the battery every two years. For temperatures above 55°C (131°F), charge the battery annually.

Battery Case Visual Inspection

Please perform regular visual inspections of the battery case. If the battery case is found to have dents, discoloration, or appears to be damaged in any way, DISCONTINUE USE IMMEDIATELY. Please contact Inventus Power for assistance with evaluating the product for continued usability.

Voltage Checking

The voltage of the battery can be monitored during normal operation or as part of standard tests performed periodically to assess the health of the battery. If you find the battery voltage under 16V at room temperature, the battery has been over-discharged or is self-discharging due to some defect/parasitic load. Discontinue use until the fault can be corrected and the battery can be recharged.

Battery Storage

- Battery should be stored between 30-50% SOC.
- Store in an open, well ventilated, and dry area <30°C for maximum life.
- Do not expose the battery to extreme temperature or sunlight over 60°C (131°F).
- Do not expose the battery to direct sunlight or moisture and/or precipitation.
- Handle each battery carefully to avoid sharp impacts or extreme pressure on the case.
- Do not store a fully discharged battery. Recharge battery after every use.

Minimum Temperature	Maximum Temperature	Duration
-20°C (-4°F)	60°C (140°F)	1 month
-20°C (-4°F)	35°C (95°F)	3 months
0°C (32°F)	25°C (77°F)	24 months

Transporting Lithium-ion Batteries

This section discusses the regulations governing the transportation of lithium-ion cells and batteries both within the United States and internationally. You should read and understand all relevant regulations discussed in this section before shipping Inventus Power PROTRXion™ batteries.

Lithium batteries are classified as Class 9 when transporting by air or ground. When shipping by air, all lithium batteries are required to have a 30% state of charge or less. Lithium batteries with capacity greater than 300 Wh and exceed 30kg (66lbs), are considered Class 9 when shipping by ground. For more information on shipping Lithium Batteries, please see your freight carrier's requirements.

NOTE: The regulations discussed in this manual apply to lithium-ion cells and batteries. Once the Inventus Power PROTRXion battery is integrated into a host system, the host may be subject to additional transportation regulations that require additional certification testing. Since Inventus Power cannot anticipate every possible configuration and application, you must verify that your system integrated with our PROTRXion™ battery system is compliant with all local ordinances and regulations.

Transporting Batteries for Installation

- Place the battery terminal protective caps on the battery terminals prior to removing the battery from its current location, to prevent accidental shorts or arcing from occurring if a terminal touches a metal object.
- Battery handle must be in the close position prior to assembly.
- Avoid heavy vibration during transportation.
- Avoid throwing, dropping, rolling and excessive stacking during loading and transportation.
- Make sure that all cables and external connectors are disconnected and properly removed from the battery prior to transporting it.
- Do not hang or hook battery handle with sharp device or at one corner only.

Transporting Batteries to a Different Location

If the battery needs to be shipped to a different location or sent back to Inventus Power for any reason:

1. Disconnect all cables, both power and communications from the batteries.
   (reference section "Disconnecting the Battery" for proper disconnection procedure)

2. Place the protective caps on the battery terminals prior to removing the battery from its current location, to prevent accidental shorts or arcing from occurring if a terminal touches a metal object.

3. All large lithium-ion batteries are considered "Dangerous Goods" by the US Department of Transportation, and as a result, transporting them by common carrier (whether by ground or by air) requires compliance with UN DOT regulations UN3480, Class 9 - "Dangerous Goods".

4. Pack the batteries in "Dangerous Goods" certified boxes and packaging materials as specified by the Department of Transportation (DOT). The packaging must protect the contents from reasonable handling damage and prevent short circuits from taking place. Ideally, one would use the original box if it's still in good condition.

5. The package should be prepared for shipment and shipping documents should be signed by an individual who is certified to handle and prepare the paperwork and products that have been designated as "Dangerous Goods" for shipment.

IMPORTANT: Each PROTRXion battery is shipped in a specially designed box to provide maximum protection for the contents. We strongly recommend that you save this box and use it whenever you need to transport or ship the battery. Please follow all local laws/regulations regarding the shipment of lithium-Ion batteries.

Following UN and DOT Regulations

Failure to comply with UN and DOT regulations while transporting Class 9 Hazardous Materials (Dangerous Goods) may result in substantial civil and criminal penalties.

Troubleshooting

Despite the high reliability of the PROTRXion battery, you may encounter situations where the battery module does not operate as expected. These situations are typically the result of misuse, abuse or a non-optimal operating or storage environment. If the battery is not operating correctly, you will need to perform the following troubleshooting procedures to fix the issue.

Fault ID	LED Status	Description of Fault	Fix
F0		**Over-temperature (cells)**	Wait for temperature to drop into acceptable operating range
F1		**Over-temperature (BMS)**	Wait for temperature to drop into acceptable operating range
F2		**Under-temperature (charge)**	Wait for temperature to drop into acceptable operating range
F3		**Over-current (recoverable)**	If charging, power cycle charger; replace charger if problem persists. If discharging, battery will resume operation after discharge has been stopped.
F4		**Over-current (permanent fault)**	Disconnect and replace battery.
F5		**Short-circuit**	Check all connection point to battery system.
F6		**Cell under-voltage during discharge only**	Recharge battery.
F7		**Cell over-voltage during charge only (primary)**	Discharge battery down to 20% SOC and then recharge battery.
F8		**Cell over-voltage during charge only (secondary)**	Disconnect and replace battery.
F9		**Safety under-voltage**	Recharge battery.
F10		**Cell pre-charge fault**	Power cycle charger and replace charger if problem persists
F11		**Charge fault**	Power cycle charger and replace charger if problem persists.
F12		**Under-temperature (discharge)**	Wait for temperature to rise into acceptable operational range.
F13		**Miscellaneous fault**	Power cycle battery. Replace battery if problem persists
F14		**Pre-discharge**	Enable the battery without load and check if fault goes away. If fault is not present, reconnect to system. If fault persists, disconnect and replace battery.
F15		**Permanent fault**	Disconnect and replace battery.

Warranty Violations

CAUTION: Performing any of the following actions will immediately void your warranty on the product and could lead to a potentially dangerous situation

1. Breaking the lid and exposing the circuit boards and battery assemblies.
2. Incorrect battery wiring and/or installation. Verify polarity at all connections with a standard voltmeter
3. Operating the battery in an environment where the temperature exceeds the specified limits.
4. Modifying or tampering with the TE M12 connector and communication interface and internal data logging functions.
5. Connecting PROTRXion battery in series configuration.
6. Incorrect battery bank sizing.
7. Verify polarity at all connections with a standard voltmeter (1) before energizing the system and (2) on batteries with threaded connections, before switching the built-in circuit breaker to the “ON” position.
8. Pairing the battery with incompatible equipment. Use of accessories not recommended or sold by the manufacturer may result in a risk of fire, electric shock, or injury to persons and will Void the Warranty.
9. Exceeding the maximum continuous discharge rate or charge rate can damage and void the PROTRXion battery.

Inventus does NOT cover product damage caused by mishandling or improper use per the Installation Manual, Integration Guides and Warranty, exposure to liquids, impacts from falling objects or being dropped, or attempts to repair the battery by any party other than Inventus.

The complete list of Warranty Exclusions is included in the Inventus Power Battery Warranty document:

If you believe that in the course of using the PROTRXion battery, you will conflict with any of the above listed conditions or any other safety precautions listed in this manual, please DO NOT proceed any further.

Contact Inventus Power immediately for guidance and information.

Recycling

Inventus Power batteries are recyclable and should not be disposed of as household or landfill waste. Do not incinerate or dispose of the battery. Return end-of-life or defective batteries to your nearest recycling center as per the appropriate local regulations. For information about recycling, please visit our website at: **www.inventuspower.com**

The EPA classifies spent batteries as “universal wastes” instead of “dangerous goods.” The shipping requirements for universal wastes are available at the EPA website at: **www.epa.gov**

Technical Support

If you have any technical questions regarding the PROTRXion™ battery, please contact our technical support team at:

Phone: +1.877.423.4242

E-mail: tech_support@inventuspower.com