



LITHIUM BATTERY	13.2V/160 Ah
SB12V160E-ZC	(2.1kW LiFePO4)



## User Manual SB12V160E-ZC Lithium Iron Phosphate battery

Dear customer,

This manual contains all the information necessary to install, use and maintain the super B SB12V160E-ZC Lithium Iron Phosphate Battery. We kindly ask of you to read this manual carefully before using the product. In this manual, the SB12V160E-ZC 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.

This is the original manual, keep it on a safe location!

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## 1. Introduction

### 1.1. Product description

The SB12V160E-ZC is a Lithium Iron Phosphate rechargeable battery. Potential applications of this battery include: off grid power supply, marine power supply, medium for (renewable) energy storage (traction) battery for vehicles. The boundaries of its use, as described in this manual should always be upheld. The Li-Ion battery may not be used in medical or in aviation related applications. The Li-Ion battery may not be used for any purposes other then described in this manual. Using the battery for any other purposes will be considered improper use and will void the warranty of the product. Super B b.v. cannot be held responsible for any damage caused by improper, incorrect or unwise use of the product. Read and understand this manual completely before using the product.

Super B provides a CE declaration of conformity (appendix 1) and a Certificate of Compliance (appendix 2) for the product. In accordance with CE guidelines, a design and manufacturing schedule is available. A Material Safety Data Sheet is also available.

**The SB12V160E-ZC complies with the following council directives:**

- 2006/66/EC on Environmental EU Compliance
- 2004/108/EC (December 15, 2004) on Electromagnetic Compatibility.

**The SB12V160E-ZC complies with the following standards:**

- IEC 61000-4-2, EMC Compliance
- IEC 62133, Safety IEC Compliance
- IEC 61960{ed2.0}, Performance IEC Compliance
- IEC 62281, Transportation IEC Compliance



During the use of the product, user safety should always be ensured, so installers, users, service personnel and third parties can safely use the product. The user must always have access to this manual; keep it in a safe accessible location.

### 1.2. Glossary of Terminology

Endurance Life-cycle:	The products maximum lifespan, achieved by adhering to the guidelines presented in this manual.
Charge cycle:	A period of use from fully charged, to fully discharged, and fully recharged again.
RSW:	Remote switch
BMS:	Battery management system
SoC:	State of charge

### 1.3. 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.

## 2. Product specifications

### 2.1. Product features

- Traction battery
- Lithium Iron Phosphate (LiFePO4)
  - Most safe lithium technology
  - Superior abuse tolerance
- Integrated BMS
- Glass fiber reinforced plastic (GRFP) Casing, Aluminum / PE sandwich side panels
- Terminals for 2 x 95mm<sup>2</sup> wire connection per terminal
- Integrated fuse, 32V / 500A
- 3C continuous discharge (480A)
- CANOpen interface for battery monitoring
- Battery monitoring / History Storage

- Adaptive cell balancing
- Serial string equalization
- Serial string connection up to 1150V DC
- External BMS Relay, latching (bi-stable)
- External BMS cut-off switch, CAN controlled

## 2.2. General product specifications

Product name:	SB12V160E-ZC
Producer:	super B b.v.
Battery type:	Lithium Iron Phosphate (LiFePO4)
Product Lifespan:	+/-5 to 10 years or 1000-2000 cycles at 1C charge / discharge or 8000 cycles at C4 charge / discharge*

\*The lifespan value given above is an indication. Battery lifespan depends strongly on the applied charging and discharging loads. For more information on the lifespan of the battery, appendix II may be consulted.

## 2.3. Technical specifications

Mass:	28.3 Kg
Ingress protection rating	IP53

### 2.3.1. Battery designation

Battery designation:	4IFP227/415/315
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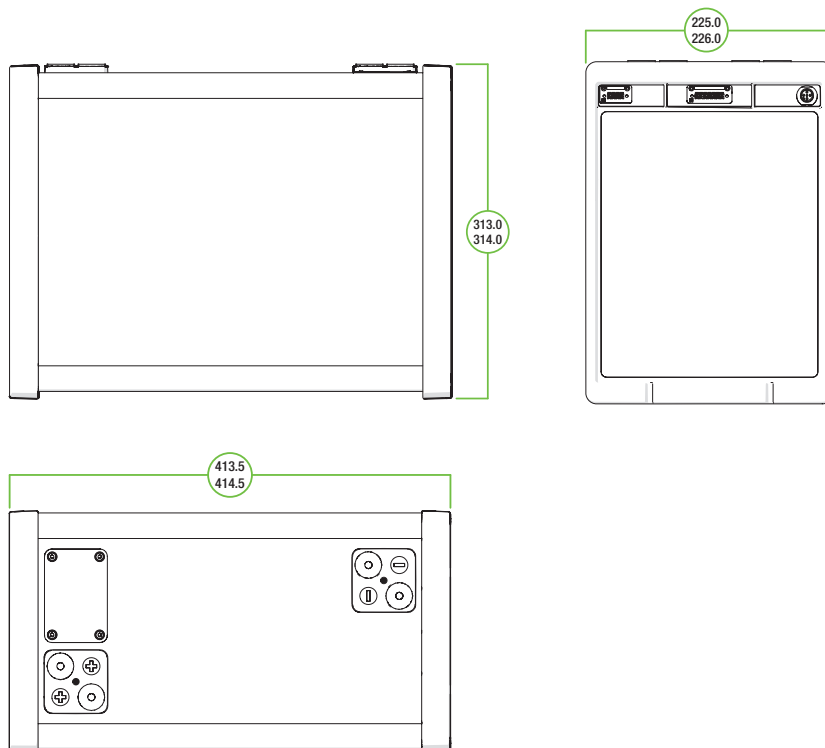
### 2.3.2. Electrical properties

Nominal voltage	13.2V DC
Charge method	CCCV
End of charge voltage	15 V DC
End of charge voltage for endurance (cycle life)	14.6V DC
Charge current	160A (1C)
Charge current for endurance (cycle life)	52.8A (C/3)
End-of-discharge voltage	8V DC
End-of-discharge voltage for endurance (cycle life)	10V DC
Maximum serial string connection voltage	1150V DC
Discharge current	480A (3C)
Discharge current for endurance (cycle life)	52.8A (C/3)
Discharge pulse current (10 seconds) (external fuse)	1280A (8C)
Discharge pulse current (60 second) (external fuse)	800A (5C)
Discharge performance at 20 °C (rated capacity)	160Ah / 2112Wh
Discharge performance at -20 °C (capacity)	104Ah / 1372.8Wh
High rate discharge performance at 20 °C (capacity)	144Ah / 1841.4Wh
Short-circuit protection (fuse):	500A
Self discharge:	± 10% per year

More information on the battery's discharge performance and capacity may be found in Appendix III.

### 2.3.3. Dimensions

Height (H):	313.00 / 314.00 mm
Width (W):	413.50 / 414.50 mm
Thickness (T):	225.00 / 226.00 mm



### 2.4. Environmental conditions

**Warning!** The Li-Ion Battery may only be used in conditions specified in this manual. Exposing the battery to conditions outside the specified boundaries may lead to serious damage to the product and/or the user.

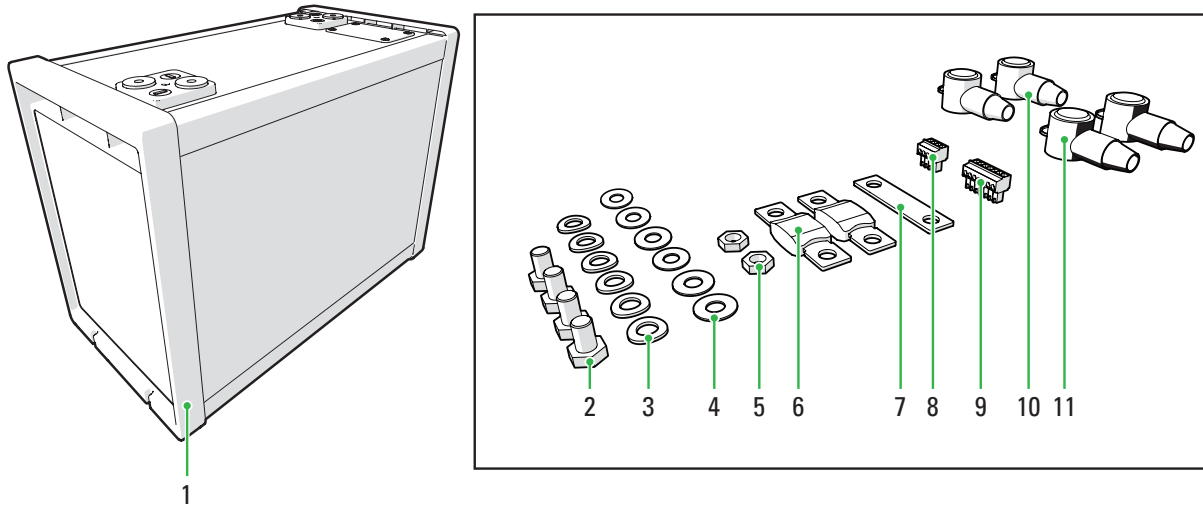
Use the battery in a dry, clean, dust free, well ventilated space. Do not expose the battery to fire or water or solvents.

Operating temperature range (Charge)	0°C to +45°C
Operating temperature range (Discharge)	-20°C to +60°C
Storage temperature range	-20°C to +60°C
Relative humidity:	Between 5 and 85 %, non condensing
Placement angle (continuously):	< 45 degrees
Maximum placement angle (< 48 hours):	90 degrees
Vibrations and shocks:	As described in UN38.3 and IEC 6228

### 2.5. Required tools

- M13 Hexagon socket wrench
- Fuse TORX key

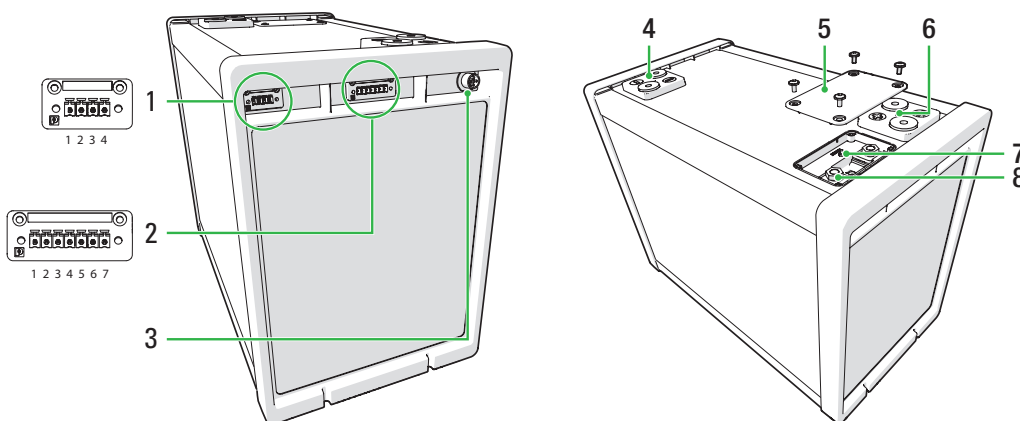
## 2.6. Components



### 2.6.1. List of components

1. (1) super B SB12V160E-ZC Battery
2. (4x) M8 Bolt
3. (6x) M8 Spring washer
4. (6x) M8 Plain washer
5. (2x) M8 Nut
6. (2x) Mega Fuse 32V/500A
7. (1x) Dummy Fuse
8. (1x) Phoenix plug 4
9. (1x) Phoenix plug 7
10. (2x) Terminal cover, Red
11. (2x) Terminal cover, Black

## 2.7. Connections, indicators and battery controls



1. Con 1 (I/O Connection 4; Phoenix FRONT-MC 1,5/4-STF-3,81 1850877)
2. Con 2 (I/O Connection 7; Phoenix FRONT-MC 1,5/7-STF-3,81 1850903)
3. Con 3 (CANOpen; 5-pin "micro" style connector)
4. Terminal - (2x 95mm<sup>2</sup> wire connection)
5. Fuse cover
6. Terminal + (2x 95mm<sup>2</sup> wire connection)
7. Fuse connections
8. Reset button

### 2.7.1. Con1 (I/O Connection 4)

Pin1:	+, OFF
Pin2:	-, ON
Pin3:	-, OFF
Pin4:	+, ON

### 2.7.2. Con2 (I/O connection 7)

Pin1:	V+ max 30 Volt
Pin2:	AN_SOC (Analogue state of charge)
Pin3:	Nc (Not connected)
Pin4:	Rc, (Relay common contact)
Pin5:	Rnc, (Relay normally close contact)
Pin6:	Rno, (Relay normally open contact)
Pin7:	GND, (Ground)

## 2.8. Peripheral equipment

### 2.8.1. Obligatory

In order for the Li-Ion battery to be used safely, an approved external switch off device must be installed. This should either be a relay or latching relay (bi-stable) controlled by the battery's BMS or a relay or latching relay controlled by a remote switch (CAN controlled). (see paragraph 4.4) Failure to install an external switch off device will void the warranty of the Li-Ion battery.

Use appropriate wire for the connection wires to ensure no overheating or unnecessary losses occur. Consult the SAE-J378 or ISO 10133:2012 standards to determine the appropriate wire properties. Use appropriate fuses matching the wires and load.

### 2.8.2. Optional






The Li-Ion battery can be used in combination with a number of (super B) products:

Article name	Article code
SB-GXL14B2B (latching relay)	9586 100 3105 0
SB-LIR250 (relay)	9586 100 3106 0
SB-V23130C2021A412-TE (latching relay)	9586 100 3108 0
SB MIC-C TERMINATOR RESISTOR FEMALE STD WH	9586 100 4001 0
SB MIC-C TERMINATOR RESISTOR MALE STD WH	9586 100 4002 0
SB Male-Female connector with 0.6m cable	9586 100 3001 0
SB Male-Female connector with 1m cable	9586 100 3002 0
SB Male-Female connector with 2m cable	9586 100 3003 0
SB Male-Female connector with 5m cable	9586 100 3004 0
SB Male-Female connector with 10m cable	9586 100 3005 0
SB 1-1 splitter	9586 100 3006 0
SB-RSW1	9586 100 3007 0
SB-MAS1	9586 100 3008 0
SB USB to Can	9586 100 3201 0
SB Monitor Software	9586 100 3201 0
SB API	9586 100 3203 0
SB USB to CAN/SB Monitor Software/SB API	total package
Mounting bracket ZC casing	9586 300 0009 0




### 3. Safety guidelines and measures



#### 3.1. General

-  **Warning!** Keep the battery away from fire, excessive heat, water, dust and contamination
-  **Corrosive!** Do not touch the battery's electrolyte after leakage. If contact occurs, flush with (lukewarm) water and seek medical assistance immediately
-  **Warning!** Do not disassemble, crush, or puncture the battery
-  **Warning!** Keep the Li-Ion battery away from children
-  **Warning!** Never touch the battery contacts or allow (conductive) objects to touch the contacts

#### 3.2. Installation

-  **Warning!** Never use the Li-Ion battery without a properly installed BMS switch off device, controlled by either the Li-Ion battery or a remote switch (SB-RSW)

#### 3.3. Use

-  **Warning!** Do not overcharge the Li-Ion battery
-  **Warning!** Never short circuit the battery




#### 3.4. Disposal



Dispose of the 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

#### 3.5. Safety symbols and markings on product

A number of safety symbols and markings can be found on the product. These markings are displayed below. Never remove these markings!

Symbol	Description
	Keep the Li-Ion battery upright. Never tilt the battery more then 90 degrees.
	Dispose of 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.
	This product, or sections of this product can be recycled

## 4. Installation

### 4.1. General information

- ⚠ **Warning!** Do not disassemble, crush, or puncture the Li-Ion battery.
- ⚠ **Warning!** Never install or use a damaged battery.

When connecting several batteries in series or parallel, always use batteries of the same brand, type, age, capacity and state of charge. The Li-Ion battery is one on one replaceable with AGM/GEL lead acid batteries.

### 4.2. Unpacking

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

### 4.3. Preparing the battery for use

#### 4.3.1. Placement of the battery

Before it is used, the Li-Ion battery must be positioned in such a way it will not move around in its compartment during use. If necessary, the Li-Ion battery may be fixed in place by means super B mounting brackets. The brackets can be screwed in place by means of bolts or screws. (See Figure 1)

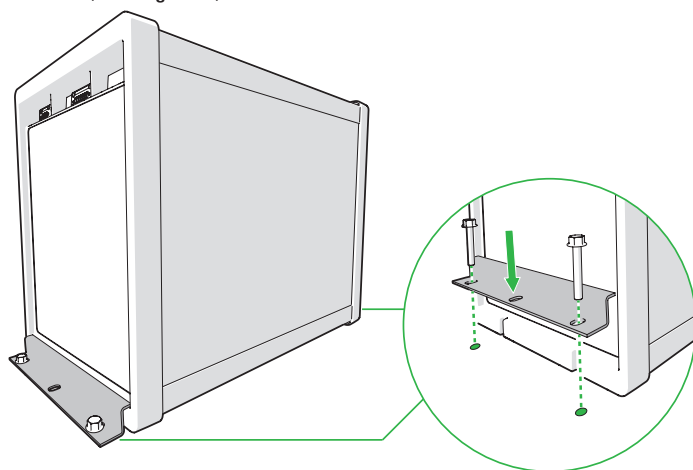


Figure 1. Installing the Li-Ion battery using the super B mounting brackets

#### 4.3.2. Placement and removal of a fuse

Before the Li-Ion battery can be used, either an internal fuse or a dummy fuse needs to be installed into it. Two 32V/500A Mega fuses and one dummy fuse are supplied with the product. Other fuses may only be used in the product when they are approved by super B for this application.

- Use an internal (Mega) fuse if a single battery is installed, if two batteries are installed in series or if a number of batteries are installed parallel to one another. The discharge current may not exceeds 500 A and the maximum voltage may not exceed 32V. (see paragraph 4.4).
- Use a dummy fuse if three or more batteries are placed in series, if maximum discharge current exceeds 500 A or if the maximum voltage exceeds 32V.

- ⚠ **Warning!** Always use an external fuse with the appropriate value when a dummy fuse is used.

Use the following steps to place a Mega Fuse or a dummy fuse in the battery (Figure 2):

1. Turn off any device or charger the battery is connected to
2. Turn off the external BMS (latching) relay or external BMS cut-off switch
3. Disconnect the negative wire from the - pole of the battery (see paragraph 4.4 for the details)
4. Disconnect the positive wire from the + pole of the battery
5. Unscrew the fuse cap using the fuse TORX key
6. Unscrew the fuse contacts using the M13 wrench
7. Press the reset button for 5 seconds
8. Place the (new) fuse between the contacts, place washers and spring washers and tighten the fuse contact points to 13 Nm.
9. Fasten the fuse cap
10. Proceed to the next paragraph to read the instructions on installing the battery in an electrical circuit

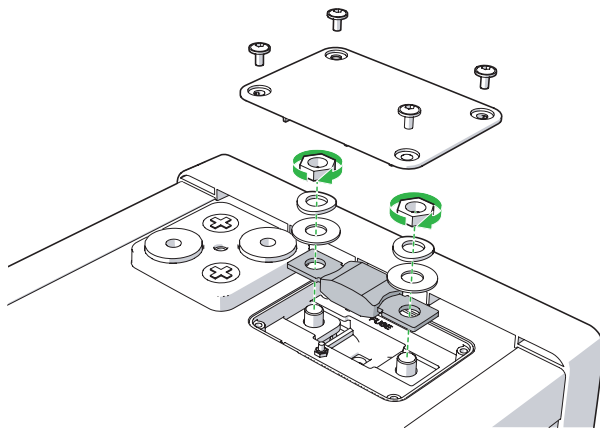


Figure 2. Install a fuse

#### 4.4. Installing the battery in an electrical circuit

- ⚠ **Warning!** Never use the Li-Ion battery without a properly installed BMS switch off device (relay or latching relay) controlled by either the Li-Ion battery or a remote switch. (SB-RSW)
- ⚠ **Warning!** Install the appropriate fuse before connecting the battery to other devices. (see paragraph 4.3.2) Use an appropriate external fuse if a dummy fuse is used.

##### 4.4.1. Installing a BMS Switch off device

An external BMS switch off device can be either installed between the + or - terminal of the battery and the load. This BMS switch off device can be controlled in one of two ways:

- Connect a latching relay or a normal relay to the battery's internal driver
- Connect a latching relay or a normal relay to a remote switch (SB-RSW). If applicable, consult the manual of the SB-RSW for the appropriate installation instructions.

##### Connecting a latching relay to the battery:

1. When using a latching relay, connect it to Con 1 (I/O Connection 4) as displayed in Figure 3. The internal driver controls both high and low side.

The output of Con 1 can be found in Table 1.

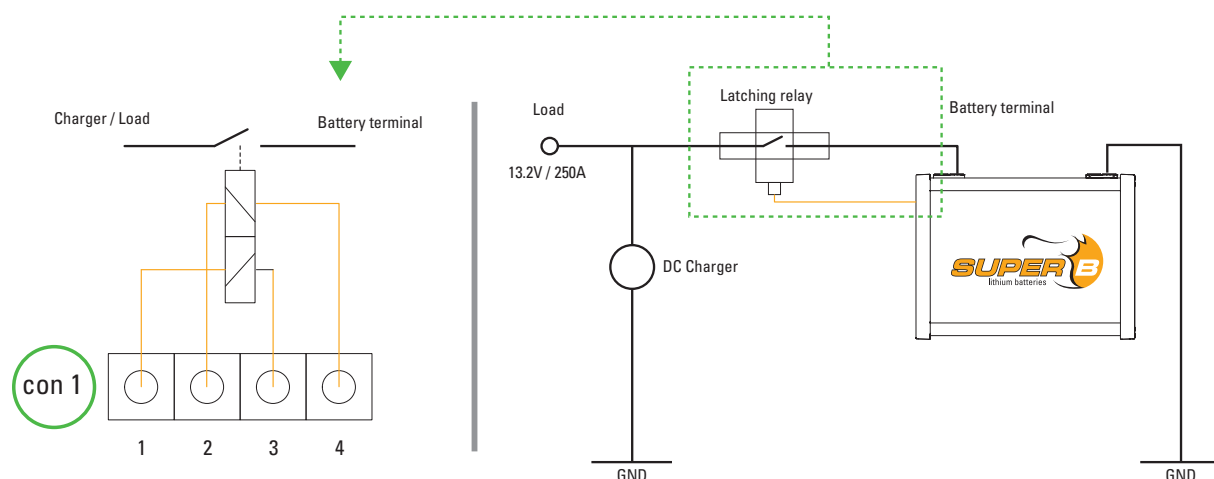


Figure 3. Connect a latching relay as BMS switch off device

	Con 1 output (12V DC)
Continuous	2,7 A
100ms pulse	15 A

Table 1.

**⚠ Warning!** Always connect the relay between the + or - terminal of the battery and the load.

- |       |                |
|-------|----------------|
|       | <b>Pin 4</b>   |
| V max | <b>250 VDC</b> |
| A max | <b>5 A</b>     |

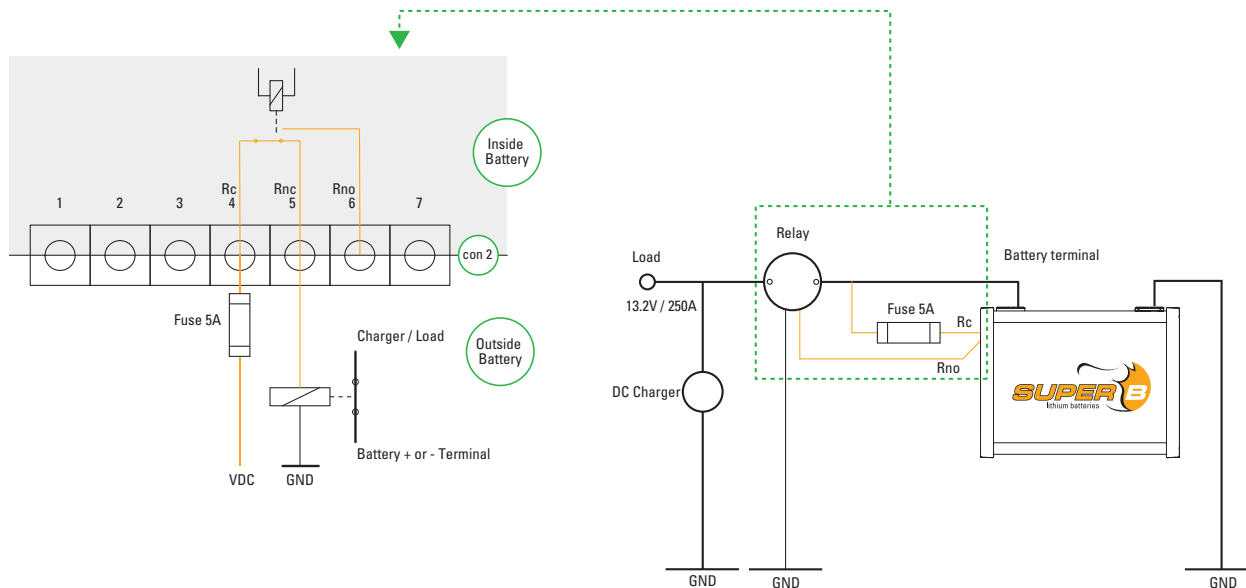


Figure 4. Connect a normal relay as BMS switch off device

To use the battery monitoring software, the CAN bus of the Li-Ion battery (CON 3) needs to be connected to the computer on which the monitoring software is installed.

- CiA 301
- CiA 303\_1 V1.8.0; Sections 5 (AC and DC parameters) and 7.2: (5-pin “micro” style connector)

The CAN Bus must be used in a bus network topology (see Figure 5 and Figure 6). Do not use a ring- or a star topology. The CAN specifications restrict the Bus length/Bus speed. Displayed in Table 2 is an overview of these restrictions.

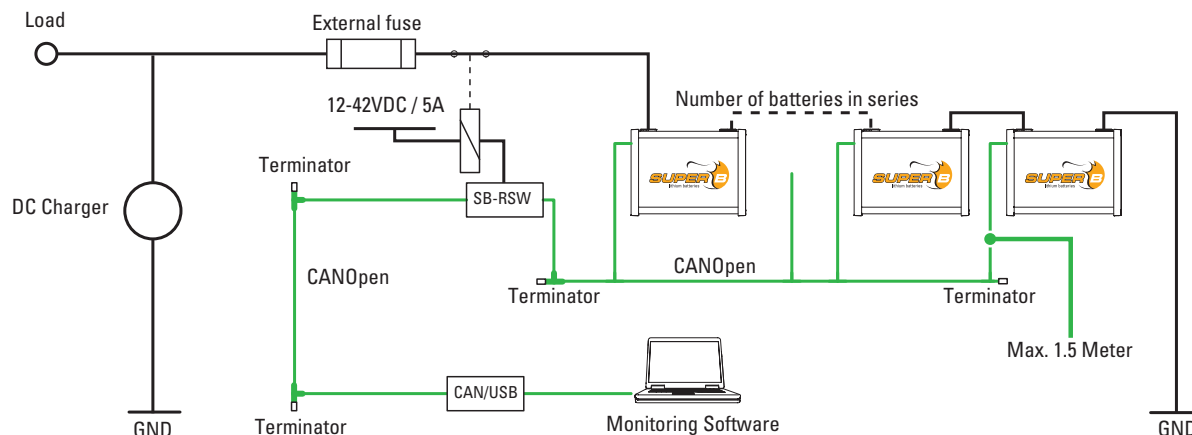


Figure 5. CAN Bus network topology

Bit rate	Bus length (L)	Max. stub length (S)	Accumulated stub length
1 Mbit/s	25 m	1.5 m	7.5 m
800 kbit/s	50 m	2.5 m	12.5 m
500 kbit/s	100 m	5.5 m	27.5 m
250 kbit/s*	250 m	11 m	55 m
125 kbit/s	500 m	22 m	110 m
50 kbit/s	1000 m	55 m	275 m
20 kbit/s	2500 m	137.5 m	687.5 m
10 kbit/s	5000 m	275 m	1375 m

Table 2. CAN bus speed

The default speed of the Can BUS is 250 kbit/s.

A high speed bus requires termination at the two ends of the bus. The CAN to USB converter can either be connected at one end of the bus (with termination) or in the middle of the bus with no termination; termination should then be placed at the endnodes of the bus line.

### Termination Resistors

Use termination resistors 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.

### CAN bus power

Due to the galvanic separation between the battery monitoring hardware and the battery, an external power supply is needed for the CAN bus. The CAN bus can be powered by either the SB-MAS or the SB-RSW. If the SB-MAS or the SB-RSW cannot be used, the CAN bus can be powered through Con 2 (I/O Connection 7). This situation may occur when a USB-to CAN interface is directly connected to the battery. (Figure 6)

1. Connect Pin 1 of Con2 to the + terminal of the battery
2. Connect Pin 7 of Con2 to the - terminal of the battery

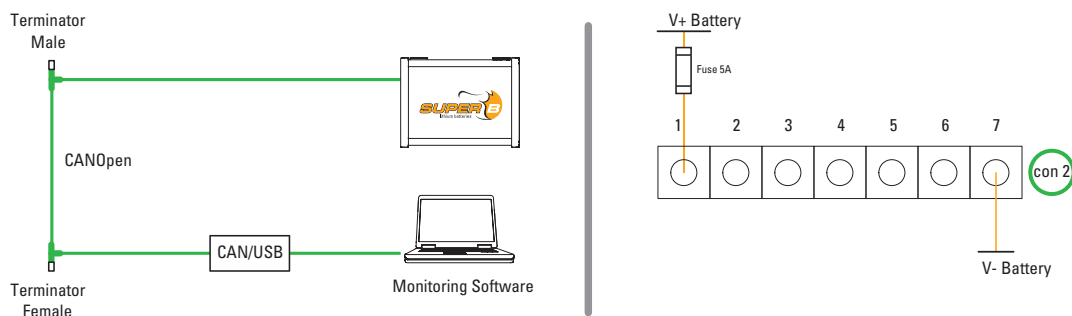


Figure 6. Use Con2 to power the CAN bus

#### 4.4.3. Connecting the battery to the load

**⚠ Warning!** Ensure you have completed all the previous steps described in chapter 4 before connecting the battery to the load.

1. Slide the terminal covers over the connection wires
2. Connect the + terminal of the battery to the - or A2 terminal of the relay (Figure 7; 1)
3. Connect the load or charger to the + or A1 terminal of the relay
4. Connect the - terminal of the battery. Do not connect the - terminal first as this may lead to short circuits (Figure 7; 2)
5. Ensure both contacts are tightened to 20 Nm
6. Place the terminal covers over the terminals (Figure 8)

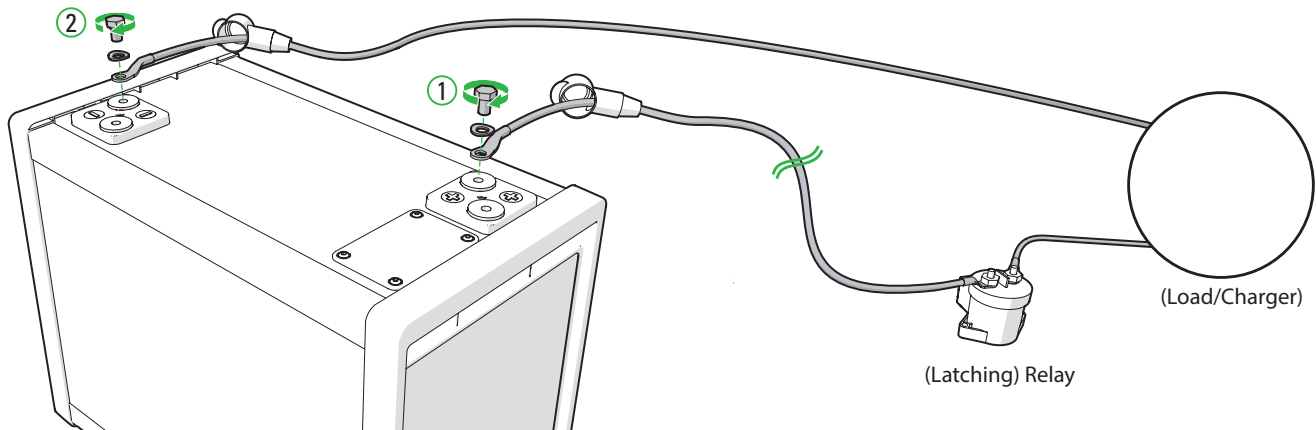


Figure 7. Connecting the battery to the load

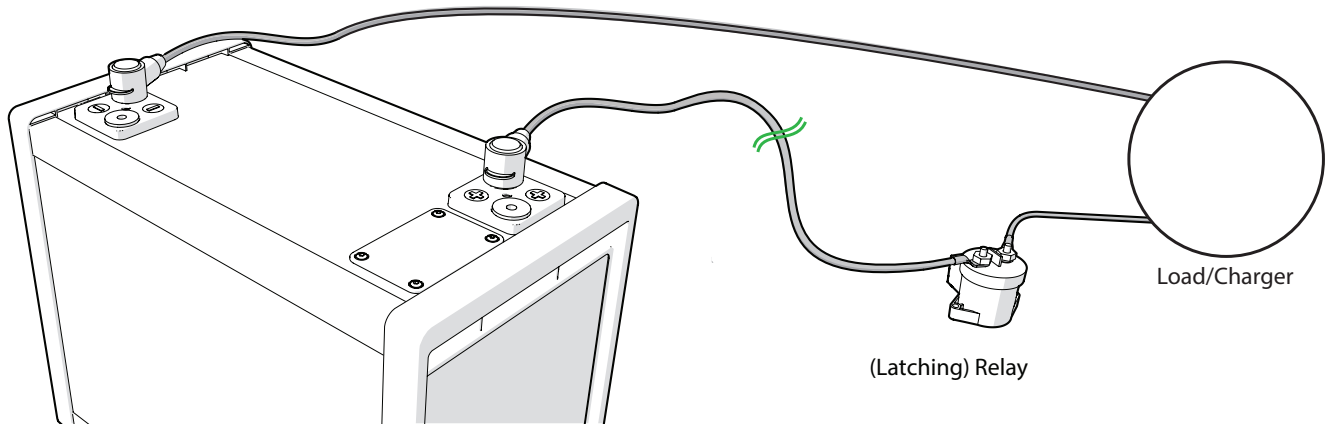


Figure 8. Securing the terminal covers

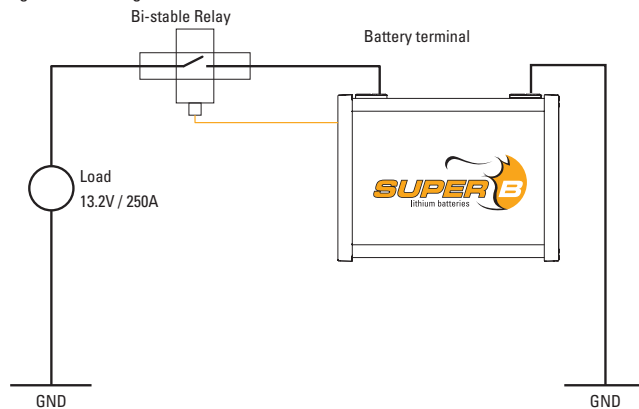


Figure 9. Connecting the battery to the load

## 4.4.4. Connecting a charger to the battery

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

1. Connect the charger behind the BMS switch off device as displayed in Figure 10
2. Disconnect the charger from the mains and the battery if it is not used for a long time

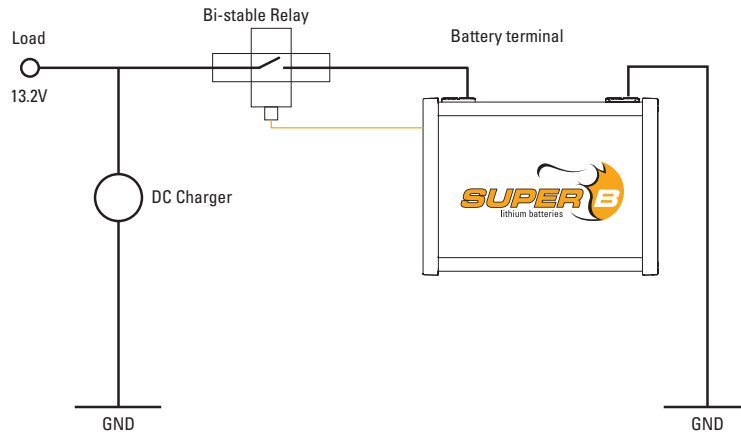


Figure 10. Connecting the charger

## 4.4.5. Disconnecting a battery

1. Turn off any device or charger the battery is connected to
2. Turn off the external BMS (latching) relay or external BMS cut-off switch
3. Disconnect the negative wire from the - terminal of the battery
4. Disconnect the positive wire from the + terminal of the battery

## 4.4.6. More configuration options

Other configurations to connect the battery are also possible: see Figure 11 - Figure 16

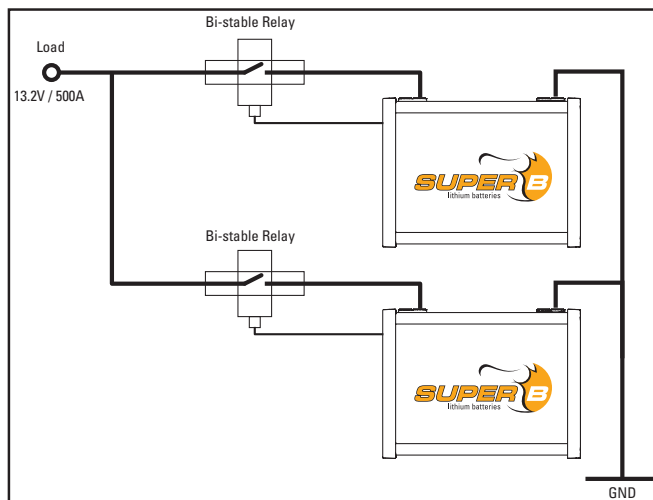


Figure 11. Example 1

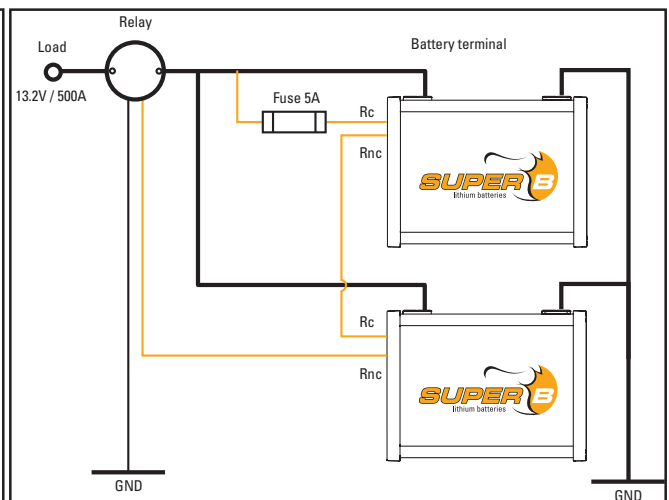


Figure 12. Example 2

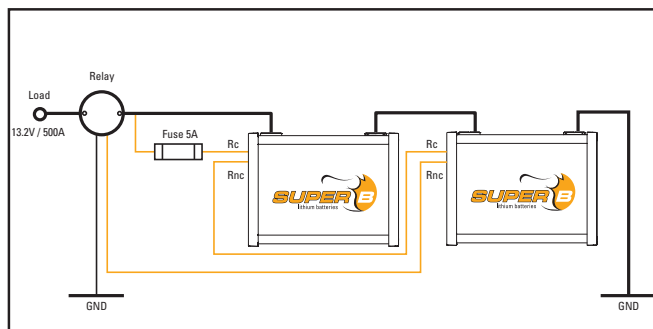


Figure 13. Example 3

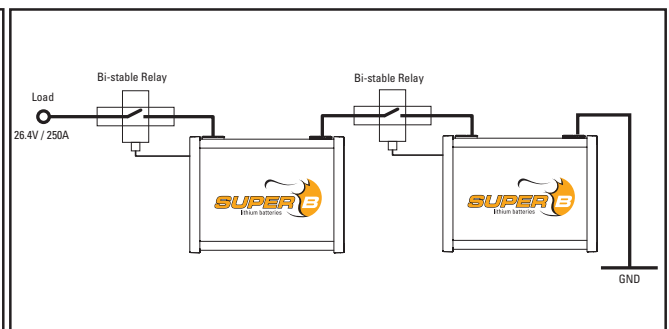


Figure 14. Example 4

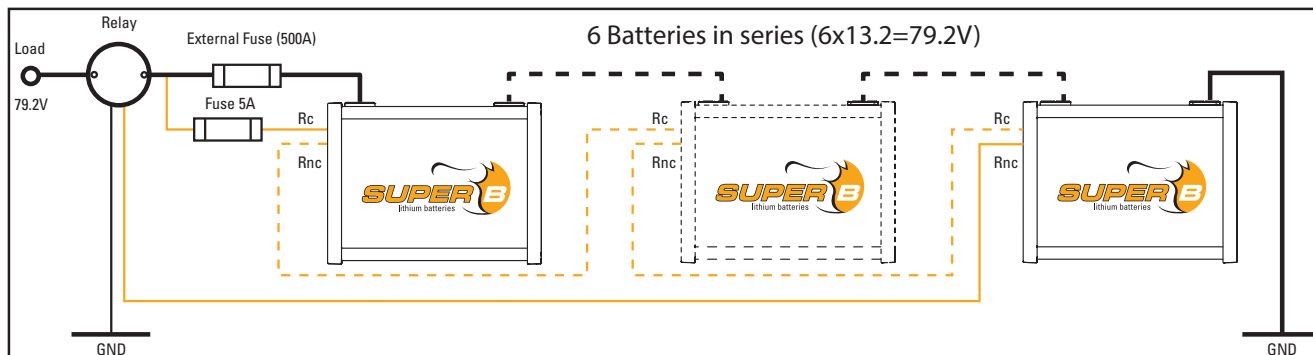


Figure 15. Example 5

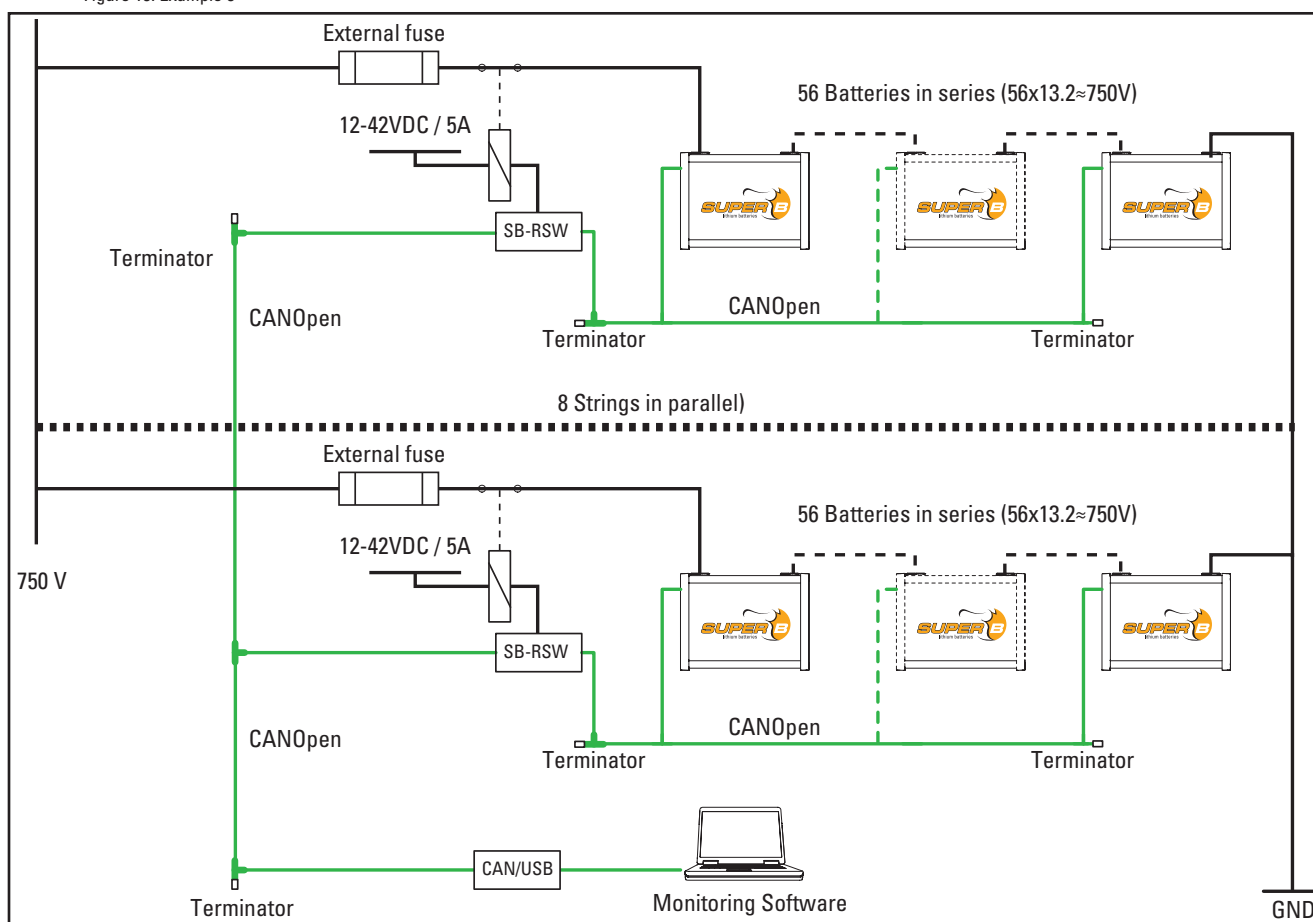


Figure 16. Example 6



5. Battery use

5.1. General information

**Warning!** Keep the Li-Ion battery away from children.

5.2. Charging

- Warning!** Never overcharge the Li-Ion battery, this will permanently damage the battery. Always use a charger which automatically halts the charging process when the battery is full.
  - Warning!** Stop the charging process if the battery gets too hot during charging (>55-60°C)
  - Warning!** Never charge a battery with a charging current larger than 1C as this will damage the battery.
  - Caution!** Disconnect the charger from the mains and the battery if it is not used for a long time.
  - Caution!** To preserve the lifespan of the Li-Ion battery use a super B charger or a charger approved by super B. The use of other chargers, such as lead-acid chargers will shorten the lifespan of the Li-Ion battery. AGM / GEL chargers may be used if the charge voltages of the different charge states don't exceed the charge voltage limits of the battery.
1. Connect the charger to the battery as described in paragraph 4.4.
  2. Charge the battery whenever the voltage of the battery drops below 10 V or if the state of charge drops below 20% to preserve the lifespan of the battery.

5.2.1. Charging rate

Lithium Iron Phosphate batteries can be charged much faster than traditional lead acid batteries. Displayed in Table 3 are the charge times for the Li-Ion battery at different charge currents. Always use the indicated charge current and end of charge voltage during charging. Consult paragraph 5.2.2 for the appropriate charging methods.

	Time	Charge current	End of charge voltage
Maximum	1 hour	1C (160A)	15 V DC
Endurance lifecycle	3 hours	C3 (52.8)	14,6V DC

Table 3. Charging rates at different charge currents

5.2.2. Charging methods

Two charging methods may be used to charge the Li-Ion battery:

Constant voltage / constant current charge (see Figure 17)

1. Set the charge current and end of charge voltage to the values described in paragraph 5.2.1.
2. Set the charger to terminate charging when the charge current drops below 3% of the recommended charge current. (3% of 160A = 4.8A)

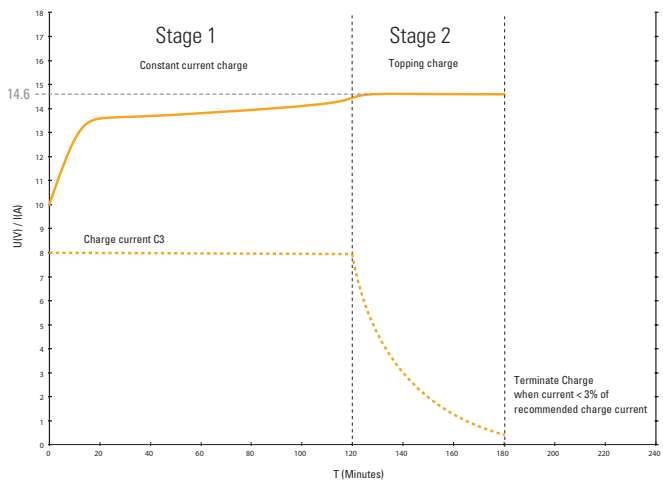


Figure 17. Constant voltage/Constant current charge

### Constant voltage / constant current charge, using an AGM/GEL battery charger algorithm (see Figure 18)

Super B recommends using this charging method since it aids in balancing the battery, prolonging the lifespan of the battery. This charging algorithm is also used for AGM/GEL batteries.

1. Set the charge current and end of charge voltage to the values described in paragraph 5.2.1.
2. Set the charger to go to float mode (13.7V - 13.9V) when the charge current drops below 3% of the recommended charge current. (3% of 160A = 4.8A)

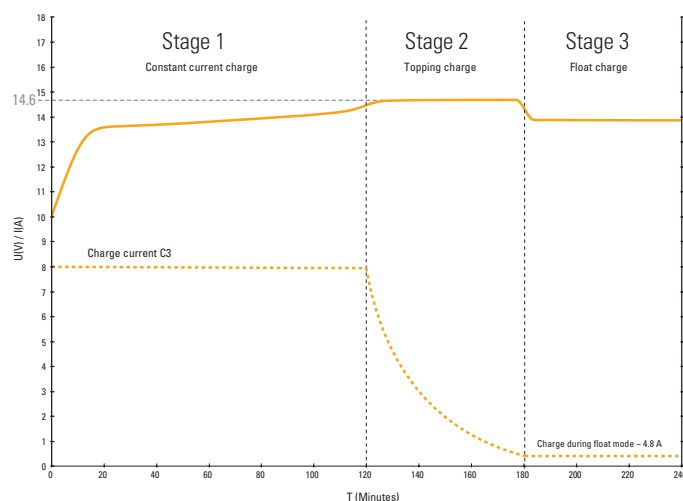


Figure 18. Constant voltage/Constant current charge with AGM/GEL battery charger algorithm

### 5.2.3. Battery balancing

- The Li-Ion battery is automatically balanced when the charger goes to float mode (AGM/GEL battery charger algorithm) and no current is drawn from the battery. (see paragraph 5.2.2)

### 5.2.4. Battery equalization

During the batteries lifespan, the cells within the battery may be unbalanced due to high discharge currents and short float charge periods. This may result in a loss of capacity and overcharged cells. Cells may be equalized by means of the following procedure:

1. Apply a constant voltage of 14.2 and a current of < 2A to manually equalize the Li-Ion battery.

### 5.2.5. Determining the battery's state of charge (SoC)

1. Connect Pin1 of Con2 to the battery's + pole
2. Connect Pin 7 of Con2 to ground
3. Determine the voltage at Pin 2 of CON2 (see Figure 19)

The analog SoC output ranges from 0 to 10 volt, in which 0V corresponds with 0% SoC and 10V corresponds with 100% SoC.

The SoC is an indication. Charging currents smaller than 100mA are not used in the SoC calculation.

4. Take the battery through a complete charge cycle if the SoC indication does not provide an accurate representation of the SoC. This will recalibrate the SoC.

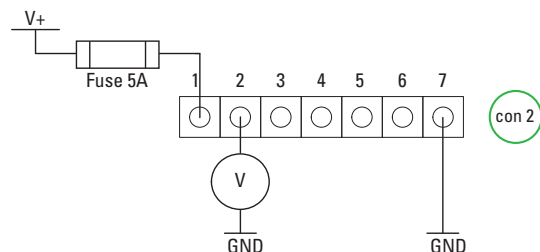


Figure 19. Determining the batteries SoC

### 5.3. Battery use

- ⚠ **Warning!** Do not short circuit the battery, this may lead to battery damage, explosion or fire.
- ⚠ **Warning!** Never touch the terminals of the battery.
- ⚠ **Warning!** Always use a BMS switch off device when connecting the battery to a load.
- ⚠ **Warning!** Always remain within the limits indicated in paragraph 2.3.2 during the use of the Li-Ion battery.

### 5.3.1. Battery fault condition

During battery use the external BMS switch off device may be triggered, disconnecting the battery from all loads and the charger. This shut off is the result of a fault condition. To identify and resolve this fault condition, chapter 10 may be consulted. The Battery Monitoring software may also be used to identify a fault condition. (see paragraph 5.4)

## 5.4. Battery Monitoring Software

Battery monitoring software offers the possibility to continuously monitor a number of battery properties through sensors within the Li-Ion battery. It also enables one to download a complete recording of the battery's properties over time (see paragraph 5.4.2).

The Battery Monitoring software and the hardware needed to connect the battery to the computer is not included with the Li-Ion battery. An overview of these products is given in paragraph 2.8.2.

### 5.4.1. Continuous Battery Monitoring

The Battery monitoring software is able to continuously monitor and relay the following battery properties:

- Battery serial number
- Battery voltage
- State of charge
- Charge / Discharge current
- Battery status (Alarms and Warnings)

### 5.4.2. Battery History Recording

The complete battery history can be downloaded with the battery monitor software. This recording can only be accessed by a reseller or super B for evaluation.

## 6. Inspection, cleaning and maintenance

### 6.1. General information

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

1. Disconnect the Li-Ion battery from all loads and charging devices before performing cleaning and maintenance activities. (see paragraph 4.4.5)
2. Remove the fuse or dummy fuse before cleaning and maintenance activities. (see paragraph 4.3.2)
3. Place the included protective caps over the terminals before cleaning and maintenance activities to avoid the risk of contacting the terminals.

### 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 battery is found, it must be replaced. Do not attempt to charge or use a damaged battery. Do not touch the liquid from a ruptured battery
2. Observe and note the run time that a new, fully-charged battery provides for powering your product. Use this new battery run time as a basis to compare run times for older batteries. The run time of the Li-Ion battery will vary depending on the products' configuration and the application it is used for.
3. Routinely check the battery's charge status. Lithium Iron Phosphate batteries continue to slowly self-discharge (10% per year) when not in use or while in storage.
4. Carefully monitor batteries that are approaching the end of their estimated life.
5. Consider replacing the battery with a new one if you note either of the following conditions:
  - The battery run time drops below about 80% of the original run time.
  - The 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.

### 6.4. Maintenance

The Li-Ion battery is maintenance free. Charge the battery to approximately 50% of its capacity at least once every 2 years to preserve the battery's capacity.

## 7. Storage

Follow the storage instructions in this manual to optimize the lifespan of the 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 battery.

1. Remove the fuse from the battery during storage. (See paragraph 4.3.2)
2. Disconnect the Li-Ion battery from all loads and, if present, the charging device.
3. Place the terminal covers over the battery's terminals during storage.
4. Store the battery in a cool and well ventilated space.
5. Avoid exposure of the battery to sunlight and/or UV radiation.
6. Charge or discharge the battery to 50% of its capacity before storage.
7. Charge the battery to approximately 50% of its capacity at least once every 2 years.

## 8. Transportation

### 8.0 General

Always check all applicable local, national, and international regulations before transporting a Lithium Iron Phosphate battery. Transporting an end-of-life, damaged, or recalled 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 battery falls within packaging group PI965 Section I.



Use Class 9 Miscellaneous Dangerous Goods and UN Identification labels for transportation of lithium ion batteries which are assigned Class 9. Refer to relevant transportation documents. Lithium and lithium ion cells and batteries are regulated in the U.S. in accordance with Part 49 of the Code of Federal Regulations, (49 CFR Sections 105-180) of the U.S. Hazardous Materials Regulations.

Visit [www.iata.org](http://www.iata.org) for the complete transport regulations and packing instructions for this product. The relevant information for Lithium batteries can be found under "Programs" > "Cargo" > "Dangerous goods (HAZMAT)".

## 9. Disposal and recycling

### 9.1. General information

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

Battery recycling is encouraged. Dispose of the battery in accordance with local, state and federal laws and regulations. Batteries may be returned to the manufacturer.

#### **USA & Canada:**

Lithium Iron Phosphate batteries are subject to disposal and recycling regulations that vary by country and region. Always check and follow your applicable regulations before disposing of any battery. Contact Rechargeable Battery Recycling Corporation ([www.rbrc.org](http://www.rbrc.org)) for U.S.A. and Canada, or your local battery recycling organization.

#### **EC**

Waste must be disposed of in accordance with relevant EC Directives and national, regional and local environmental control regulations. For disposal within the EC, the appropriate code according to the European Waste Catalogue (EWC) should be used.

#### **Other**

Many countries prohibit the disposal of waste electronic equipment in standard waste receptacles.

## 10. Troubleshooting

Problem	Possible reason	Solution
The capacity of battery has decreased	The cells within the battery are not properly balanced, causing them to discharge at different rates.	Connect the Monitor Software to the battery to verify the status of the battery. If the battery status "balancing required" is active, follow the procedures described in paragraphs 5.2.3 and 5.2.4 to balance the cells within the battery. If no difference is found, the lost capacity is due to battery aging. This process cannot be reversed.
The battery does not provide a charge / the battery cannot be charged	The fuse of the battery is not installed	Install the fuse; follow the procedures described in paragraph 4.3.2
	The fuse in the battery is broken	Disconnect all loads and chargers, check and correct for short circuits and defects. Then replace the fuse; follow the procedures described in paragraph 4.3.2
	The reset button was not pressed for 5 seconds after the installation of the fuse or after a fault condition.	Press the reset button for 5 seconds.
	Batteries connected in series may fail to charge if a defective battery is present in the series.	Check the series for defective batteries. If a defective battery is found, replace it.
	The battery has been discharged to deeply causing the battery management system to trigger the external switch off device. The BMS is now in "fault condition".	Disconnect all loads and connect a charger to the battery. Then press the reset button for at least 5 seconds to resolve the "fault condition". (The reset button can be found in the fuse compartment; see paragraph 2.7.)
	The battery has been overcharged, causing the battery management system to trigger the external switch off device. The BMS is now in "fault condition".	Disconnect the charger from the battery and press the reset button for at least 5 seconds to resolve the "fault condition". (The reset button can be found in the fuse compartment; see paragraph 2.7.)
	The batteries cells have become unbalanced. During charging one or more cells overcharge, causing the battery management system to trigger the external switch off device. The BMS is now in "fault condition".	Disconnect the charger from the battery and press the reset button for at least 5 seconds to resolve the "fault condition". (The reset button can be found in the fuse compartment; see paragraph 2.7.) Drain the battery, then equalize the battery's cells as described in paragraph 5.2.4.
	The battery has overheated causing the battery management system to trigger the external switch off device. The BMS is now in "fault condition".	Disconnect the charger and all loads and wait for the battery to cool down. Then press the reset button or at least 5 seconds to resolve the "fault condition". (The reset button can be found in the fuse compartment; see paragraph 2.7.)
A ticking sound can be heard from within the battery	The Battery Management System has detected an error and is trying to trigger an external switch off device to disconnect from the load/charger. The BMS uses an internal relay to do so. However no external switch off device is connected (to the BMS), causing the internal relay to keep firing.	Immediately disconnect the battery from the load and install a switch off device; see paragraph 4.4.1, Then press the reset button for at least 5 seconds to resolve the "fault condition".

## 11. Warranty and liability

11.1 Upon delivery, the customer is obliged to immediately verify whether the products have been damaged during transport. If its not, the customer must notify Super B of such transport damage as soon as possible, in any event no later than within three (3) days of delivery, by means of an accurate, written statement, stating the damage and where possible a photograph.

11.2 If the customer demonstrates that the products do not conform to the agreement, Super B has the option to repair and/or replace the relevant products by new products when returned and/or to refund the invoice value, exclusive of any dispatch costs.

11.3 If the customer is a private individual not acting for or on behalf of any company or business, the customer has the right to return the product to Super B within seven (7) days of delivery. In this event, goods returned are only accepted if the product and its original packaging are free of damage, while the dispatch costs for returning the goods shall be at the customer's expense.

11.4 Super B shall use its best endeavors to manufacture reliable and safe products and to deliver these to the customer.

11.5 Super B grants a three year limited warranty for manufacturing faults. 'Manufacturing faults' do not include damage caused as a result of (a) general tear and wear, (b) short circuit, (c) overcharging, (d) deep discharging, (e) a wrongful connection to engines and other devices, (f) the absence of an approved and properly installed external BMS relay or other switch off device (g) any other wrongful use contrary to the user instruction; and (h) any use contrary to the product specifications of that product.

11.6 Any liability to the customer in any case ends if the customer fails to notify Super B of the existence of the defect within three (3) days of having discovered the defect, in writing, in order to enable Super B to investigate this.

11.7 Any liability of Super B for damage suffered by the customer is in any case limited to the invoice amount of the relevant products. Super B can never be held liable for consequential damage or losses of profits, unless such damage has been caused by gross negligence or willful misconduct of Super B.

11.8 To the extent that a court determines that the limitation of liability as meant in clause 11.7 cannot be invoked against a particular claim for damages by the customer, Super B's liability for loss of property, damage to property and bodily injury (including death) caused by the application of those particular Super B products shall in any event be limited to the amount actually paid out by Super B's insurance company to Super B in accordance with the insurance cover of that insurance policy for that particular type of damage. Super B has taken out insurance against certain risks, namely for the application of Super B products in land vehicles and in aviation, respectively, each as described in the respective insurance policies. These policies contain a usual limitation of insurance payment to be paid out to Super B if, and to the extent that, the event is a covered event.

## Appendix I. EC Declaration of conformity

**super B b.v.**

Diamantstraat 1e, 7554 TA, Hengelo, the Netherlands  
+31 (0) 74-8200010, [www.super-b.com](http://www.super-b.com)

November 7, 2012

### EC Declaration of Conformity

**Product Number/Name/Description:**

SB12V160E-OC (Lithium Ion Battery) 13.2V /160Ah /2122Wh (Energy/TractionBattery)

**The undersigned hereby declares, on behalf of super B b.v. Hengelo, the Netherlands, that the above-referenced product, to which this declaration relates, is in conformity with the provisions of:**

- Council Directive 2006/66/EC, Environmental EU Compliance
- Council Directive 2004/108/EC (December 15,2004) on Electromagnetic Compatibility

European standards used:

- IEC 61000-4-2, EMC Compliance
- IEC 62133, Safety IEC Compliance
- IEC 61960{ed2.0}, Performance IEC Compliance
- IEC 62281, Transportation IEC Compliance

The Technical Construction File required by this Directive is maintained at the corporate headquarters of super B b.v., Diamantstraat 1e, 7554TA, Hengelo, the Netherlands.

M.H. Doornekamp

CEO

## Appendix II. Certificate of Compliance

**super B b.v.**

Diamantstraat 1e, 7554 TA, Hengelo, the Netherlands  
+31 (0) 74-8200010, [www.super-b.com](http://www.super-b.com)

November 7, 2012

### Certificate of Compliance

**Product Number/Name/Description:**

SB12V160E-OC (Lithium Ion Battery) 13.2V /160Ah /2122Wh (Energy/TractionBattery)

**The undersigned, on behalf of super B, does hereby certify that the product listed above is compliant to:**

- a) The testing requirements for Lithium Batteries in Section 38.3; Part III; of the UN Recommendations on the TRANSPORT OF DANGEROUS GOODS, Manual of Tests and Criteria, Fourth revised edition;[ST/SG/AC.10/11/Rev.4].
- b) IEC 62281, Transportation IEC Compliance
- c) SP 230, Special provision
- d) SP 188 / PI965, Part II IATA , Packing instructions
- e) Council Directive 2006/66/EC, Environmental EU Compliance
- f) Council Directive 2004/108/EC (December 15,2004) on Electromagnetic Compatibility
- g) IEC 62133, Safety IEC Compliance
- h) IEC 61000-4-2, EMC Compliance
- i) IEC 61960{ed2.0}, Performance IEC Compliance

M.H. Doornekamp

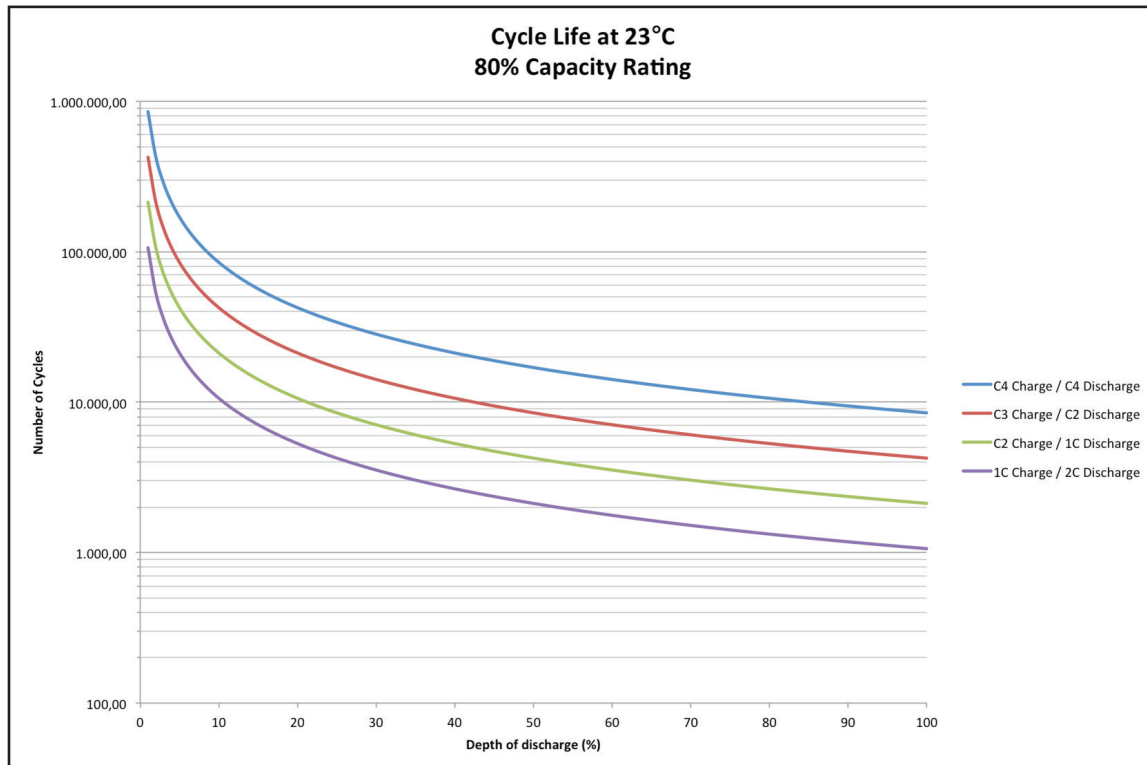
CEO

super B b.v.

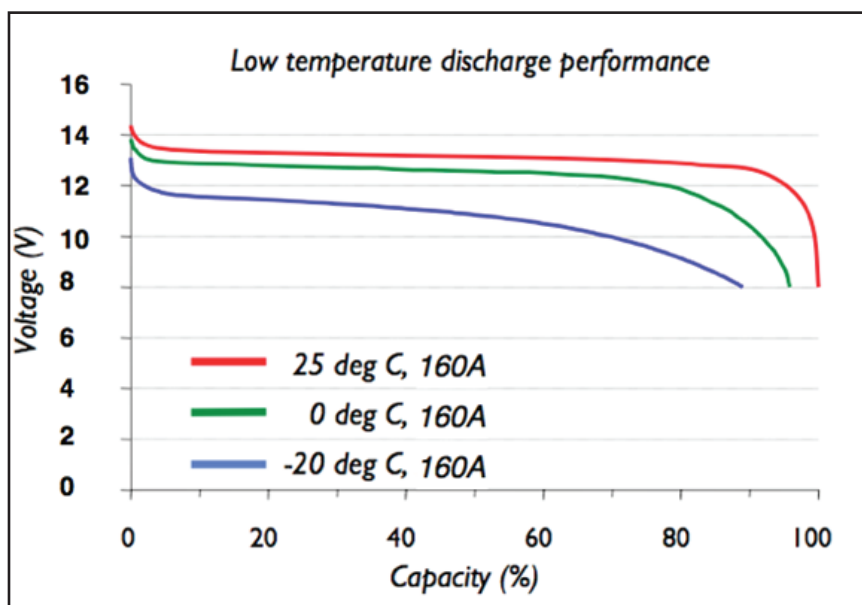


## Appendix III. Performance Graphs

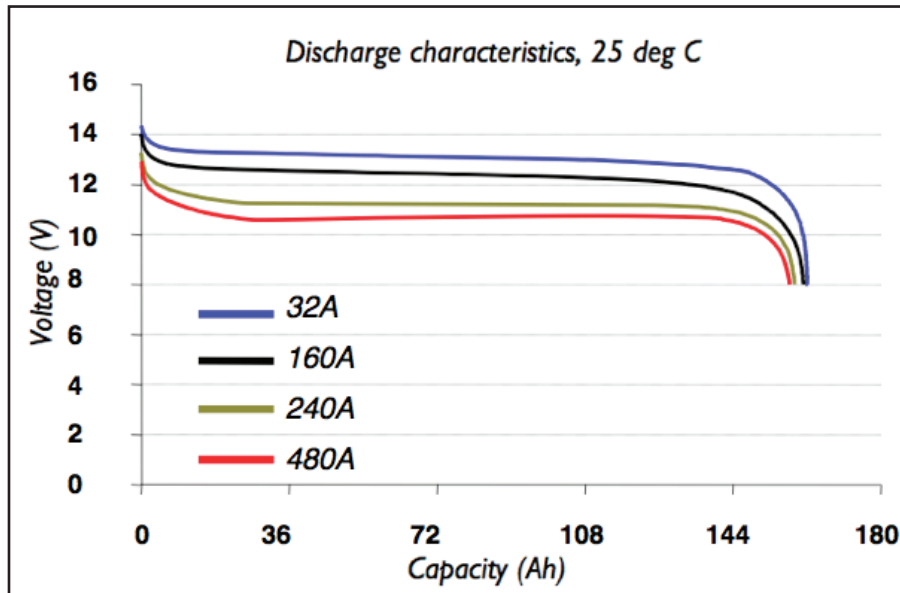
### Depth of Discharge v/s Cycle life



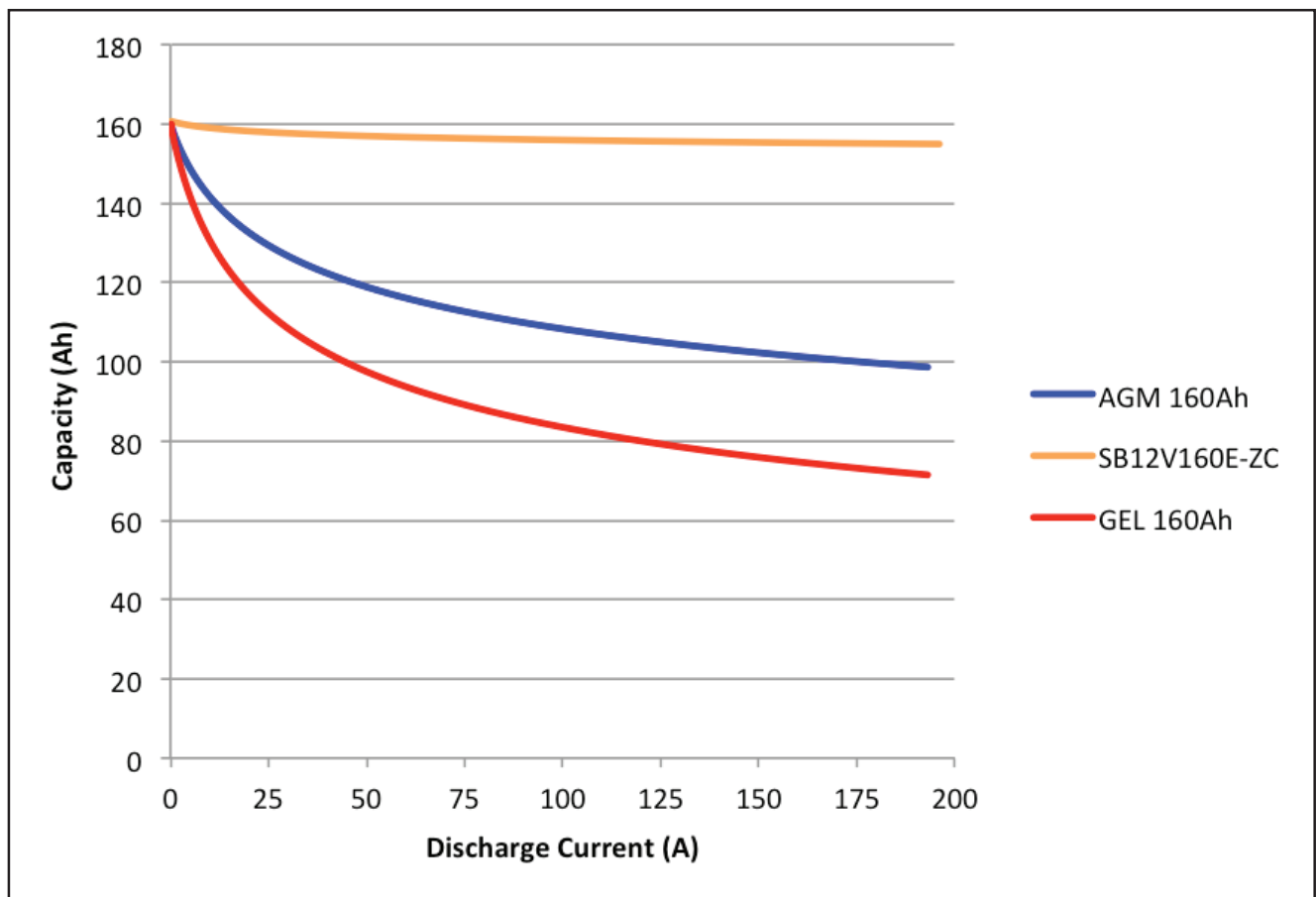
### Temperature performance



## Load performance



## Peukert component







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