SUPER B
lithium batteries

Manual

Version
May 2022

EPSILON 12V100Ah
EPSILON 12V150Ah

User Manual Epsilon 12V100Ah / 12V150Ah

Dear customer,

This manual contains all the information necessary to install, use and maintain the Li-ion battery. We kindly ask you to read this manual carefully before using the product. In this manual, the Super B Epsilon 12V100Ah/12V150Ah Li-ion battery will be referred to as: the Li-ion battery. This manual is meant for the installer and the user of the Li-ion battery. Only qualified, certified personnel may install and perform maintenance on the Li-ion battery. Please consult the index at the start of this manual to locate information relevant to you.

During the use of the product, user safety should always be ensured, so installers, users, service personnel and third parties can safely use the Li-ion battery.

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1. Safety guidelines and measures

1.1. General

- Do not short-circuit the Li-ion battery.
- Treat the Li-ion battery as described in this manual.
- Do not dismantle, crush, puncture, open or shred the Li-ion battery.
- Do not expose Li-ion battery to heat or fire. Avoid exposure to direct sunlight.
- Do not remove the Li-ion battery from its original packaging until required for use.
- In the event of electrolyte leaking, do not allow the liquid to come in contact with the skin or eyes. If contact has been made, wash the affected area with water and seek medical advice.
- Always use a class 2 charger which is specifically provided for use with a Lithium Iron Phosphate battery (LiFePO4). For more information, please refer to the charging manual on our website.
- Observe the plus (+) and minus (–) marks on the Li-ion battery and equipment and ensure correct use.
- Do not mix batteries of different manufacturer, capacity, size, type or age within a system.
- Keep the Li-ion battery clean and dry.
- Secondary batteries need to be charged before use. Always use a correct charger (see charging manual on our website) and refer to this manual for proper charging instructions.
- Do not leave the Li-ion battery on prolonged charge when not in use.
- After extended periods of storage, it may be necessary to charge and discharge the Li-ion battery several times to obtain maximum performance.
- During long periods of storage maintenance, charging is needed to prevent deep discharge by self discharge.
- Retain the original product documentation for future reference.
- Disconnect the Li-ion battery from the equipment when not in use.

⚠ **Warning!** Keep the Li-ion battery away from water, dust and contamination. Place the Li-ion battery in well ventilated areas.

1.2. Disposal

Dispose the Li-ion battery in accordance with local, state and federal laws and regulations.
Batteries may be returned to the manufacturer.
Do not mix with other (industrial) waste.

2. Introduction

2.1. Product description

The Epsilon is a self-protected Lithium Iron Phosphate rechargeable battery. The unique combination of state-of-the art technology and smart software makes this Li-ion battery a robust, safe and easy to use energy storage solution. The Epsilon is available in a 12V100Ah and 12V150Ah variant.

The Li-ion battery uses safe Lithium Iron Phosphate (LiFePO4) technology. With its integrated battery management system (BMS) the Li-ion battery is protected from deep discharging, overcharging and overheating. Eliminating the need for an external safety relay means the Li-ion battery is very easy to install.

The Li-ion battery also has integrated battery monitoring which provides details about its status such as voltage, current, temperature, state of charge and time remaining. Hands-on monitoring is possible via the Be In Charge app, Be In Charge Software, CI-bus, external monitoring devices and LED indicators inform you about the actual status of your Li-ion battery.

The Li-ion battery can use the integrated heating to heat up, or keep the cells at a temperature level to be able to charge the battery in sub-zero degrees environment conditions. This ensures that the cells are used within their specifications enlengthening the Li-ion batteries lifetime.

Under the Li-ion batteries protective lid easy to use connections such as configurable inputs / outputs, CAN and LIN connection, external heater power input and accessory power connection can be found. All using standardized connections which makes it very easy to install the Epsilon in the application.

2.2. Intended use

The Epsilon 12V100Ah/12V150Ah Li-ion battery serves as an energy source of 12V in power systems for recreational vehicles, commercial vehicles, leisure boats, commercial vessels and stationary applications. Potential applications of this Li-ion battery include: off grid power supply, marine power supply, medium for (renewable) energy storage and (traction) battery for vehicles. Use as a starter battery is not possible. Never install multiple Epsilon Li-ion batteries in series. Up to 8 batteries can be connected in parallel to increase the total capacity up to 800Ah or 1200Ah depending on the Epsilon variant.

Always connect batteries of the same type / capacity and age in a parallel setup and do not add more batteries to the parallel bank after a certain time. This could lead to a degradation of the total capacity and disturbed current distribution within the system.

2.3. Glossary of Terminology

BMS:	Battery Management System
Charge cycle:	A period of use from fully charged, to fully discharged, and fully recharged again
Endurance Life-cycle:	The products maximum lifespan, achieved by following the guidelines presented in this manual
LiFeP04	Lithium Iron Phosphate
SoC	State of Charge
SoH	State of Health
CCCV	Constant Current - Constant Voltage
DoD	Depth of Discharge
I/O	Inputs and Outputs

Table 1. Glossary of terminology

2.4. Used symbols

The following icons will be used throughout the manual:

⚠ **Warning!** A warning indicates severe damage to the user and/or product may occur when a procedure is not carried out as described.

⚠ **Caution!** A caution sign indicates problems may occur if a procedure is not carried out as described. It may also serve as a reminder to the user.

3. Product specifications

3.1. Product features

- A-grade prismatic cells for highest possible energy density and quality
- Lithium Iron Phosphate (LiFePO4): Safe lithium technology
- Integrated short circuit protection
- Integrated protection device for maximum protection and safety
- Integrated BMS (Battery Management System)
- Integrated cell heating to allow safe charging below 0°C (with autonomous operation if needed)
- Adaptive cell balancing
- Robust casing made from environmentally friendly materials (fully recyclable)
- Overheating protection on battery terminals in case of badly connected cables

- Communication interface: Bluetooth (wireless), CAN bus(wired) and LIN bus (wired
- Configurable general purpose inputs/outputs to control external devices (chargers for example)
- Separate power output connection for powering accessories. Analog SoC output.
- Battery monitoring / History Storage
- Monitoring via Be In Charge Bluetooth app (iOS and Android) and Be In Charge Software (PC)
- Multi-connectable coated aluminium terminals, including temperature sensors for protection.
- LN3 / DIN H6 and LN5 / DIN H8 sizes available in different capacity (100Ah and 150Ah)

3.2. Product specifications

3.2.1. Electrical specifications

	Epsilon 12V100Ah	Epsilon 12V150Ah
Nominal capacity	100Ah	150Ah
Energy	1280Wh	1920Wh
Nominal voltage	12.8V	12.8V
Open circuit voltage	13.2V	13.2V
Self discharge	<3% per month	<3% per month

Table 2. Electrical specifications

3.2.2. Mechanical specifications

	Epsilon 12V100Ah	Epsilon 12V150Ah
Dimensions (LxWxH)	278 x 175 x 190 mm 11" x 6.9" x 7.5" [= DIN H6 / LN3]	353 x 175 x 190 mm / 13.9" x 6.9" x 7.5" (= DIN H8 / LN5)
Weight	11 kg / 24 lbs	16 kg / 35.2 lbs
Case material	PC /ABS	PC / ABS
Ingress protection	IP56	IP56
Cell type / chemistry	Prismatic - LiFePO4	Prismatic - LiFePO4

Table 3. Mechanical specifications

3.2.3. Charge & discharge specifications

	Epsilon 12V100Ah	Epsilon 12V150Ah
Charge method	CCCV	CCCV
Charge voltage	14.3V - 14.6V	14.3V - 14.6V
Max charge current	90A	135A

End of discharge voltage	8V	8V
Discharge current continous	Max. 190A	Max. 200A
Discharge pulse current (10 sec)	300A	350A

Table 4. Charge and discharge specifications

3.2.4. Temperature specifications

Charge temperature (heating off)	0°C to 45°C / 32°F to 113°F
Charge temperature (heating on)	-30°C to 45°C / -22°F to 113°F[1]
Discharge temperature	-20°C to 60°C / -4°F to 140°F
Storage temperature short term (<1 month)	-20°C to 45°C / -4°F to 113°F
Storage temperature long term (>1 month)	18°C to 28°C / 64°F to 82°F
Relative humidty	10-90%

Table 5. Temperature specifications

[1]Charging from -30 °C is only possible with an external power source to power the heaters, the correct settings should be used

3.2.5. Compliance specifications

Certifications	CE, FCC, UN 38.3, UN ECE R10.06, UL1642 (Cells)
Shipping classification	UN 3480

Table 6. Compliance specifications

3.2.6. General product specifications

	Epsilon 12V100Ah	Epsilon 12V150Ah
Battery designation	IFpP/27/148/135[2p4s] M/-20+60/95	IFpP/27/148/135[3p4s] M/-20+60/95
Cycle life	>5000 (0.3C charge/discharge, DoD 100%)[2] >3500 (0.9C charge/discharge, DoD 100%)[2]	

Table 7. General product specifications

[2]The cycle life value given above is an indication at 23°C. The Li-ion battery cycle life depends strongly on temperature and the applied charging and discharging loads.

3.3. Environmental conditions

⚠ **Warning!** The Li-ion battery may only be used in conditions specified in this manual. Exposing the Li-ion battery to conditions outside the specified boundaries may lead to serious damage to the product, user and/or environment.
Use the Li-ion battery in a dry, clean, dust free, well ventilated space. Do not expose the Li-ion battery to fire, water, solvents or excessive heat.

3.4. Scope of delivery

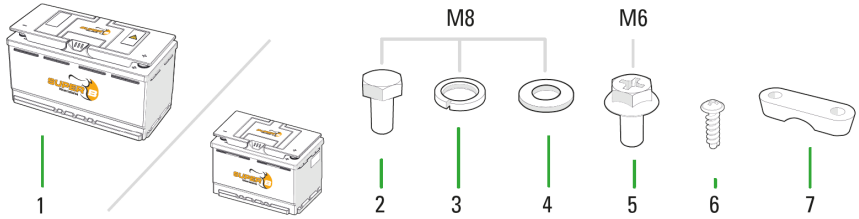

Figure 1. Components

1. (1x) Super B Epsilon 12V100Ah / Epsilon 12V150Ah Li-ion battery
2. (2x) Hex bolt M8x16
3. (2x) Washer M8
4. (2x) Lockring M8
5. (2x) Terminal Screw M6
6. (4x) Philips screw
7. (2x) Cable clamp

3.5. Terminals and LED indicators

The picture below is showing the terminals of the Li-ion battery

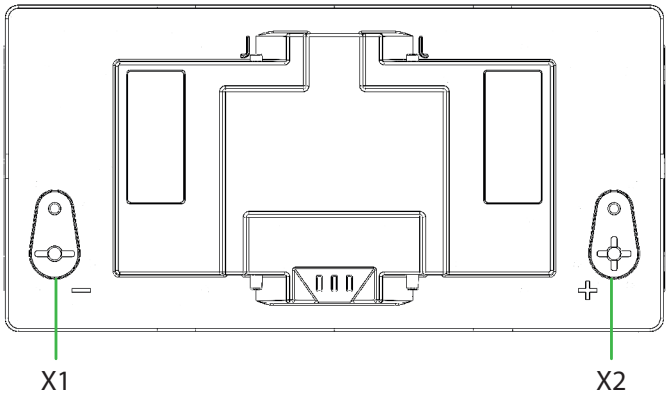

Figure 2. Battery terminals

X1: Battery Terminal up to 1x 95mm2 wire connection or standard automotive terminal and 1x M6 bolt for accessory connection
X2: Battery Terminal up to 1x 95mm2 wire connection or standard automotive terminal and 1x M6 bolt for accessory connection

3.5.1. X1 / X2 Battery terminal interface

Terminal #	Service description	Function	Range
1	Battery - Terminal	-	Minus supply of battery
2	Battery + Terminal	+ (14.6Vdc)	Plus supply of battery

Table 8. Battery terminals interface

3.5.2. LED Indicators

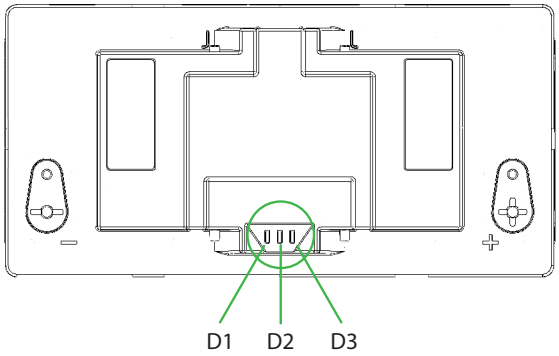

Figure 3. LED Indicators

	D1 (Green)	D2 (Yellow)	D3 (Red)	Mode
1	Off	Off	Off	Empty / Deep discharged
2	Off	Off	On	Error mode
3	On	Off	Off	Operational mode
4	Off	On	Off	Warning mode

Table 9. LED Mode

When the Li-ion battery is in operational mode "not charging or discharging", LED indicator flashes every 3 seconds (for more information refer to chapter 10: troubleshooting).

3.6. Signal interfaces

The signal interfaces are located underneath the removable lid.

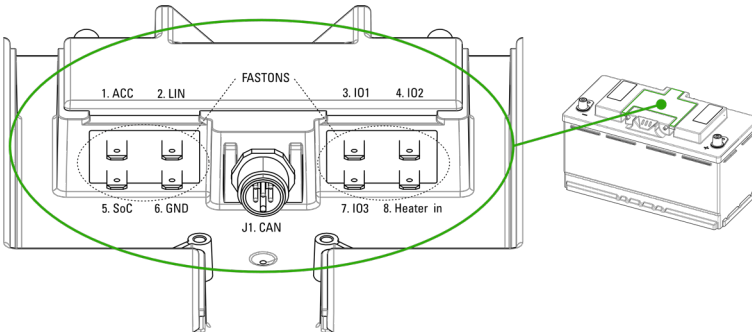

Figure 4. Signal interfaces

3.6.1. J1 CAN

The CAN interface of the Li-ion battery is not galvanically isolated. The CAN ground pin is fused with respect to the terminal minus with a 200 mA resettable fuse.

PIN #	Signal	Description
1	CAN_SHLD	Optional CAN Shield
2	NC	Not in use
3	CAN_GND	Ground / 0V
4	CAN_H	CAN_H bus line (dominant high)
5	CAN_L	CAN_L bus line (dominant low)

Table 10. J1 CAN interface[1].
[1]Please note: CAN bus is not galvanically isolated

The CAN connector is provided with a protective M12 cap (see figure 4). When CAN is not used it must be mounted to ensure the IP rating of the Li-ion battery.

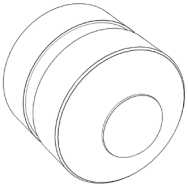

Figure 5. Protective M12 cap

3.6.2. FASTON Connections

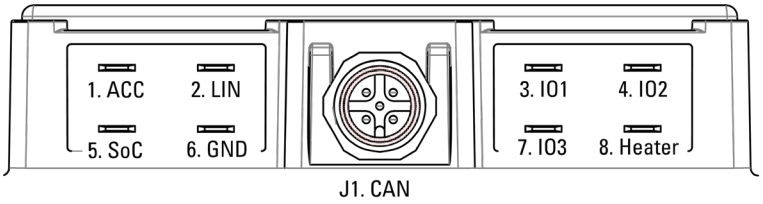

Figure 6. FASTON Connections. Note: FASTON connections are also shown on the inside of the protective lid.

Faston #	Description	Function
1	Accessory power output	Connection for power to accessories (fused internally, resettable)
2	LIN bus connection	LIN bus communication channel (CI-bus support)
3	IO1 connection	Input or output 1 (configurable)
4	IO2 connection	Input or output 2 (configurable)
5	SOC output (analogue)	Analogue SOC output (0-10V) (load must be higher than 100kOhms)
6	GND connection	GND connection (fused internally, resettable)
7	IO3 connection	Input or output 3 (configurable)
8	Heater power supply input	External power supply for heater (12-14V) (120W / 10A max)

Table 11. FASTON connections

3.6.3. FASTON Connection electrical specifications

	Description	Value	Units
I/O connection 1-3	Input voltage range	0 .. 15	V
	Input impedance	>100	KOhm
	Input high level	>8.4	V
	Input low level	<6.8	V
	Output current sink (open drain output type)	0.5	A
SoC output	Output voltage range	0.01 .. 10	V
	Output impedance	<1	Ohm
Heater input	Input voltage range	12 .. 15	V
	Power rating 150Ah	120	W
	Power rating 100Ah	80	W

Table 12. FASTON connection electrical specifications

3.6.4. Bluetooth

Service description	Type of signal	Range
Bluetooth Low Energy (5.1 standard)	Communication	10 - 25 meter (typical)

Table 13. Bluetooth

⚠ **Caution!** Bluetooth range is strongly dependent on the environment and how the Li-ion battery is positioned. Metal parts such as battery boxes, covers and cabling can affect the Bluetooth range and can lead to reduced range. The mentioned range only applies to an "open field situation", and can be less or more depending on the situation.

3.6.5. Modes and states of the Li-ion battery

The Li-ion battery knows two modes: operational and non-operational.

Non-operational mode

If the Li-ion battery is in non-operational mode, it cannot be used anymore. This can happen if the BMS detects a malfunction in the battery's monitoring and control, or when a deep discharge has occurred which led to cell damage. A deep discharge occurs when one of the cell blocks is 1.5V or lower. This is even possible when the Li-ion battery is at 10V. The Li-ion battery will store the state internally. The Li-ion battery is not usable anymore. The battery's protective disconnect device is non-conducting.

Operational mode

The Li-ion battery knows 3 states in operational mode:

- Normal state: the units the Li-ion battery monitors (voltage, current and temperature) are within the operational level of the cells and other components in the Li-ion battery.
- Warning state: the units the Li-ion battery monitors are threatened to go beyond the operational level of cells or other internal components. The battery's protective disconnect device will stay on.
- Alarm state: the units the Li-ion battery monitors are beyond the operational level of cells or other internal components. The battery's protective disconnect device will disconnect the cells from the terminals and the Li-ion battery. It can be that charging is disabled, discharging is disabled, or both are disabled.

Charging disabled causes

Charging disabled causes are triggered in the following events:

- Overcurrent during charging, the charge current is too high
- Overvoltage due to charging, the charger is too high in voltage or battery cells can be out of balance
- The temperature to be able to charge is too high or too low

Discharging disabled causes

Discharging disabled causes are triggered in the following events:

- Overcurrent during discharging, the load current is too heavy
- Undervoltage due to discharging, the Li-ion battery is empty
- The SoC 'off' level has been reached
- The temperature to be able to discharge is too high or too low

Discharging and charging disabled causes

- The protective disconnect device is too hot

3.6.6. Operation states dependencies

State	Protective disconnect device	Communication	BMS
Normal state	Conducting	Yes	Active
Warning state	Conducting	Yes	Active
Alarm state	One current direction conducting or non-conducting	Yes	Active

Table 14. System components operation modes dependencies.

3.7. Optional Components

Article name	EAN code
Be In Charge Monitoring Kit	8718531362086
Battery Bracket set for Epsilon	8718531362222
CAN Cable 0.4m Y-split straight female to straight male-female	8718531362239
Touch Display + Connection set 5m for Epsilon 12V100/150Ah	8718531362291
Touch Display + Connection set 10m for Epsilon 12V100/150Ah	8718531362307
Touch Display + Connection set 15m for Epsilon 12V100/150Ah	8718531362352
Display BM01 12V + Cable 2.5m for Epsilon 12V100/150Ah	8718531362369
Display BM01 12V + Cable 5m for Epsilon 12V100/150Ah	8718531362260
Display BM01 12V + Cable 10m for Epsilon 12V100/150Ah	8718531362277

Table 15. Optional components that can be used with the Li-ion battery

4. Installation

4.1. General information

⚠ **Warning! 12V systems only.** Never install multiple Li-ion batteries in series.
⚠ **Warning!** Never install or use a damaged Li-ion battery.
⚠ **Caution!** Do not reverse connect the power cables (polarity)

When connecting several batteries in parallel, always use batteries of the same brand, type, age, capacity and state of charge.

4.2. Unpacking

Check the Li-ion battery for damage after unpacking. If the Li-ion battery is damaged, contact your reseller or Super B. Do not install or use the Li-ion battery if it is damaged!

4.3. Placement of the Li-ion battery

Before it is used, the Li-ion battery must be fastened in such a way that it will not move during use. The Li-on battery may be placed on its long or short side, but not upside down. Use appropriate fastening brackets for mounting (see chapter 3.7; optional components).

4.4. Connection wires

Use appropriate cables and cable lugs for the connection to the terminals. This prevents overheating and unnecessary losses. Use appropriate fuses matching the cables and load. Super B advises to use 95mm2 connection cables. Cables with less diameter can cause overheating or unnecessary losses. Always use the correct crimp tools to crimp the cable lugs and follow the instructions provided by the cable lug manufacturer.

⚠ **Caution!** When using more Epsilon Li-ion batteries in parallel the wiring should be sized and specified according to the maximum current the parallel bank can deliver.

4.4.1. Connecting power cables with automotive type terminals

1. Connect the load or charger to the X2 (+) terminal of the Li-ion battery. (Figure 7)
2. Connect the load or charger to the X1 (-) terminal of the Li-ion battery. (Figure 7)
3. Ensure both contacts are tightened. (20Nm)
4. Place the handle covers over the terminals. (Figure 8)

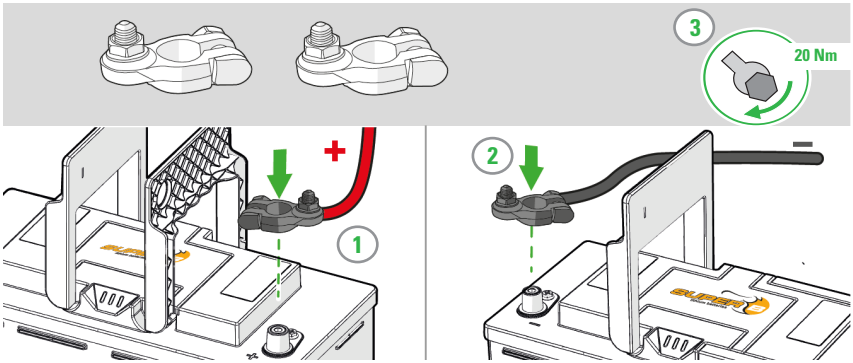

Figure 7. Connecting power cables with automotive type terminals

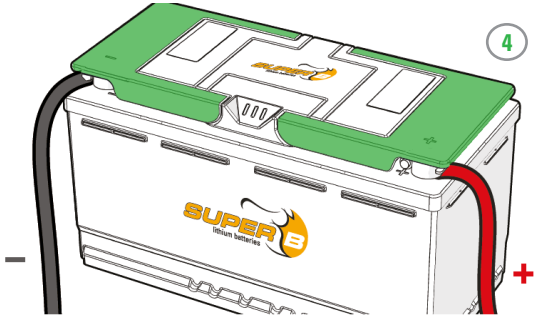

Figure 8. Place the handle covers over the terminals

4.4.2. Connecting power cables with cable lugs

1. Remove the automotive power terminals. (Figure 9)
2. Connect the load or charger to the X2 (+) terminal of the Li-ion battery. (Figure 10)
   Use the included M8 bolt, spring washer and plain washer to connect the Li-ion battery cable.
3. Connect the X1 (-) terminal of the Li-ion battery. (Figure 10)
   Use the included M8 bolt, spring washer and plain washer to connect the Li-ion battery cable.
4. Ensure both contacts are tightened to 20Nm.
5. Place the handle covers over the terminals. (Figure 11)

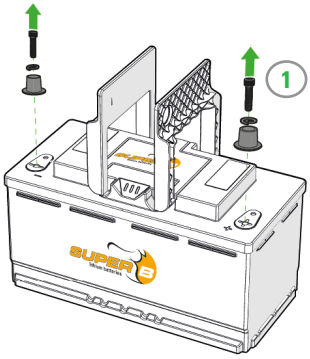

Figure 9. Remove the automotive power terminals.

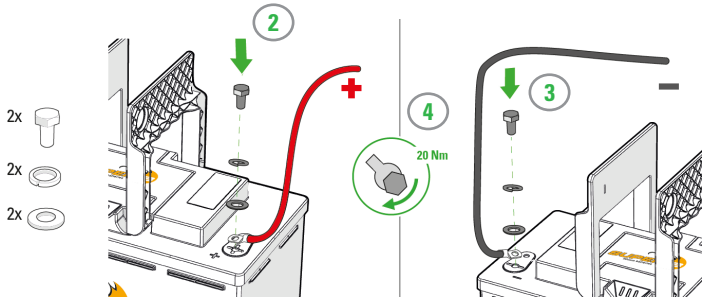

Figure 10. Connecting power cables with cable lugs

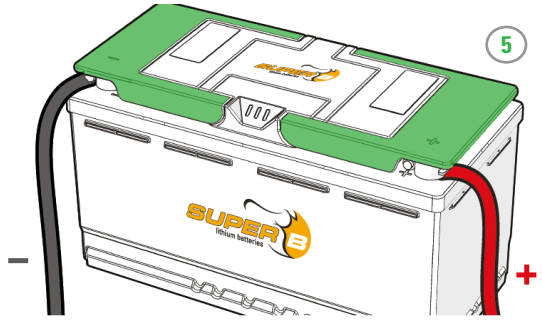

Figure 11. Place the handle covers over the terminals

4.4.3. Connecting small consumers to the terminals

The Li-ion battery has a M6 thread on both terminals that is intended to supply power to small consumers. Below it is described and depicted how to connect small consumers. This is not the accessory power; that one is FASTON 1 underneath the lid (see figure 6, paragraph 3.6.2).

1. Connect the plus of the power cable of the small consumer to the X2 (+) terminal of the Li-ion battery (Figure 12) . Use the included M6 bolt.
2. Connect the minus of the power cable of the small consumer to the X1 (-) terminal of the Li-ion battery (Figure 12). Use the included M6 bolt.
3. Ensure both contacts are tightened to 10Nm.
4. Place the handle covers over the terminals. (Figure 11)

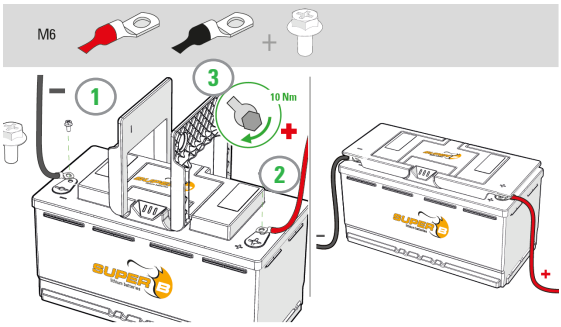

Figure 12. Connecting accessoires to the terminals.

4.5. Communication and FASTON connections

All connections, except for the connection terminals, can be made in one central place under the protective lid. This protective lid is mounted and held in place using self-retaining clips, the lid can be easily removed with light force and replaced in the same way.

The specific connections and assignment are indicated on the inside of the lid. The connections can be made using standard 4.75mm wide automotive FASTON crimp terminals.

All connections and cabling can be secured using the integrated cable strain relief, which can easily be unscrewed to secure all cables to the FASTONS. The M12 CAN cable is not fed through the strain relief, as the M12 connector itself has a built-in strain relief (see figure 14) and this would damage the wire.

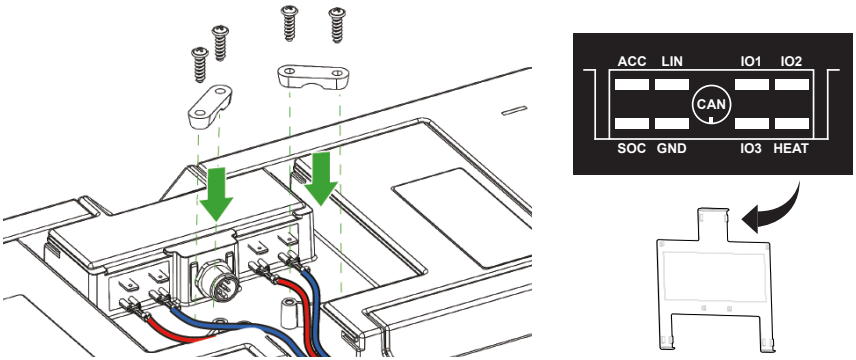

Figure 13. Communication and FASTON connection

⚠ **Warning!** Never use the cabling to lift the Li-ion battery, even when the strain relief is holding the wires / cabling in place.

4.6. Connecting to the CAN interface

4.6.1. Connecting the data cables

The wired communication interface must be used in a bus network topology (Table 17). Do not use a ring- or a star topology. The wired communication interface specifications restrict the Bus length/Bus speed.

Bus length (L)	Max. stub length (S)	Accumulated stub length
250 m	11 m	55m

Table 16. Wired network interface cable lengths

CAN Cables

The connection to the CAN bus can be made using standard CAN cable wiring and accessories. An Y-split CAN cable and inline CAN terminator cable is available for easy installation and connection to other Li-ion batteries (see chapter 3.7; optional components).

⚠ **Warning!** Always use the supplied protective M12 cap when the CAN connection is not used. Otherwise, ingress protection is not guaranteed and water/moisture may enter the Li-ion battery casing, which may cause serious damage.

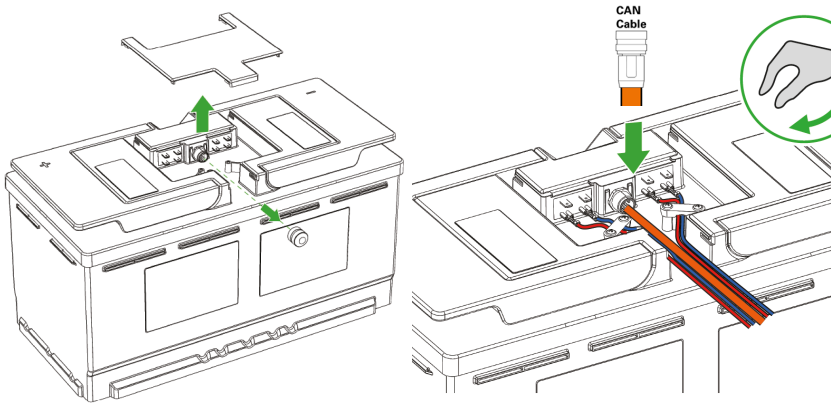

Figure 14. Connecting to the CAN Interface

Termination Resistors

Use termination resistors or the inline CAN terminator cable at the end nodes to impede

reflections on the line. The value of this resistor should be +/- 120 ohms. More information on termination resistors can be found in CiA document 303_1 V1.8.0, section 5.

4.7. Connecting to the LIN interface

The Li-ion battery includes a LIN interface (Local Interconnect Network). The LIN interface can be used to connect to a LIN master which are often present in (recreational) vehicles or caravans. The LIN interface is meant to provide the LIN master with information of the Li-ion battery like SoC and other data. The LIN bus is accessible on FASTON 2 under the protective lid. Depending on the electrical installation, LIN ground can be either the terminal minus or the FASTON GND. Make sure no ground loops are made when using the FASTON GND.

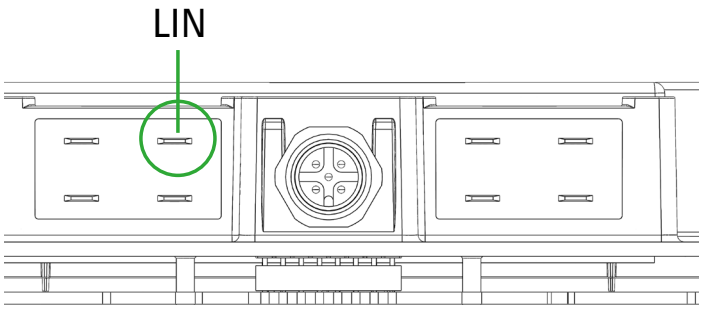

Figure 15. LIN bus FASTON connection

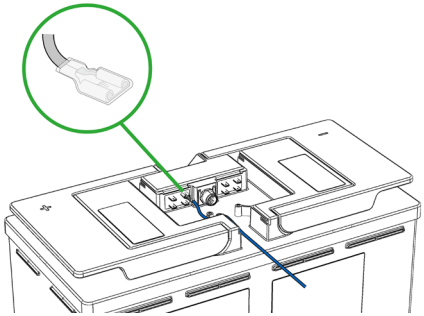

Figure 16. Connecting the LIN Interface using the FASTON connection

4.7.1. CI-BUS protocol

To support easy integration within the RV/caravanning industry the LIN bus protocol is configurable. One of the protocols which can be selected is the CI-BUS protocol. When enabled, the LIN bus provides all information necessary for the system using the CI-BUS protocol. For more information about the CI-BUS visit the CIVD website (https://www.civd.de/en/artikel/ci-bus-board-management-system/).

4.7.2. Other protocols

The LIN bus on the Li-ion battery can also support protocols defined by other manufacturers, this support is extended on a regular basis and prone to change. Please contact Super B to gather information about the supported protocols on the LIN bus.

4.7.3. IO FASTON connection and functionality

The Li-ion battery has three electrical input or output interfaces accessible by FASTON 3, 4 and 7. These interfaces can be used for different purposes, and are configurable with the Be In Charge App and/or Be In Charge Software.

IO functionality	Description
Generator control (IO 1, output)	Active when SoC is below 20%, off when SoC is 100%, hysteresis of 80 %
Inverter control (IO 2, output)	Active when SoC above 21%, off when SoC is below 10 %, hysteresis of 11 %
Reserved (IO3)	Reserved for future use

Table 17. IO functionality

The list of supported functionalities will grow in the future. More functionalities will become available, and can be updated with an update of the battery software and the Be In Charge App and Be In Charge Software.

The I/O port can service two features: input or output. When used as an input, the input can measure a digital level between 0 V and 12V (typical value). 12V on the input means that the input is made active, 0V means input not active.

The I/O port can also serve as an output. When configured as such, the output acts as an “open drain” output. Open drain means that the output is pulled to 0V when active and is floating when not active.

All I/O ports are fused with an internal resettable fuse. When overloaded, the output will not work anymore and the overload or short circuit needs to be taken away to reset the fuse.

4.8. Connecting a charger to the Li-ion battery

Warning! Ensure you have completed all the previous steps described in chapter 4 before connecting the Li-ion battery to the charger.

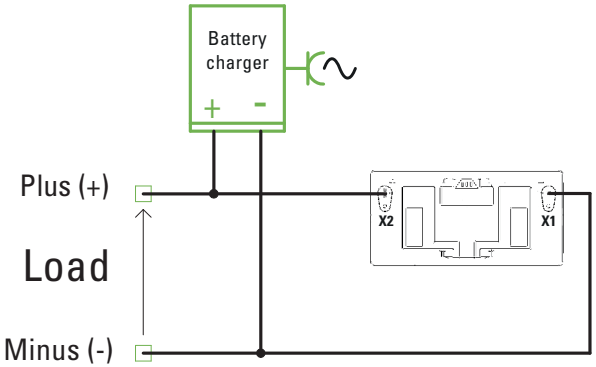

Figure 17. Connecting a charger to the Li-ion battery

4.9. Connecting Li-ion batteries in parallel

The max. number of Li-ion batteries in parallel is 8. To divide the current equally amongst batteries, use the schematic bellow:

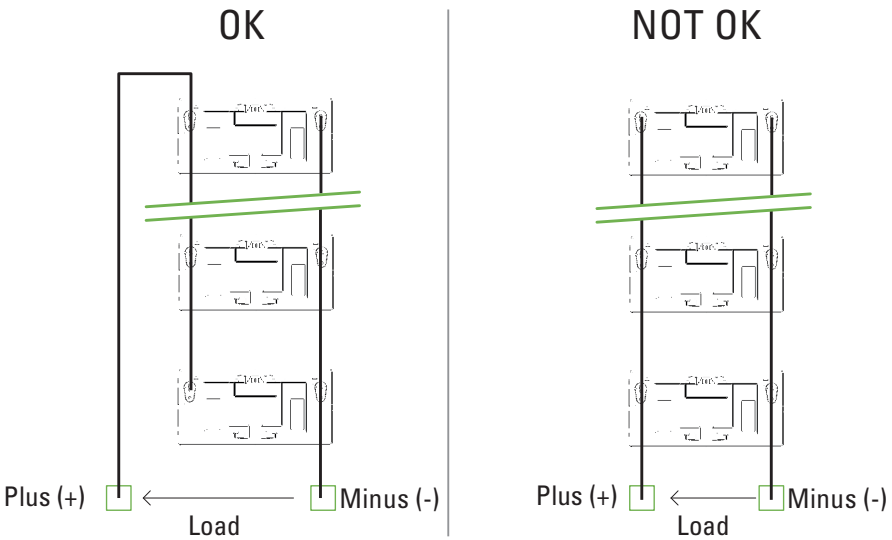

Figure 18. Connecting Li-ion batteries in parallel

OK: Equally divided battery current.
All batteries contribute equally to the current into the load.

NOT OK: Current not equally divided.
Batteries closest to load will have the highest contribution to the current into the load.
Whereas batteries further away from load will have lesser current contribution.
Wear and tear will be higher on the Li-ion battery close to the load. Never connect the setup like this!

4.10. Disconnecting the Li-ion battery

1. Turn off any device or charger the Li-ion battery is connected to.
2. Disconnect the negative wire and accessories connection from the - terminal of the Li-ion battery.
3. Disconnect the positive wire and accessories connection from the + terminal of the Li-ion battery.
4. Disconnect all other connections like the FASTON and communication interface connection which are located under the protective lid.

5. Battery use

5.1. General information

⚠ **Warning!** Follow the safety guidelines and measures of chapter 1.
⚠ **Caution!** Charge the Li-ion battery before use.
⚠ **Caution!** Do not operate the Li-ion battery beyond its maximum specifications.
⚠ **Caution!** Charging at deep discharge conditions can lead to venting, excessive heat or thermal runaway of the cells.
⚠ **Caution!** This Li-ion battery stores fault conditions and usage storage internally, like excessive charge current or deep discharge situations. Super B uses this information in the warranty process.
⚠ **Warning!** Do not overcharge the Li-ion battery.

5.2. Charging

⚠ **Warning!** Never charge the Li-ion battery with a charging current higher than mentioned in table 4.
⚠ **Caution!** Stop charging in case the Li-ion battery switches into error mode.
⚠ **Caution!** Disconnect the charger from the Li-ion battery if it is not used for a long time.
⚠ **Caution!** To charge the Li-ion battery, use a charger which follow Super B's charging profile (see charging manual which can be found on the Super B website).
1. Connect the charger to the Li-ion battery as described in paragraph 4.8.

2. Charge the Li-ion battery immediately in case of an under-voltage shutdown or if the state of charge drops below 20% to preserve the lifespan of the Li-ion battery.

5.2.1. Charging rate

The Li-ion battery can be charged from empty to full in approximately 1 hour and 15 minutes. Table 18 shows the charging times for the Li-ion battery at different charge currents. Always use the indicated charge current and end of charge voltage during charging.

Charging rate Epsilon 12V150Ah		
	Time	Charge current
Maximum	±1 hour 15 minutes	135A
Endurance lifecycle	3 hours	C3 (50A)

Charging rate Epsilon 12V100Ah		
	Time	Charge current
Maximum	±1 hour 15 minutes	90A
Endurance lifecycle	3 hours	C3 (33A)

Table 18. Charging rates at different charge currents

5.3. Heater functionality

The Li-ion battery has functionality to heat up the cells and make charging possible if the ambient temperature is causing the cell temperature to drop below charging temperature level (charging LiFePO4 cells is only allowed if they are above 0°C). The heater for this purpose is internally located in the Li-ion battery and is controlled by the BMS firmware. If heating is requested, this depends on the heating feature configuration and cell temperature, the heater is enabled to heat up and keep the cells at a temperature where they are allowed to be charged.

5.3.1. Heater power source

The internal heater can be powered in two different ways:

1. Power is supplied by the Li-ion battery itself and can be aided or fully supplied by a charger connected to the terminals.
2. Power is supplied by an external source via FASTON Heater power input and the minus terminal .

⚠ **Caution!** The FASTON GND; GND FASTON is fused at a lower rate than the heater consumes. Do not connect the GND for the heaters at the FASTON GND connection.

When an external source is connected, it is automatically used to heat the Li-ion battery cells. The BMS detects whether power is available at the FASTON Heater power input. If the user wants to use external power only, heating from terminal power must be disabled (method 1) or method 2 must be used. This is to prevent the energy from the Li-ion battery from being used when the external source is not present (e.g. a grid power failure)

5.3.2. Heating methods

There are three heating methods that can be used (or heating can be disabled):

1. Heat up before charging (default);
2. Keep at charge temperature by external source;
3. Keep at charge temperature source independent;
4. No heating.

Only one of them can be enabled and which method to use can be selected using the Be In Charge App or Be In Charge Software

Method 1: Heat up before charging
If one or more cells are below 0°C and a charge current is detected, the disconnect device will open the charge path, preventing the Li-ion battery from being charged. The power for the heaters is then taken from the terminals, hence the charger supplies the power to heat the cells. As long as there is charging current, the heaters must be used to keep the cells above 0°C.

If a charger is used that can be regulated by the Li-ion battery, the charging path will remain closed when a charging current is detected. If power is detected on the FASTON Heater power input, it will use that power to heat up the cells to 0 °C before charging, not the chargers power. However, in case of external power, method 2 or 3 are more appropriate to use.

Method 2: Keep at Charge Temperature by external source
This method keeps the cell temperature above the allowable charging temperature of 0°C, and uses power from the FASTON heater power input. If there is no external source available and charging is detected with cells below 0°C, the Li-ion battery will behave as method 1.

Method 3: Keep at charge temperature source independent
This method keeps the cell temperature above 0°C from external power supply energy or the Li-ion battery energy itself. If an external source is available, it will be used for heating. If the external source is not present, energy from the Li-ion battery will be used to keep at 0°C. In

that case it will keep it at 0°C until the SoC drops below a configurable level. If that level is reached the heaters will stop to prevent draining the Li-ion battery. In Table 19 the range that can be set is stated.

SoC	SoC Heater Off (%)
Minimum	20
Maximum	80
Default	50

Table 19. SoC Heater levels

Behavior when there is no external source available

- When the SoC is below the 'Soc Heater OFF' setting, the heating feature will fall back to method 1: heat up before charging.
- When the external power source is connected/detected again, the Li-ion battery will start heating if needed, independent of the SoC.

Behavior when there is external source available and the battery is drained

If the Li-ion battery is drained due to non-heating use and therefore the SoC level drops below 'SoC Heater Off', and the external power source is used to maintain the Li-ion battery at CAT (Charge Accept Temperature) level, the heaters will continue to be powered by the external source

5.4. Battery balancing

The BMS automatically balances the cells if necessary. The Li-ion battery can be used normally during balancing. Balancing ensures all cells are at the same voltage level and enhances usable battery capacity.

5.5. Be In Charge Software and App

Super B provides a Be In Charge Software tool which can be used to read out the internal BMS system. The software uses a CAN to USB converter to connect to the communication interface. The software is capable of reading out the actual status like battery / cell voltages and temperature but also statistical information. The Be In Charge software can also be used to update the installed firmware of the Li-ion battery. The Be In Charge software and hardware are not part of the Li-ion battery scope of delivery.

Super B also provides a Be In Charge App for mobile devices such as Android and Apple . The app can be found in the Google play store or Apple app store.

SCAN ME

The Be In Charge App uses the Bluetooth connection of a mobile device to connect to the Li-ion battery. After the connection has been established all important information can be read out such as voltage / current levels, warnings / errors and state of charge.

⚠ **Caution!** when updating the battery firmware the battery might become unresponsive and can disable the output voltage on the terminals for a few seconds to minutes. Please be aware of this happening in your application and make sure this firmware update can be carried out safely

5.5.1. Bluetooth pairing (PIN code)

For security reasons the Epsilon Bluetooth connection is protected with a PIN code. This PIN code is needed when pairing to the Li-ion battery and can be found on the label under the protective lid (see figure 19). It is advisable to write down this PIN code before installation of the Li-ion battery.

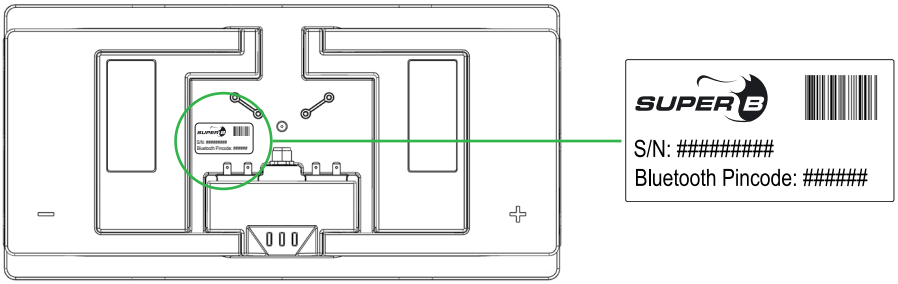

Figure 19. Bluetooth Pairing PIN code

5.5.2. Battery history recording

The complete Li-ion battery history and statistics can be downloaded using the Be In Charge Software.

5.5.3. Reading the battery's State of Charge (SoC)

The Li-ion battery is equipped with an analogue SoC output, this output provides a voltage between 0 and 10 Volts which reflects the 0-100% state of charge value. The state of charge can also be read out using the Be In Charge App for Android and Apple, and with the Be In Charge Software for PC applications. The information is also available via LIN bus (CI-BUS protocol)

5.5.4. Reading the battery's State of Health (SoH)

The Li-ion battery keeps track of its health using algorithms. These algorithms determine the remaining capacity at that specific moment in the battery life, relative to the initial capacity (as new). Example: A state of health of 95% for a Epsilon 12V150Ah, means that the actual remaining usable capacity in the Li-ion battery is 142.5Ah.

6. Inspection and cleaning

6.1. General information

⚠ **Warning!** Never attempt to open or dismantle the Li-ion battery! The inside of the Li-ion battery does not contain serviceable parts.

1. Disconnect the Li-ion battery from all loads and charging devices before performing cleaning and maintenance activities.
2. Before cleaning and maintenance activities place the enclosed protective caps over the terminals, put the M12 protective cap back in place as well as the protective lid.

6.2. Inspection

1. Inspect for loose and/or damaged wiring and contacts, cracks, deformations, leakage or damage of any other kind. If damage to the Li-ion battery is found, it must be replaced. Do not attempt to charge or use a damaged Li-ion battery. Do not touch the liquid from a ruptured Li-ion battery.
2. Routinely check the Li-ion battery's SoC. Lithium Iron Phosphate batteries continue to slowly self-discharge (<3% per month) when not in use or stored.
3. Consider replacing the Li-ion battery with a new one if you note either of the following conditions:
   - The Li-ion battery run time drops below about 80% of the original run time.
   - The Li-ion battery charge time increases significantly.

6.3. Cleaning

If necessary, clean the Li-ion battery with a soft, dry cloth. Never use liquids, solvents, or abrasives to clean the Li-ion battery.

7. Storage

Follow the storage instructions to optimize the lifespan of the Li-ion battery during storage. If these instructions are not followed and the Li-ion battery has no charge remaining when it is checked, consider it to be damaged. Do not attempt to recharge or use it. Replace it with a new Li-ion battery.

See chapter 3.2.4 for storage temperature conditions.

The self-discharge of the Li-ion battery is <3% per month.

1. Charge the Li-ion battery to 80% of its capacity before storage.
2. Disconnect the Li-ion battery from all loads and, if present, the charging device.
3. Place the terminal covers over the Li-ion battery's terminals during storage.
4. Charge the Li-ion battery to 80% of its capacity every year.

8. Transportation

Always check all applicable local, national, and international regulations before transporting a Li-ion Iron Phosphate battery.

Transporting an end-of-life, damaged, or recalled Li-ion battery may, in certain cases, be specifically limited or prohibited.

The transport of the Li-ion battery falls under hazard class UN3480, class 9. For transport over water, air and land, the Li-ion battery falls within packaging group PI965 Section II.

9. Disposal and recycling

Always discharge the Li-ion battery before disposal. Use electrical tape or other approved covering over the Li-ion battery connection points to prevent short circuits.

Li-ion battery recycling is encouraged. Dispose of the Li-ion battery in accordance with local, state and federal laws and regulations.

10. Troubleshooting

Problem	Possible situation	Solution
The Li-ion battery cannot be discharged.	Li-ion battery is in operation mode Green LED is lit or flashing. No current can be drawn from the battery	Check the installation of the Li-ion battery. Check main switches / fuses or other external disconnect devices.
	All LED's are OFF (Li-ion battery voltage <8V)	Battery is deeply discharged and completely shut down. Do not try to charge or discharge anymore. Contact Super-B's service department or local dealer.
	Red LED is flashing: alarm mode is active. The discharge currents or internal temperature is too high. internal disconnect device is open.	Check the maximum current which the connection installation can draw from the battery. Let the battery cool down and wait for the state to reset (this can take a while). If the LED flashes red after cooling down, the BMS might still detect an Issue. Readout using Be In Charge App or Software might tell more about the issue.
	Red LED is flashing: alarm mode is active. The battery is drained and an undervoltage has occurred. internal disconnect device is open.	Recharge the battery to 100% again.
The Li-ion battery cannot be charged.	Li-ion battery is in operation mode. Green LED is lit or flashing.	Check the installation of the Li-ion battery. check all main switches / fuses and other external disconnect devices.
	Li-ion battery is in alarm mode because the charging voltage is too high. Red LED is lit or flashing.	Verify that the charging voltage is within the Li-ion battery specifications. Discharge the Li-ion battery.
	Li-ion battery is in alarm mode because of high temperature. Red LED is lit or flashing.	Disconnect the Li-ion battery from load/ charger and wait for it to cool down.
	Li-ion battery is in alarm mode because of too high charge current. Red LED is lit or flashing	Discharge the Li-ion battery, lower charge current.

The heater does not seem to work	Li-ion battery is in operational mode but temperature is within normal cell specifications. No need to heat up the cells	Heater is not broken, when the temperature drops below zero degrees it will turn on when the settings are correct.
	Li-ion battery is in operational mode. temperature is below zero degrees C and there is a need to charge.	Check settings for the heaters. Check if external power is active and can deliver enough power to supply the heaters.
The capacity of the Li-ion battery has decreased.	The cells within the Li-ion battery are not properly balanced or the Li-ion battery is worn out.	Perform one full charge (100% SoC) cycle to balance the cells.
Bluetooth errors / connection problems	Connection rejected.	Remove Bluetooth pairing from device settings. Verify no other device is using the Bluetooth connection. re-pair again. use correct PIN code supplied with the Li-ion battery.
	Connection cannot be made or battery cannot be found.	Check if the Phone and Li-ion battery are within range. Make sure the Li-ion battery has a working LED Indication. Check if no other devices are connected to the Li-ion battery. Switch off/on bluetooth on your phone and retry.
Touch display errors	Touch display show CAN error.	Make sure the cables are connected the right way. Always use the termination resistors and undamaged / correct CAN cabling.
CAN connection errors	CAN connections does not seem to work stable or does not work at all.	Make sure to use the right CAN cables. make sure all connections are made and all connectors are screwed down. Make sure to always use two terminator resistors in the CAN bus at both ends of the bus. Make sure that the cables are in good condition and connectors are not broken or damaged.

Table 20. Troubleshooting

11. Warranty and liability

No rights can be derived from this document. Any installation or use contrary to these instructions may void the warranty granted to you. Please refer to the sales agreement for warranty and other provisions applicable to your purchase. If the product is defective, please contact the dealer, reseller or retailer that you purchased the product from. Super B's liability for any of its products is limited to the corresponding provisions under mandatory applicable law.

SUPER B
lithium batteries

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