



Lithium Battery Manual

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1. Safety precautions



Observe these instructions and keep them located near the battery for future reference.



The Material Safety Datasheet can be downloaded from the "Material Safety Datasheet menu" located on the [Lithium Smart product page](#).



Work on a li-ion battery should be carried out by qualified personnel only.

1.1. General warnings



While working on a li-ion battery wear protective eyeglasses and clothing.



Any uncovered battery material such as electrolyte or powder on the skin or in the eyes must immediately be flushed with plenty of clean water. Then seek medical assistance. Spillages on clothing should be rinsed out with water.



Explosion and fire hazard. The terminals of a li-ion battery are always live, therefore do not place metallic items or tools on top of a li-ion battery. Avoid short circuits, too deep discharges and too high charge currents. Use insulated tools. Do not wear any metallic items such as watches, bracelets, et cetera. In case of fire, you must use a type D foam or CO2 fire extinguisher.



Do not open or dismantle the battery. Electrolyte is very corrosive. In normal working conditions contact with the electrolyte is impossible. If the battery casing is damaged do not touch the exposed electrolyte or powder because it is corrosive.



Li-ion batteries are heavy. If involved in an accident they can become a projectile! Ensure adequate and secure mounting and always use suitable handling equipment for transportation.



Handle with care because a li-ion battery is sensitive to mechanical shock.



Do not use a damaged battery.



Do not wet the battery.

1.2. Charge and discharge warnings



Too deep discharges will seriously damage a li-ion battery and can even be dangerous. Therefore, use of an external safety relay is obligatory.



Use only with a Victron approved BMS.



If charged after the Lithium Battery was discharged below the "Discharge cut-off voltage", or when the Lithium Battery is damaged or overcharged, the Lithium Battery can release a harmful mixture of gasses such as phosphate.



The temperature range over which the battery can be charged is 5°C to 50°C. Charging the battery at temperatures outside this range may cause severe damage to the battery or reduce battery life expectancy.



The temperature range over which the battery can be discharged is -20°C to 50°C. Discharging the battery at temperatures outside this range may cause severe damage to the battery or reduce battery life expectancy.

1.3. Transportation warnings



The battery must be transported in its original or equivalent package and in an upright position. If the battery is in its package, use soft slings to avoid damage.



Do not stand below a battery when it is hoisted.



Never lift the battery at the terminals or the BMS communication cables, only lift the battery at the handles.

Batteries are tested according to UN Handbook of Tests and Criteria, part III, sub section 38.3 (ST/SG/AC.10/11/Rev.5).

For transport the batteries belong to the category UN3480, Class 9, Packaging Group II and have to be transported according to this regulation. This means that for land and sea transport (ADR, RID & IMDG) they have to be packed according to packaging instruction P903 and for air transport (IATA) according to packaging instruction P965. The original packaging complies with these instructions.

1.4. Disposal of lithium batteries



Batteries marked with the recycling symbol must be processed via a recognized recycling agency. By agreement, they may be returned to the manufacturer.



Batteries must not be mixed with domestic or industrial waste



Do not throw a battery into fire.

2. Introduction

2.1. Lithium iron phosphate battery

The lithium iron phosphate battery (LiFePO₄ or LFP) is the safest of the mainstream lithium battery types. A single LFP cell has a nominal voltage of 3.2V. A 12.8V LFP battery consists of 4 cells connected in series and a 25.6V battery consists of 8 cells connected in series.

LFP is the chemistry of choice for very demanding applications. Some of its features are:

- Rugged - It can operate in deficit mode during long periods of time.
- High round trip efficiency.
- High energy density - More capacity with less weight and volume.
- High charge and discharge currents - Fast charge and discharges are possible.
- Flexible charge voltages.

The lithium iron phosphate battery is therefore the chemistry of choice for a range of very demanding applications.

2.2. Lithium Smart battery models

The Lithium Smart Battery is available in a variety of capacities and in two different voltages, namely 12.8V and 25.6V. These are all available battery models:

- LiFePO₄ Battery 12,8V/60Ah Smart
- LiFePO₄ Battery 12,8V/100Ah Smart
- LiFePO₄ Battery 12,8V/160Ah Smart
- LiFePO₄ Battery 12,8V/200Ah Smart
- LiFePO₄ Battery 12,8V/300Ah Smart
- LiFePO₄ battery 25,6V/200Ah Smart

For more information see the [Lithium Smart product page](#).

2.3. Battery Management System



The battery cells in the Smart Lithium batteries are protected against over-charge, under-charge, charging at too low temperatures as well as charging at too high temperatures.

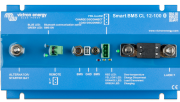

As part of the protection the battery has an integrated Balancing, Temperature and Voltage control system, the BTV. The BTV connects to an external Battery Management System, the BMS. In case of multiple batteries, the BTVs of several batteries are daisy chained and then connected to the BMS.

This is how it works: The BTV monitors each individual battery cell; it balances the cell voltages and in case of high or low cell voltage or in case of high or low cell temperature, it will generate an alarm signal. The alarm signal is received by the BMS and the BMS will turn off loads or chargers accordingly.

A Victron Energy BMS is essential for a correct operation of the lithium battery. The lithium battery is not allowed to be used without one. In addition to this you will also need to ensure that the BMS correctly controls all loads and charge sources that are connected to the battery.

The BMS is not included with the battery. It needs to be purchased separately. There is a choice of 4 different BMS types:

| BMS type | Voltage | Features |
|---|--------------------|---|
|  <p>VE-Bus BMS</p> | 12, 24 or 48 V | <ul style="list-style-type: none"> Controls MultiPlus or Quattro via VE.Bus Controls loads and chargers via on/off signals Pre-alarm control signal |
|  <p>smallBMS</p> | 12, 24, 36 or 48 V | <ul style="list-style-type: none"> Controls loads and chargers via on/off signals Pre-alarm control signal Note: the smallBMS was previously named miniBMS |

| BMS type | Voltage | Features |
|--|---------|---|
|  <p>Smart BMS CL 12/100</p> | 12 V | 100A dedicated alternator port Controls loads and chargers via on/off signals Pre-alarm control signal Bluetooth |
|  <p>BMS 12/200</p> | 12 V | 200A dedicated alternator port 200A dedicated load and charger port |

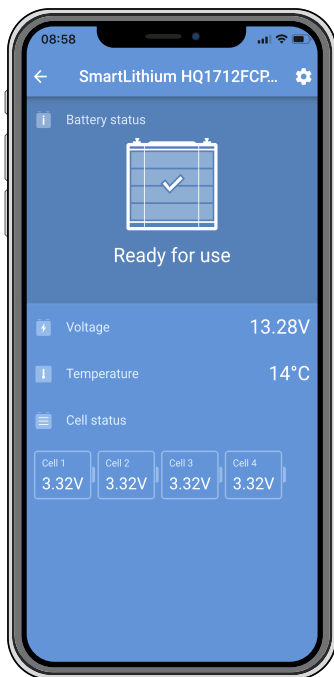
For more information see the [BMS product page](#)

The battery is equipped with BMS communication cables. These are used to connect the battery to the BMS. The cables are 0.5m long. In case the BMS cables are too short to reach the BMS, they can be extended using (not included) BMS extension cables:

- M8 circular connector Male/Female 3 pole cable 1m (bag of 2)
- M8 circular connector Male/Female 3 pole cable 2m (bag of 2)
- M8 circular connector Male/Female 3 pole cable 3m (bag of 2)
- M8 circular connector Male/Female 3 pole cable 5m (bag of 2)

For more information see the [BMS extension cable product page](#)

2.4. VictronConnect



The battery is equipped with Bluetooth and uses this to communicate with the VictronConnect app. The VictronConnect app is used for reading out battery information, for making or changing battery settings, receiving alarms and to update firmware. VictronConnect also contains a demo modus.

For more information see the [VictronConnect manual](#).

3. System design

When designing a system with a lithium battery, a basic understanding of how the battery interacts with the BMS and how the BMS interacts with loads and chargers is required.

3.1. The battery cell alarm signal

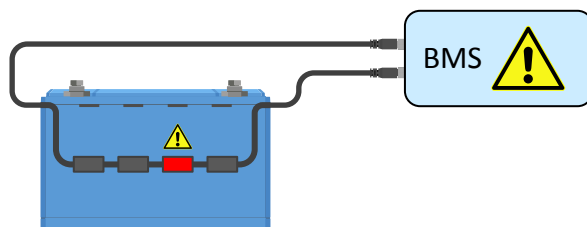
The battery communicates with the BMS via its BMS cables. If the system contains multiple batteries, all batteries are connected in series via the BMS cables and then the first and last battery is connected to the BMS.

The battery monitors its cells and it will send an alarm signal to the BMS in case of a:

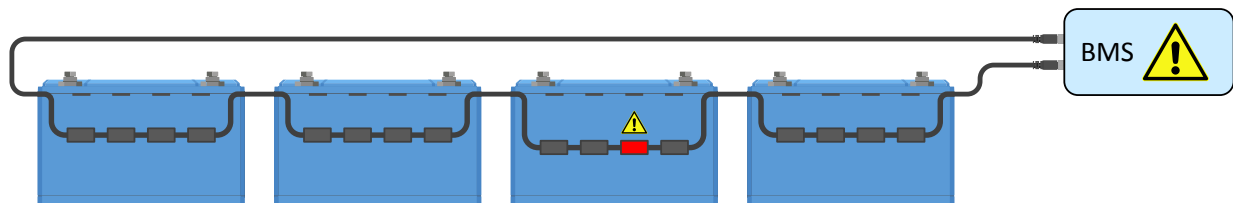
- Low cell voltage alarm signal
- Low cell voltage pre-alarm signal
- High cell voltage signal
- Low temperature signal
- High temperature signal

The BMS will act by turning loads and/or chargers off as soon it receives an alarm signal from one of the cells in the battery.

The alarm communication process between the battery and the BMS is depicted in images below.



The BMS receives an alarm signal from a battery cell



The BMS receives an alarm signal from a cell in a multiple battery setup

3.2. The pre-alarm signal

The purpose of the pre-alarm is to warn that the BMS is about to turn off the loads due to cell under voltage. For example; you would want an early warning that loads are going to be turned off while manoeuvring your boat, or if lights are turned off when it is dark. We recommend connecting the pre-alarm to a clearly visible or audible alarm device.

Switching behaviour

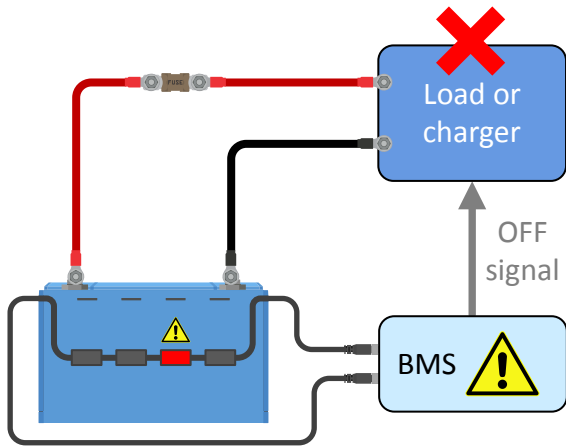
In case of an imminent under voltage shutdown, the pre-alarm output of the BMS will switch on. In case the voltage continues to decrease, the loads are switched off (load disconnect) and at the same time the pre-alarm output will switch off again. In case the voltage rises again (operator has enabled a charger or has reduced the load) the pre-alarm output will switch off, once the lowest cell voltage has risen above 3.2V.

The BTV ensures a minimum delay of 30 seconds between enabling the pre-alarm and the load-disconnect. This delay is to allow the user a minimal amount of time to prevent the shutdown.

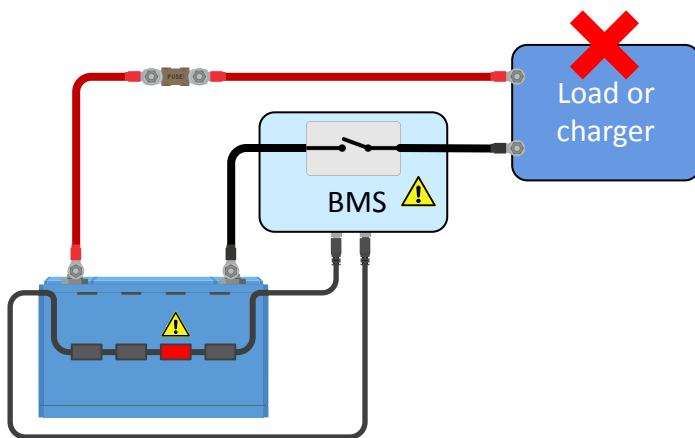
3.3. The BMS

Besides making above pre-alarm signal available, the main purpose of the BMS is to control the chargers and the loads. There are two ways that it can do that:

1. By sending a signal to the charger or load.
2. By physically connecting or disconnecting a load or a charge source from the battery, using for example a large contactor.



The BMS sends an on/off signal to a load or charger



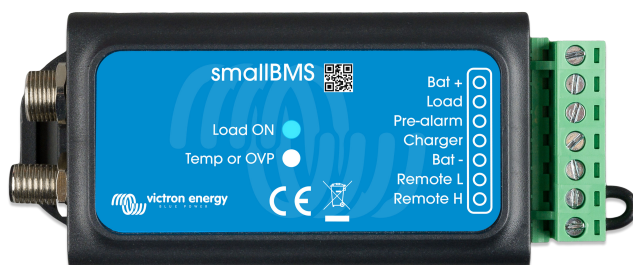
The BMS connects or disconnects from a load or charger

The available BMS types for the lithium battery either rely on one or both of these technologies. The BMS types and their functionality are briefly described in this chapter. For the full BMS information see the BMS product information page.

The smallBMS

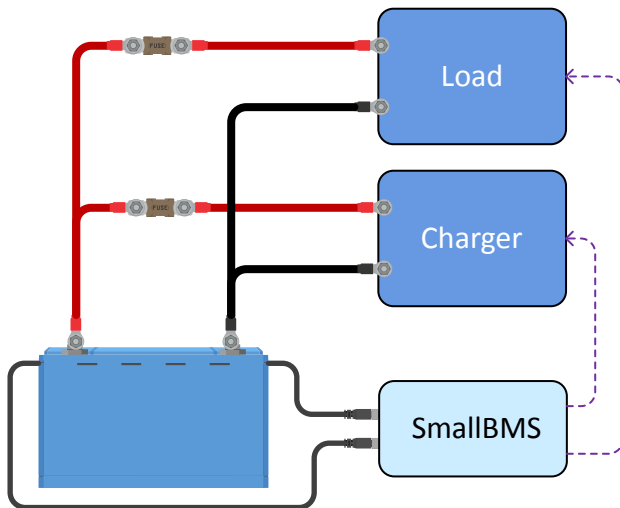
The smallBMS is equipped with a “load disconnect”, a “charge disconnect” and a pre-alarm contact.

- In the event of low cell voltage, the smallBMS will send a “load disconnect” signal to turn the load(s) off.
- Prior to turning the load off, it will send a pre-alarm signal indicating imminent low cell voltage.
- In the event of high cell voltage or low or high cell temperature, the smallBMS will send a “charge disconnect” signal to turn the charger(s) off.



smallBMS

For more information see the [smallBMS product page](#).



The smallBMS controls loads and chargers via “load disconnect” and “charge disconnect” signals

The VE.Bus BMS

The VE.Bus BMS directly communicates with a Victron Energy inverter/charger system via the VE.Bus. Just like the smallBMS, it also features a “load disconnect”, a “charge disconnect” and a pre-alarm contact.

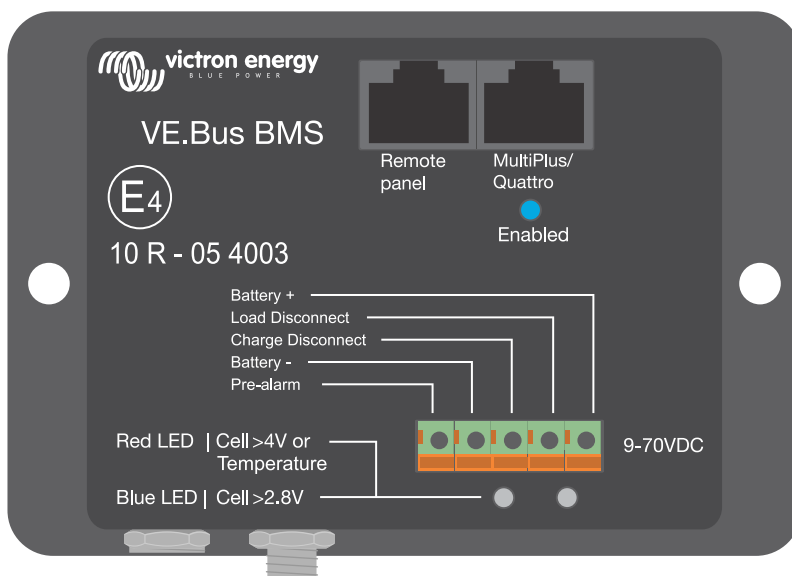
- In the event of low cell voltage, the VE.Bus BMS will send a “load disconnect” signal to turn off the load(s) and it will also turn the inverter of the inverter/charger off.
- Prior to turning loads off, it will send a pre-alarm signal warning of imminent low cell voltage.
- In the event of a high cell voltage or high/low cell temperature, the VE.Bus BMS will send a “charge disconnect” signal to turn the charger(s) off and it will also turn the charger of the inverter/charger off.

The mains detector ships together with the VE.Bus BMS.



NOTE

Special programming of the inverter/charger is required for the BMS to be able to communicate with the inverter/charger.

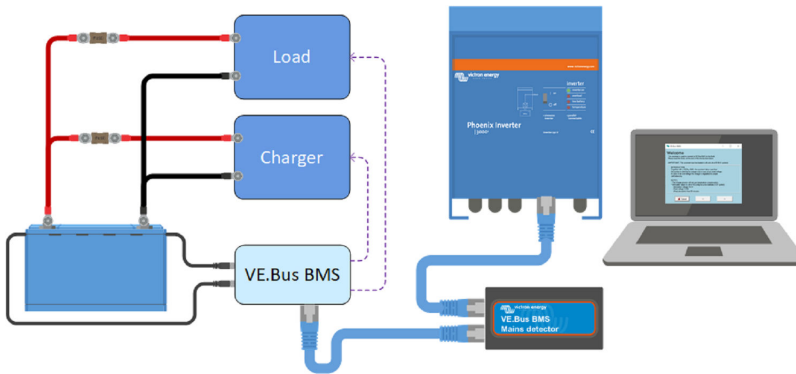


VE.Bus BMS



Mains detector

For more information see the [VE.Bus BMS product page](#).

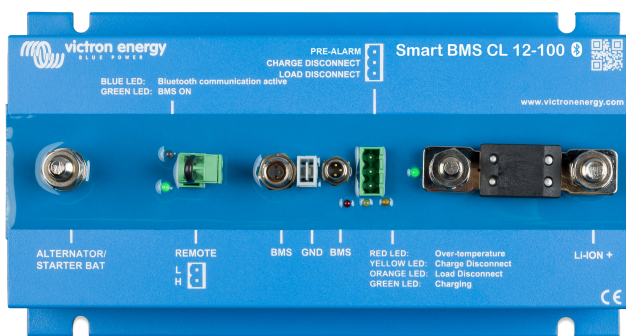


The VE.Bus BMS will turn loads and chargers off via "load disconnect", and "charge disconnect" and controls the inverter/charger

The Smart BMS CL 12/100

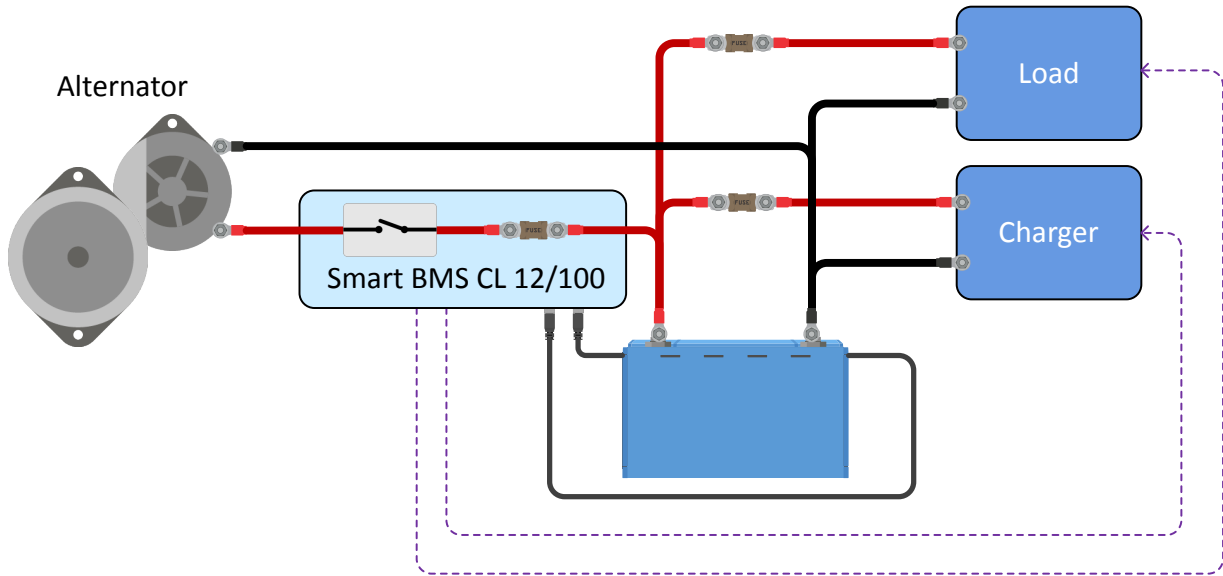
The Smart BMS CL 12/100 is equipped with a "load disconnect", a "charge disconnect" and a pre-alarm contact. It also features a dedicated 100A alternator port

- In the event of low cell voltage, the Smart BMS CL 12/100 will send a "load disconnect" signal to turn the load(s) off.
- Prior to turning load off it will send a pre-alarm signal indicating imminent low cell voltage.
- In the event of high cell voltage or low/high cell temperature, the Smart BMS CL 12/100 will send a "charge disconnect" signal to turn the charger(s) off.
- The alternator port controls and current limits the alternator.



Smart BMS CL 12/100

For more information see the [Smart BMS CL 12/100 product page](#).

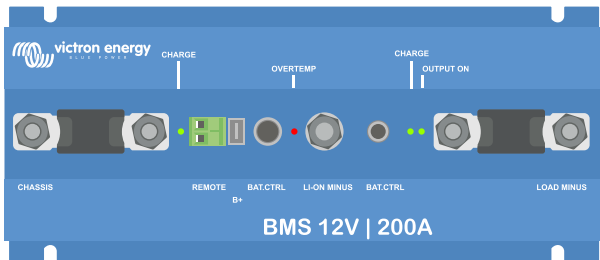


The Smart BMS CL 12/100 will turn loads and chargers off via "load disconnect" and "charge disconnect". It also controls and limits the alternator.

The BMS 12/200

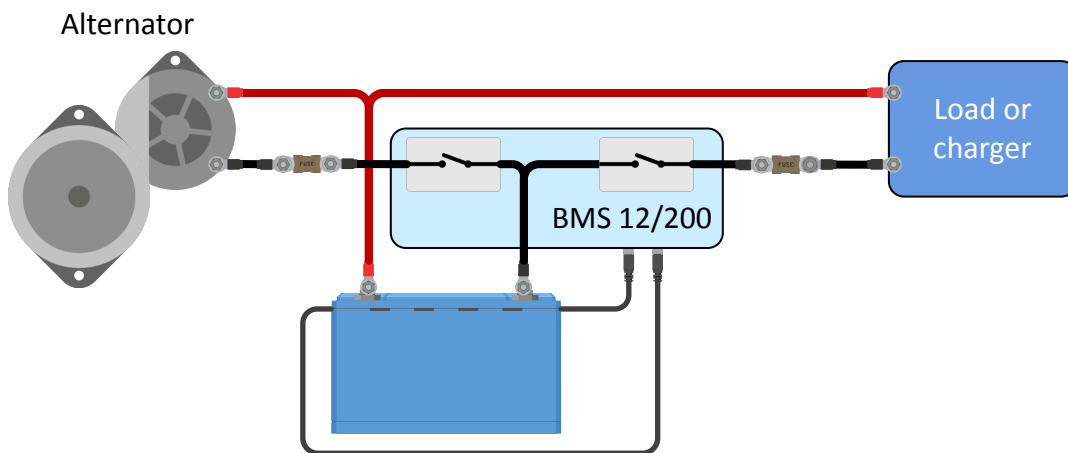
The BMS12/200 is equipped with a port to connect an alternator and a port to connect loads and/or chargers. The alternator port is rated to 80A and the load/charger port is rated to 200A.

- The alternator port controls and current limits the alternator
- The load port controls both loads and chargers



BMS 12/200

For more information see the [BMS12/200 product page](#).



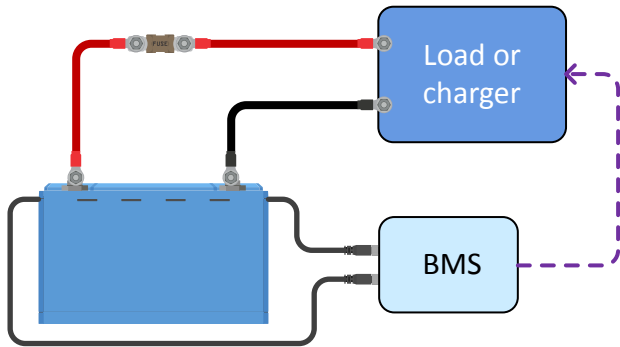
The BMS 12/200 disconnect loads and chargers. It also controls and current limits the alternator.

3.4. BMS controlled loads or chargers

The BMS sends a “load disconnect” signal to loads in case of a low cell voltage alarm and it sends a “charge disconnect” signal to chargers in case of a high cell voltage or a cell temperature alarm. The loads or chargers can be controlled by the BMS either directly or indirectly.

Direct control via a charger or load remote on/off terminal

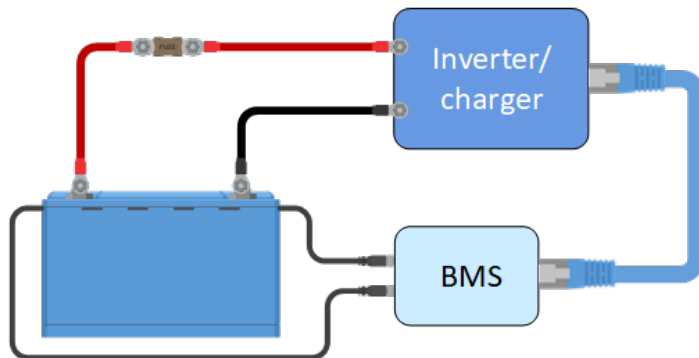
Products like chargers, inverters, solar chargers, DC/DC converters or DC/DC chargers are often equipped with a remote on/off terminal. The BMS “charge disconnect” or “load disconnect” signal connects directly to the remote on/off terminal.



The BMS directly controls the load or charger

Direct control via VE.Bus

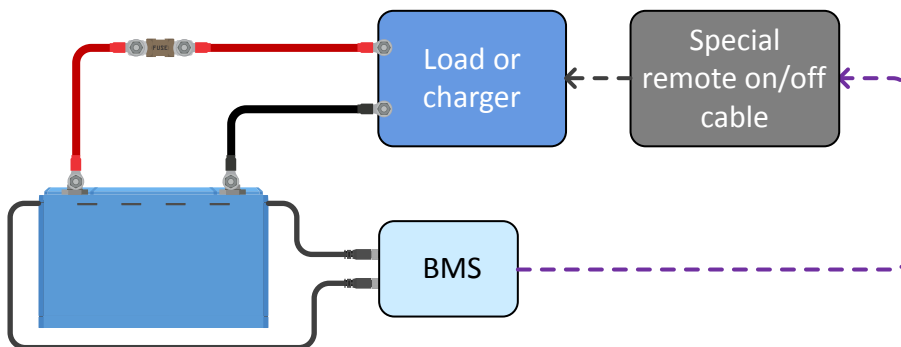
Inverter/chargers, like the MultiPlus, the MultiPlus-II or the Quattro are equipped with a VE.Bus RJ45 terminal. The VE.Bus BMS communicates directly to the inverter/charger via the VE.Bus and will turn off the inverter or the inverter/charger in case of a “load disconnect” or a “charge disconnect” event.



The BMS controls an inverter/charger directly via the VE.Bus

Direct control via a special “inverting” or “non-inverting” remote on/off cable

Not all Victron products have a remote on/off connector or the remote on/off connector might not be suitable to connect straight to the BMS. In these cases, a special “inverting” or “non-inverting” remote cable is needed, so that the BMS can turn off a product in case of a “load disconnect” or a “charge disconnect”.

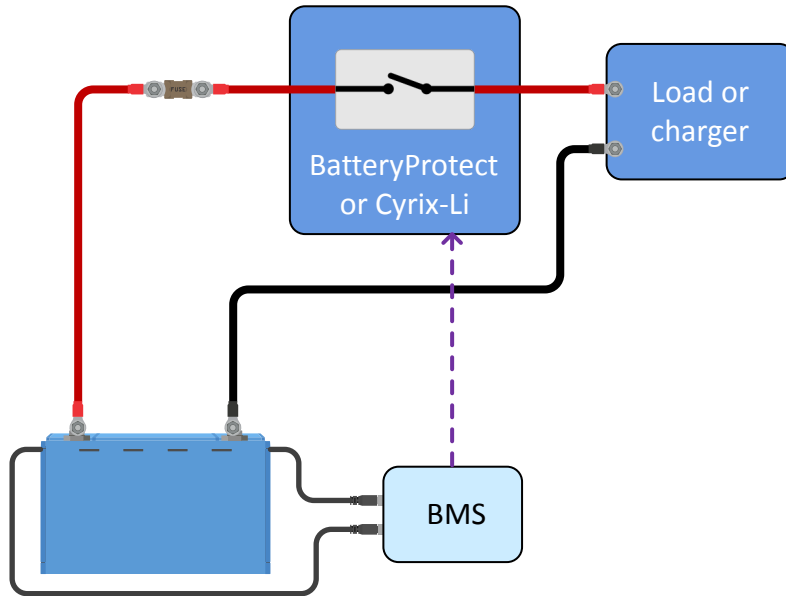


The BMS controls the remote on/off cable and the cable converts this to a signal suitable to control a load or charger

Indirect control

In case a load or a charger does not have a way of being remotely controlled, a device that can be controlled by the BMS must be connected between the battery and the load or charger. These are the options:

- The BatteryProtect is mainly used for loads, but can also be used for charge sources, but be aware that the current flow is one-directional. The BatteryProtect has a very low self-consumption while in protection mode.
- The Cyrix-Li relay is mainly used for charge sources but can also be used for loads. The current flow is bi-directional. But be aware that the Cyrix has a higher self-consumption when in protection mode than the BatteryProtect has.

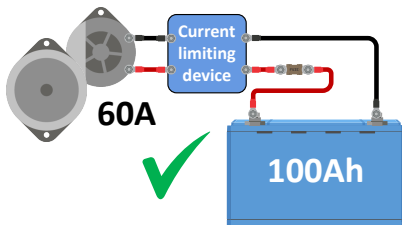
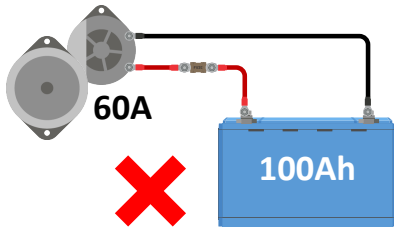
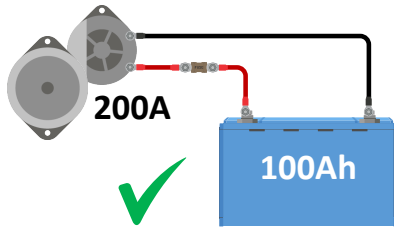


The BMS controls the BatteryProtect or Cyrix-Li, which in turn disconnects the load or charger from the battery

3.5. Charging from an alternator

Lithium batteries have a very low internal resistance and will readily accept a high charge current. Because of this, special care must be taken when lithium batteries are charged from an alternator. Most alternators are not able to limit the current going into a lithium battery and can be damaged when they are used to charge a lithium battery. To safely connect an alternator, there are two options:

- Either make sure that alternator rating is at least twice the battery rating. For example; a 400A alternator can be safely connected to a 200Ah battery.
- Or use an alternator that is equipped with a current limiting feature. If the alternator does not have a current limiting feature, a current limiting device needs to be added between the alternator and the starter battery. Possible current limiting devices that can be used in this scenario are:
 - The alternator port of a [Smart BMS CL 12/100](#).
 - The alternator port of a [BMS 12/200](#).
 - Add a [DC/DC converter or charger](#).



Alternator charging

For more information on charging lithium battery with an alternator, see the [Alternator lithium charging blog and video](#).

3.6. Battery monitoring

The battery internals (temperature & cell voltages, as well as alarms and other BTV parameters) can be monitored with the VictronConnect App. It connects to the battery via Bluetooth.

State of charge monitoring is not built into the battery or in the BMS. If state of charge monitoring is needed, an additional battery monitor such as a BMV, SmartShunt, Lynx shunt or GX device will need to be added to the system.

In case a GX device is part of the system, make sure to read the chapter: "Battery State of Charge" in the [GX device manual](#) to determine if a battery monitor is required or not.

When a battery monitoring device is used, special settings need to be made in the battery monitor to accommodate the lithium battery. This information can be found in the battery monitor manual. For more information see the [Battery monitor product page](#).

3.7. Monitoring limitations

It is not possible to connect a VE.Direct cable (or any other communication cables) to the battery. The VE.Direct to USB interface can also not be used. This also rules out the Windows version of the VictronConnect App, as the Windows version of the app does not support Bluetooth.

A GX device can also not be used to connect to the lithium battery. Although the battery has Bluetooth and the Victron GX monitoring device might also have Bluetooth, these are not compatible with each other, thus cannot communicate with each other.

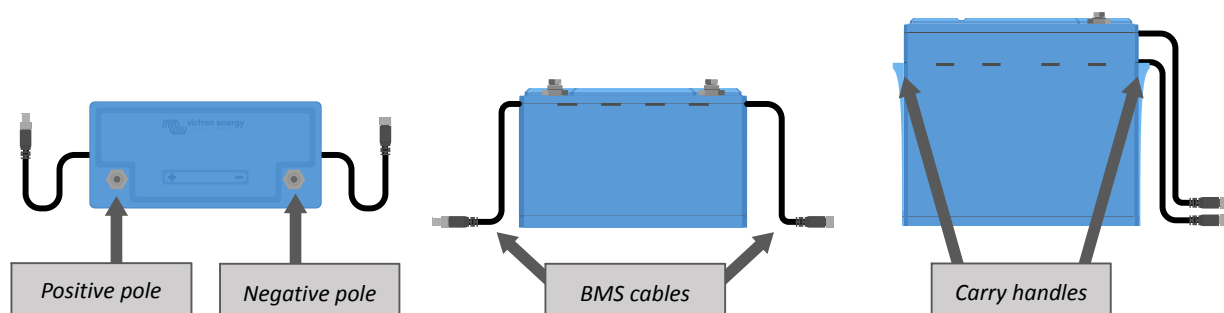
4. Installation

4.1. What's in the box

Take care when unpacking the battery. Batteries are heavy. Do not lift it by its poles or by its BMS cables. The battery has two carry handles on either side of the battery. The weight of the battery can be found in the "Technical data" chapter.

Familiarize yourself with the battery. The battery poles are located on top of the battery. The polarity of the battery poles is indicated at the top of the battery. The positive pole is indicated by a "+" symbol and the negative pole is indicated by a "-" symbol.

The battery has two BMS cables. These cables are used for communication with the BMS. One cable has a male 3-pole connector and the other has a female 3-pole connector. Depending on the battery model, the BMS cables are located on one side of the battery or on two opposite sides of the battery.



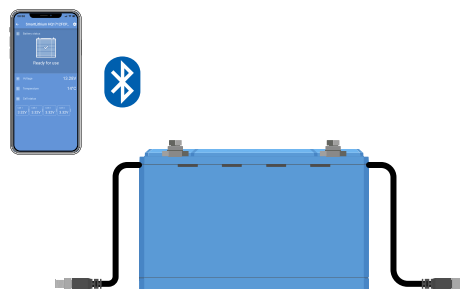
Top view battery showing battery terminals - Side view two different battery models showing BMS cables

Pay attention to the location of the BMS cables when handling the battery. The BMS cables can easily get damaged. Take care not to damage the BMS cables by lifting or moving the battery by pulling on the cables or crushing the cables by getting them stuck underneath the battery or in between two batteries.

4.2. Download and install the VictronConnect App

The VictronConnect App is needed to communicate with the battery. The app can run on an Android, iOS or macOS device. Although there also is a Windows version of the app, it is not possible to use the Windows version of the VictronConnect App for the Smart Lithium batteries, as Windows Bluetooth is not supported by the VictronConnect App.

For download location or help with the app see the [VictronConnect manual](#).





VictronConnect communicates with the battery via Bluetooth

4.3. Update the battery firmware

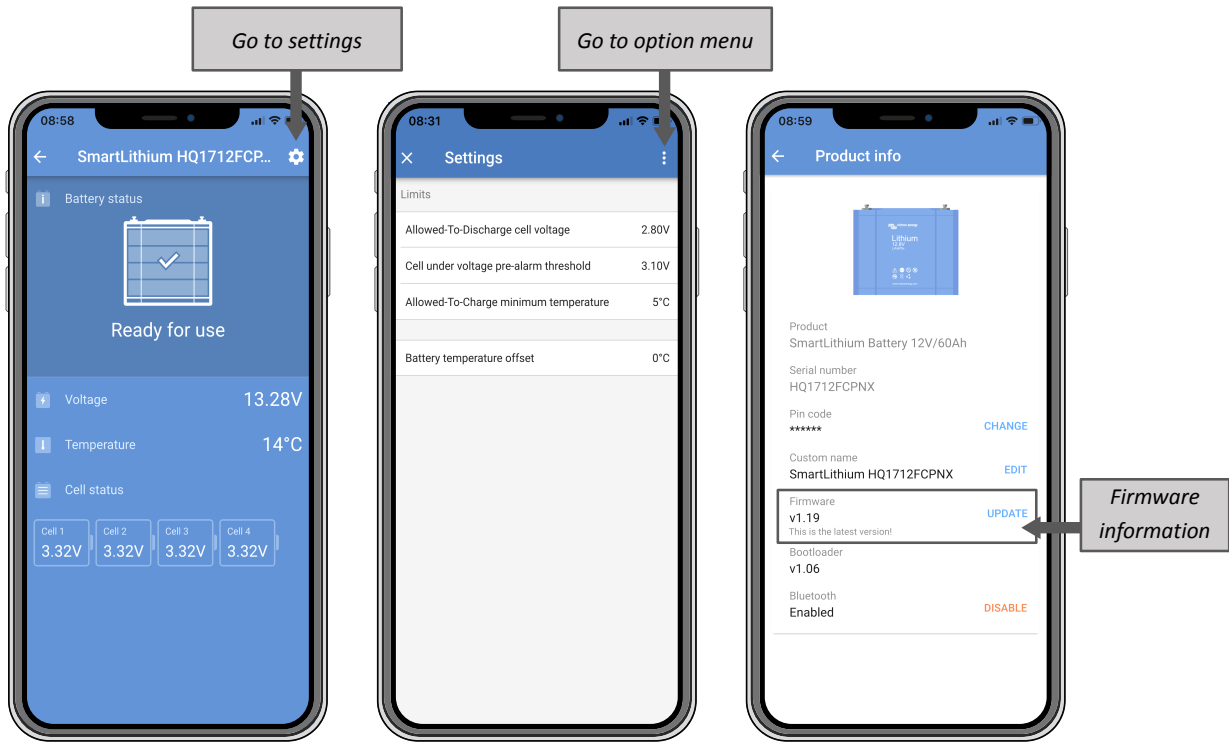
Before the battery is going to be used, it is important to check if the battery has the most up to date firmware. The firmware can be checked and updated with VictronConnect.

VictronConnect might ask on first connection to update firmware. If this is the case, let it perform a firmware update.

If it did not automatically update, check if the firmware is already up to date using the following procedure:

- Connect to the battery.
- Click on the settings symbol 
- Click the option symbol 
- Go to product info.
- Check if you are running the latest firmware and look for the text: "This is the latest version".

- If the battery does not have the most up to date firmware, perform a firmware update.



Main battery screen

Setting screen

Product info screen

4.4. Charge batteries before use



NOTE

When installing a single battery or multiple batteries in parallel, the procedure outlined in this chapter is not required.

If multiple batteries are going to be connected in series or in series/parallel, each individual battery needs to be charged before all batteries are interconnected.

Background: batteries are approximately 50% charged when shipped from the factory. This is because of transportation safety requirements. Due to differences in transportation routes and warehousing the batteries do not all have the same state of charge by the time they are installed.

And as the system is only able to correct small differences in state of charge from one battery to another, a large imbalance with newly installed batteries will not be corrected. Note that this type of imbalance, different state of charge between batteries, is different from imbalance of cells within a battery.

4.4.1. Initial charge settings



WARNING

Same as for when an already installed battery a BMS must be used.

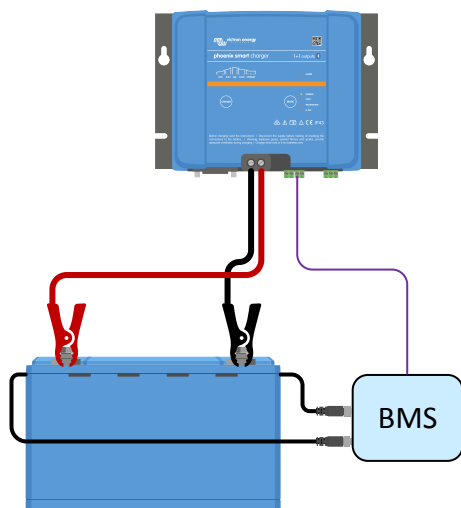
Charger or inverter/charger settings for initial charge with a BMS (same settings as for normal operation):

| Recommended charger settings | | | | | |
|------------------------------|---------------------|----------------|--------------------|-----------------|---------------|
| Battery model | Max. charge current | Charge profile | Absorption voltage | Absorption time | Float voltage |
| 12.8 V - 60 Ah | 30 A | Lithium, fixed | 14.2 V | 2h | 13.5 V |

| Recommended charger settings | | | | | |
|------------------------------|-------|----------------|--------|----|--------|
| 12.8 V - 100 Ah | 50 A | Lithium, fixed | 14.2 V | 2h | 13.5 V |
| 12.8 V - 160 Ah | 80 A | Lithium, fixed | 14.2 V | 2h | 13.5 V |
| 12.8 V - 200 Ah | 100 A | Lithium, fixed | 14.2 V | 2h | 13.5 V |
| 12.8 V - 300 Ah | 150 A | Lithium, fixed | 14.2 V | 2h | 13.5 V |
| 25.6 V - 200 Ah | 100 A | Lithium, fixed | 28.4 V | 2h | 27.0 V |

Initial charge procedure:

- Connect each individual battery to a charger or to an inverter/charger and to a BMS (and repeat for every other battery).
- Refer to the BMS manual on how to set the BMS up.
- Set the charger to the charge profile as indicated in above table.
- Ensure that the battery, the BMS and the charger are communicating with each other. Check this by disconnecting one of the BMS cables from the BMS and verify if the charger turns off. Then reconnect the BMS cable and verify that the charger turns back on.
- Turn the charger on and check that the charger is charging the battery.
- Be aware that in case of unbalance, the charger will be turned off and on by the BMS multiple times. This will manifest as follows: The charger will be on for a short period of time, then the charger will be off for a few minutes and then on again for a short time and so on. This might be repeated many times. This is nothing to be worried about. This is part of the charge process in case of unbalance and is expected behaviour. If the cells are balanced, the charger will not be turned off until the battery is fully charged. For more information about cell unbalance and charger behaviour see paragraph: "Cells out of balance".
- The process is completed when the battery is fully charged, and all cells are balanced. Use VictronConnect to check this while the charger is still in absorption! The battery voltage must be 14.2V and each cell must be 3.55V +/- 0.02V. Restart the charger in case it has already dropped to float (13.5V). Note that, depending on the level of balance when starting this procedure, it might be necessary to restart the charger multiple times. More details in the "Cells out of balance" chapter.



Initial charge with using a BMS

4.5. Mounting

The battery needs to be mounted in an upright position. The battery is only suitable for indoor use and needs to be located in a dry location.

Batteries are heavy. When moving the battery into its destined location, use suitable handling equipment for transportation.

Ensure adequate and secure mounting as the battery can become a projectile if involved in an accident.

Batteries produce a certain amount of heat when they are charged or discharged. Keep a 20mm space on each side of the battery for ventilation purposes.

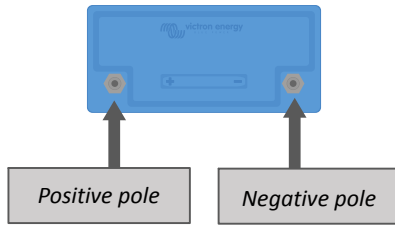
4.6. Connect the battery poles

The positive pole is indicated by a "+" symbol and the negative pole is indicated by a "-" symbol.

Observe the battery polarity when connecting the battery poles to a DC system or to other batteries. Take care not to short circuit the battery poles.

Connect the cables; place the cable's cable lug on the battery pole, place the washer, place the spring washer and then insert and tighten the bolt

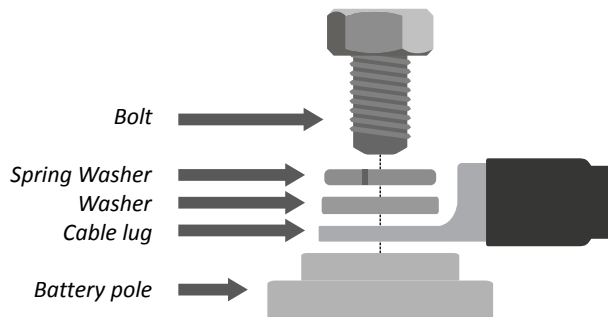
When tightening the bolt, use the correct torque and use insulated tools that match the batteries spanner size



Battery pole locations

Table 1. Battery pole connections

| Battery model | Nut size | Torque moment |
|-----------------|----------|---------------|
| 12.8 V - 60 Ah | M8 | 10Nm |
| 12.8 V - 100 Ah | M8 | 10Nm |
| 12.8 V - 160 Ah | M8 | 14Nm |
| 12.8 V - 200 Ah | M8 | 14Nm |
| 12.8 V - 300 Ah | M10 | 20Nm |
| 25.6 V - 200 Ah | M8 | 14Nm |



Battery cable connection

4.6.1. Cable cross sectional area and fuse ratings

Use battery cables with a cross sectional area that matches the currents that can be expected in the battery system.

Batteries can produce very large currents; it is therefore necessary that all electrical connections to a battery are fused.

The battery fuse rating has to match the current rating of the battery cable that has been used. Both the battery cable and the fuse have to also match the expected maximum system currents.

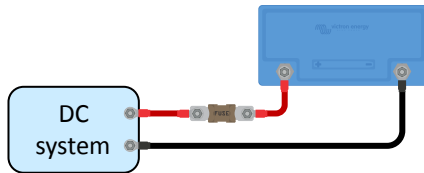
The battery maximum discharge rating is indicated in below table. The system current and therefore also the fuse rating should not exceed this current rating. The fuse has to match the lowest current rating, being the cable current rating, the battery current rating or the system current rating.

| Maximum current rating Smart Lithium batteries | |
|--|------------------------|
| Battery model | Maximum current rating |
| 12.8 V - 60 Ah | 120 A |
| 12.8 V - 100 Ah | 200 A |
| 12.8 V - 160 Ah | 320 A |
| 12.8 V - 200 Ah | 400 A |
| 12.8 V - 300 Ah | 600 A |
| 25.6 V - 200 Ah | 400 A |

For more information on cable cross sectional area, fuse types and fuse ratings see the [Wiring Unlimited book](#).

4.6.2. Connecting a single battery

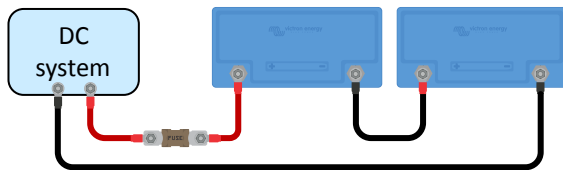
- Fuse the battery on the positive side.
- Single battery Connect the battery to the DC system.



Single battery

4.6.3. Connecting multiple batteries in series

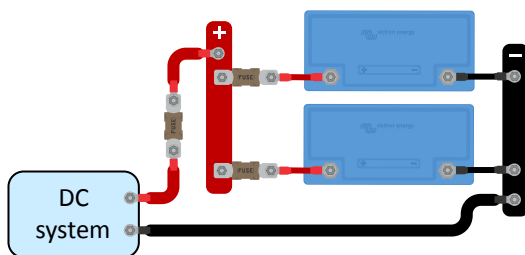
- All batteries need to be the same model and age.
- Each battery needs to have been fully charged individually.
- Connect a maximum of four 12.8V batteries or a maximum of two 25.6V batteries in series.
- Connect the negative to the positive of the next battery. Fuse the series string on the positive side.
- Connect the battery bank to the system.



Multiple batteries in series

4.6.4. Connecting multiple batteries in parallel

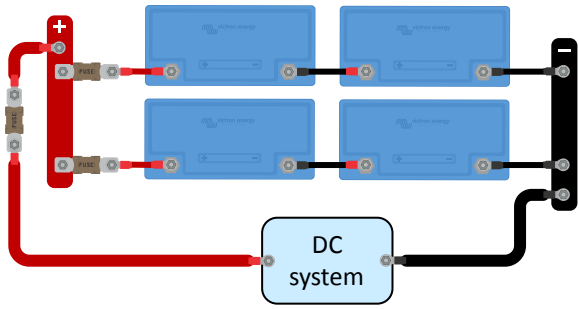
- All batteries need to be the same model and age.
- Connect a maximum of 5 batteries.
- Fuse each battery on the positive side.
- Connect the system cables diagonally to ensure an equal current path through each battery.
- Take care that cross-sectional area of the system cable is equal to the cross-sectional area of the string cable times the number of strings.
- Fuse the positive main cable going to the battery bank.
- Multiple batteries in parallel Connect the battery bank to the system.
- For more information on how to construct a parallel battery bank see the [Wiring Unlimited book](#).



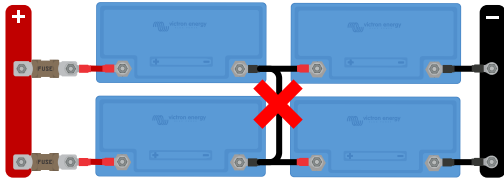
Multiple batteries in parallel

Connecting multiple batteries in series/parallel

- All batteries need to be the same model and age.
- Connect a maximum of 5 batteries or battery series strings in parallel.
- Each battery needs to have been fully charged individually.
- Fuse each series string on the positive side.
- Multiple batteries in series/parallel Connect the system cables diagonally to ensure an equal current path through each battery string.
- Take care that cross-sectional area of the system cable is equal to the cross-sectional area of the string cable times the number of strings.
- Do not interconnect the intermediate battery to battery connections of two or more battery series strings.
- Fuse the positive main cable going to the battery bank.
- Connect the battery bank to the system.
- Do not interconnect midpoints or other between string points For more information on how to construct a series/parallel battery bank see the [Wiring Unlimited book](#).



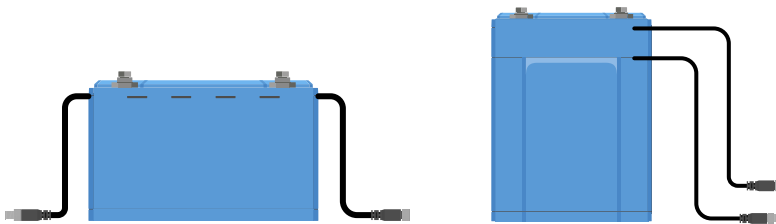
Multiple batteries in series/parallel



Do not interconnect midpoints or other between string points

4.7. Connect the BMS

Each battery has two BMS cables. Depending on the battery model, the BMS cables are located on either side or on one side of the battery.



BMS cables on either side

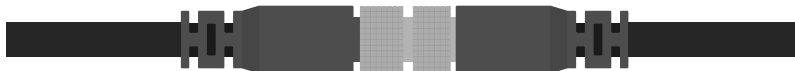
BMS cables on one side

One of the cables has a female 3-pole connector and the other cable has a male 3-pole connector. The BMS also has the same male and female connectors.



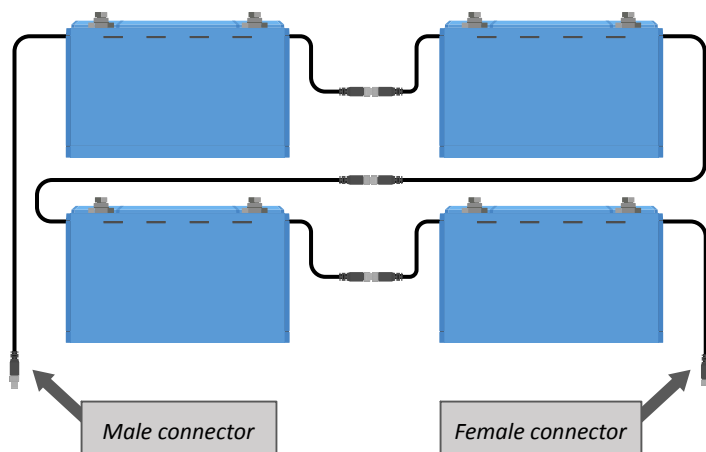
Female BMS cable connector

Male BMS cable connector



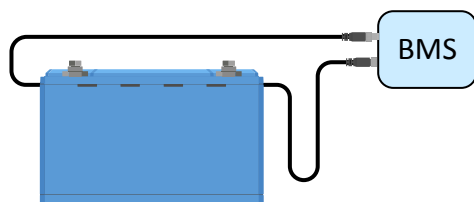
Connected male and female BMS cable connector

If multiple batteries are used, the BMS cables of the batteries need to be interconnected (daisy chained). The batteries can be interconnected in any order.

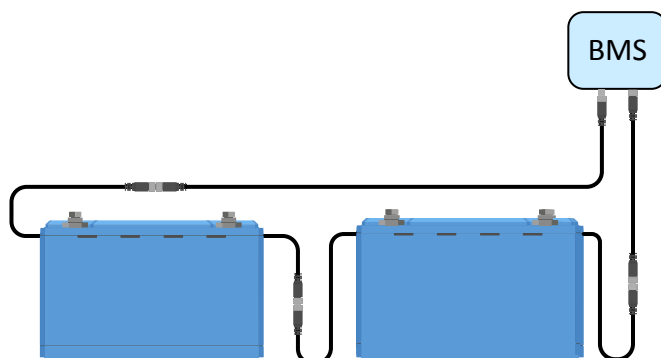


Interconnecting BMS cables

Connect the BMS. In case of a single battery, connect both BMS cables to the BMS and in case of multiple batteries connect the first and last BMS cable to the BMS.



Single battery BMS connection



Multiple battery BMS connection with extension cables

If the BMS is too far away for the cables to reach, use the optional extension cables. The BMS extension cables are available as a pair and come in a variety of lengths. For more information see the [BMS extension cable product page](#).



BMS extension cable

4.8. Battery settings

The default settings in the Smart Lithium battery are suitable for almost all applications. There is no need to change these settings unless the application requires very specific conditions.

If settings need to be changed use the VictronConnect App. To access the settings, click on the settings symbol .

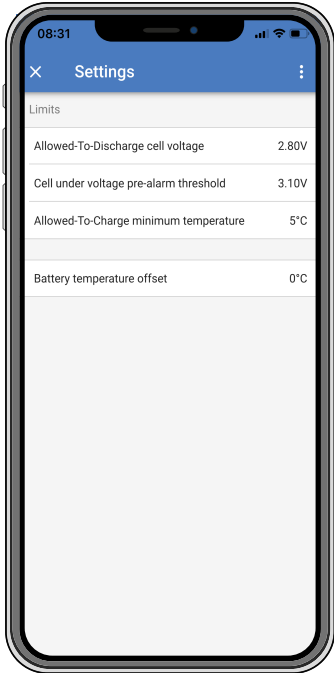
4.8.1. Allowed-To-Discharge cell voltage

This is the lowest battery cell voltage, at which discharging the battery is disallowed. A lithium battery cell will be damaged if the voltage drops too far. As soon as one of the cells reaches this voltage, the BMS will disable all loads by sending a signal to the load or to the load disconnection device. Keep this setting at the default 2.80V value.

The only scenario where a lower setting might be applicable is in emergency systems where it could be a requirement to discharge the battery as far as possible and therefore sacrificing part of the battery's overall lifetime.

Be aware that, if a lower value is selected, the battery needs to be recharged earlier after a low voltage shutdown to prevent a further permanent reduction of battery lifetime.

The default value is 2.80V, the range is 2.60V to 2.80V.



4.8.2. Cell under voltage pre-alarm threshold

When the cell voltage drops below this threshold, the pre-alarm signal is sent to the BMS. The purpose of the pre-alarm is to warn the user that the system is about to shut down due to undervoltage. For more details see chapter: "System design".

The default value is 3.10 V and the range is 2.80 V to 3.15 V.

4.8.3. Allowed-To-Charge minimum temperature

This setting defines the lowest temperature at which the BMS allows battery charging. A lithium battery cell will sustain permanent damage when it is charged at temperatures below 5°C.

The default value is 5°C and the range is -20°C to +20°C.



WARNING

Setting this temperature below 5°C will void the warranty.

4.8.4. Battery temperature offset

This setting can be used to set an offset to improve the accuracy of the battery temperature measurement.

The default value is 0°C and the range is -10°C to +10°C.

4.9. Charger settings

Set all charge sources to the following charge parameters:

| Recommended charger settings | | | | | | | |
|------------------------------|----------------------------|------------------------|----------------|-----------------------|------------------|---------------|-------------------|
| Battery model | Recommended charge current | Maximum charge current | Charge profile | Absorption voltage | Absorption time* | Float voltage | Storage voltage** |
| 12.8 V - 60 Ah | 30 A | 100 A | Lithium, fixed | Between 14.0V – 14.4V | 2h | 13.5 V | 13.5 V |
| 12.8 V - 100 Ah | 50 A | 200 A | Lithium, fixed | Between 14.0V – 14.4V | 2h | 13.5 V | 13.5 V |

| Recommended charger settings | | | | | | | |
|------------------------------|-------|-------|----------------|--------------------------|----|--------|--------|
| 12.8 V - 160 Ah | 80 A | 320 A | Lithium, fixed | Between 14.0V – 14.4V | 2h | 13.5 V | 13.5 V |
| 12.8 V - 200 Ah | 100 A | 400 A | Lithium, fixed | Between 14.0V – 14.4V | 2h | 13.5 V | 13.5 V |
| 12.8 V - 300 Ah | 150 A | 600 A | Lithium, fixed | Between 14.0V – 14.4V | 2h | 13.5 V | 13.5 V |
| 25.6 V - 200 Ah | 100 A | 400 A | Lithium, fixed | Between 28.0V – 28.8V | 2h | 27.0 V | 27.0 V |

* Absorption time: 2 hours for a 100% charge, or a few minutes for a 98% charge.

** Storage stage is not per se needed for a lithium battery, but if the charger has a storage mode, set it at the same as the float voltage.

5. Commissioning

Once all connections have been made, the system wiring needs to be checked, the system needs to be powered up and the BMS functionality needs to be checked. This is how to do this:

- Check polarity of all battery cables.
- Check cross sectional area of all battery cables.
- Check if all battery cable lugs have been crimped correctly.
- Check if all battery cable connections are tight (don't exceed maximum torque).
- Tug slightly on each battery cable and see if the connections are tight.
- Check all BMS cable connections and make sure the connector screw rings are screwed all the way down.
- Connect with VictronConnect to each battery.
- Check if each battery has the most up to date firmware.
- Check if each battery has the same settings.
- Connect the system positive and negative DC cable to the battery (or battery bank).
- Check the string fuse(s) rating (if applicable).
- Place the string fuse(s) (if applicable).
- Check the main fuse rating.
- Place the main fuse.
- Check if all battery charge sources have been set to the correct charge settings.
- Turn on all battery chargers and all loads.
- Check if the BMS is powered up.
- Disconnect a random BMS cable and verify that the BMS is turning off all charge sources and all loads.
- Reconnect the BMS cable and check if all charge sources and loads turn back on.

6. Operation

Once in operation, it is important to take proper care of the battery to maximise its lifetime.

These are the basic guidelines:

- Prevent total battery discharge at all times.
- Familiarize yourself with the pre-alarm feature and act when pre-alarm is active to prevent a DC system shutdown.
- If the pre-alarm is active, or if the BMS has disabled the loads, make sure that the batteries are recharged as soon as possible. Minimise the time the batteries spend in a far discharged state as much as possible.
- The batteries need to spend at least 2 hours in absorption charge mode each month to ensure sufficient time in balancing mode.
- When leaving the system unattended for some time, make sure to either keep the batteries charged during that time, or make sure the batteries are almost full and then disconnect the DC system from the battery.

6.1. Monitoring

VictronConnect App can be used to monitor the battery via Bluetooth.

VictronConnect will show the voltage of each cell, the battery temperature and if there are active voltage and/or temperature alarms. Alarm messages can only be seen or received when VictronConnect is actively connected to the battery and the phone is actively showing the Smart lithium screen. The app is not active in the background or when the screen is off.



VictronConnect

This manual describes the Lithium Smart related functionality of VictronConnect. For more general information, we recommend to read the [VictronConnect manual](#).

6.2. Warnings and alarms

These are the possible warnings and alarms that can be generated by the battery:

Cell under voltage warning

The voltage of one or more cells is becoming too low and discharging has been disabled. To remedy this warning, recharge the battery as soon as possible.

Under voltage alarm

This alarm is generated when the battery has been deeply discharged and discharging has been disabled. To remedy this alarm, recharge the battery as soon as possible.



Under voltage alarm

Over voltage alarm

The voltage of the battery has become too high. Immediately disable all chargers and contact the system installer to check that all chargers are properly controlled by the “charge disconnect” contact on the BMS. When properly controlled, a high voltage situation is not possible, as the BMS disconnects all chargers well before raising the high voltage alarm.

Under temperature alarm

The battery has reached its low temperature threshold and charging is disabled.

Over temperature alarm

The battery has reached its high temperature threshold and charging is disabled.

Settings data is corrupt

To remedy this, go to the settings page and reset settings to factory defaults. This will also reset the Bluetooth bonding information and as such the product must be removed from the Bluetooth paired devices list in order to connect again. For more details see the [VictronConnect manual](#).

Please contact your Victron representative and ask him to escalate this to Victron Energy, as this error should never happen. Please include battery serial number and firmware version.

Hardware failure alarm

This alarm is generated when hardware has failed in the Battery. Contact your dealer or distributor to resolve this situation.

Other alert and errors

In case of any of these alerts or errors, contact your dealer or distributor to resolve this situation:

- Balancer failure
- Internal communication failure
- Cell 2 voltage error
- Cell 3 voltage error
- Balancer 1 update error
- Balancer 2 update error
- Balancer 3 update error

7. Battery charging and discharging

This chapter describes the charging, discharging and cell balancing process in more detail for those who are interested in the technical background.

7.1. Charging

Lithium batteries are easier to charge than lead-acid batteries. The charge voltage may vary anywhere from 14V to 15V for a 12.8V lithium battery and 28V to 30V for a 25.6V lithium battery, as long as no cell is subjected to more than 4.2V. Lithium batteries will become permanent damaged if they are over-charged.

Should a cell reach 4.2V, impossible on a properly installed system, all charge into that cell will be dissipated as heat.

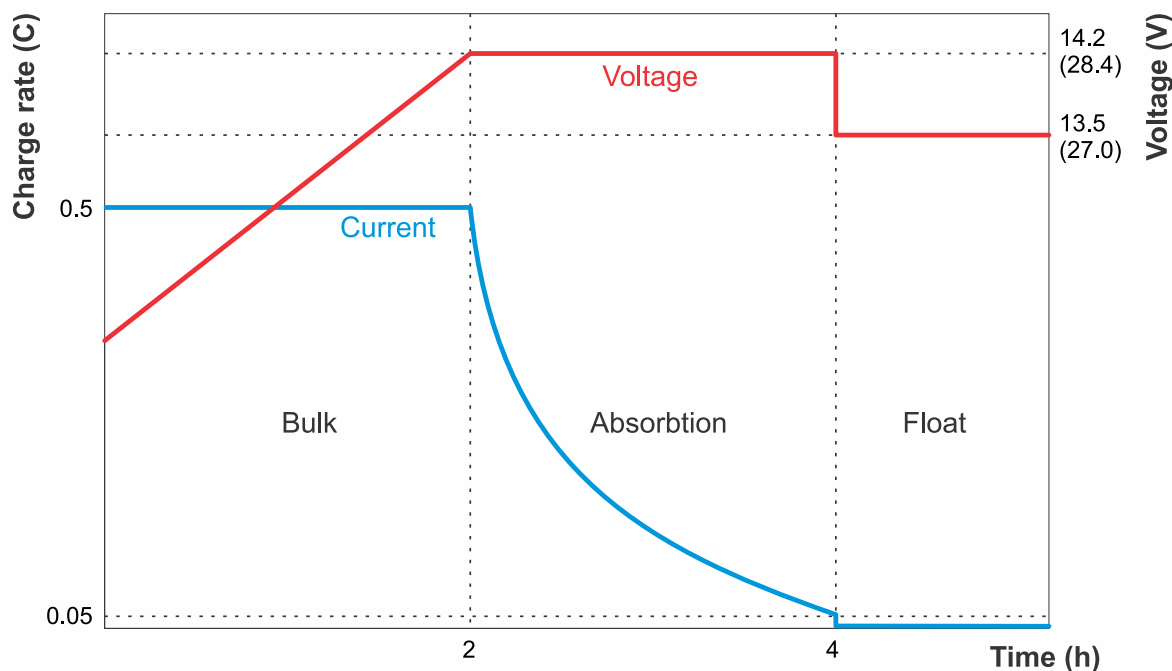
We advise to keep the absorption charge voltage between 14V (28V) and 14.4V (28.8) and the float voltage at 13.5V (27V).

Because of the flexibility in charge voltages, up to 5 batteries can be connected in parallel without much problems. No damage will occur if there are small differences in individual battery voltages because of varying cable resistances or internal battery resistances.

Once the absorption stage has been finalized, the battery charger goes into float. We recommend setting the float voltage at 13.5V (27.0V).

The storage stage is not per se needed for a lithium battery, but if the charger has a storage mode, set the storage voltage at the same value as the float voltage.

We recommend a charge current of 0.5C. This means that if the battery is completely empty, it will take 2 hours to charge the battery. A charge rate of 0.5C for a 100Ah battery is 50A charge current. The maximum charge current is 2C, for a 100Ah battery this is 200A. This will charge the battery in half an hour. But be aware that the batteries will produce more heat when high charge currents are used. More ventilation space is needed around the batteries and depending on the installation, hot air extraction or forced air cooling might be needed.



Lithium battery charge graph

The BMS will turn off all charge sources as soon as a battery cell voltage reaches 3.75V or if the battery temperature drops below 5°C or increases above 75°C. This means that all charge sources that are connected to the lithium battery need the ability to be controlled by the BMS.

7.2. Cell balancing

The lithium battery consists of four lithium cells that are connected in series for the 12.8V battery, and eight cells in series for the 25.6V battery

Though carefully selected during the production process, the cells in the battery are not 100% identical. Therefore, when cycled, some cells will be charged or discharged earlier than the other cells. The differences will increase over time if the cells are not regularly balanced.

The same happens in a lead-acid battery, but that self-corrects without the need for electronics: a small current will continue to flow even after one or more cells are fully charged. This current helps to fully charge the other cells that are lagging behind, thus equalizing the charge state of all cells. The current through a lithium cell however, when fully charged, is almost zero, and lagging cells will not be charged further.

Cells will not get damaged if they have different balance levels, but rather the imbalance will manifest itself in a (temporary) reduced battery capacity.

To keep all cells in balance, the Smart lithium batteries have built-in active cell balancing. Each cell is equipped with monitoring and cell balancing electronics. The lithium battery measures the voltage of each cell and, when required, moves energy from the cell(s) with the highest voltage to the cells with a lower voltage. It will keep doing this until the voltage difference between the cells is below 0.01V. This process is called active balancing.

At what voltage the balancing starts depends on the imbalance. In case of significant cell imbalance, the cell balancing process starts as soon as the first cell reaches 3.3V during charge. The cell balancing continues while the battery is being charged further. And, due to the flat voltage curve of lithium chemistry, cell voltages need to be 3.50V or higher to correct smaller differences in balance.

Above explanation is the reason why a 2-hour fixed absorption period is recommended for lithium batteries: that is to allow the electronics to equalise all the cells. During absorption, the voltage is 14.2V, equalling 3.55V per cell in case of a fully balanced battery.

It is important to regularly fully charge the battery (once a month).

If the system is intensively used and has charge/discharge cycles each day or a few times per week, or the system is deeply discharged, more absorption (cell balancing) time per month is needed.

Please note that a higher charge voltage will not speed up the cell balancing process. Battery cells are charged by current and not by voltage. Feeding current into a cell will cause the voltage to increase over time, but this is a fixed process and applying more voltage will not speed this process up. In addition to this, the speed of balancing is determined by the maximum rated power of the active and passive balancing circuits and not by charge voltage.

There are some applications in where the battery cells will become quicker unbalanced than usual. In these cases, a weekly full charge needs to be performed:

- Systems with series connected batteries
- Systems with high discharge currents
- Systems with short charge periods or low charge voltages

7.3. Discharging

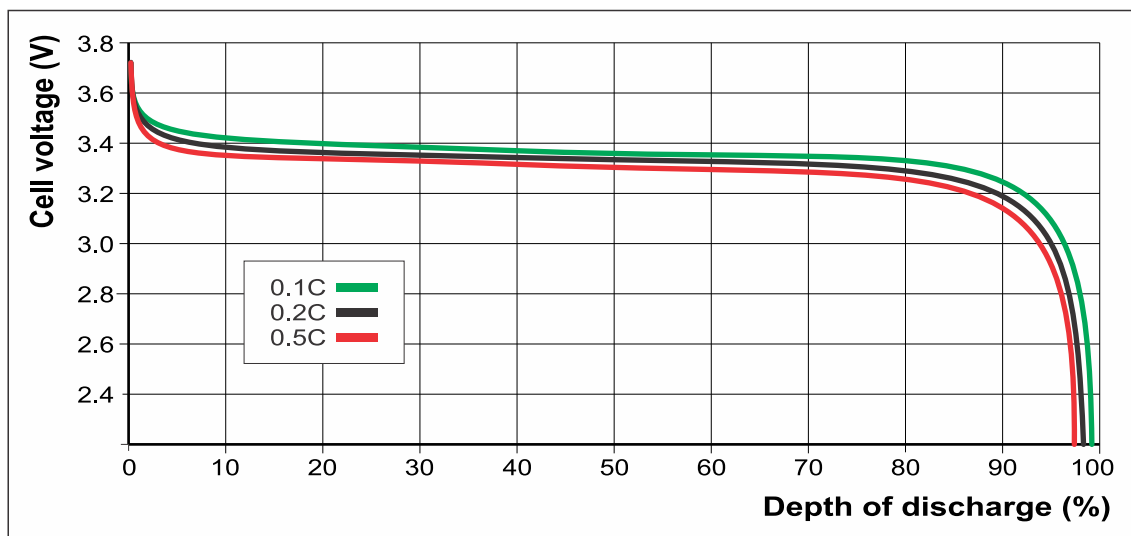
Nearly the whole available battery capacity can be used, with exception of the approximate last 3% of remaining capacity. Lithium batteries will become permanently damaged if they are discharged too deeply.

Lithium batteries can be discharged with high currents. The maximum discharge of the lithium battery is 2C. For a 100Ah battery this means a 200A discharge current. This current will discharge the battery in half an hour. However, we recommend not to discharge above a 1C rate. A 1C rate means that the battery is discharged in 1 hour. For a 100Ah battery this is a discharge current of 100A.

When using a higher discharge rate, the battery will produce more heat than when a low discharge rate is used. More ventilation space is needed around the batteries and depending on the installation, hot air extraction or forced air cooling might be needed. Also, some cells might reach the low voltage threshold quicker than the other cells. This can be because of a combination of heat and ageing.

To be able to tell if a battery is too deeply discharged you will need to look at the individual cell voltages. As the battery is being discharged, the cell voltage drops. This is indicated in below discharge graph. When the battery is almost empty, the voltage will drop faster. This is the sign that the battery is almost empty. This happens at around a cell voltage of 2.80V to 2.60V. Further discharge needs to be prevented, otherwise the battery will get damaged. So as soon as one of the cells has reached this voltage the BMS will disable all DC loads.

The under voltage shutdown threshold is configurable, if it is set to a higher voltage the reserve capacity is greater than if it is set at a lower voltage. It is set by default at 2.8V and the range is 2.6V to 2.8V.



Discharge graph showing cell voltage at various depths of discharge for different discharge rates

The BMS will turn off all loads as soon as a battery cell voltage drops below the low voltage threshold.

Although a BMS is used, there are still a few possible scenarios where the battery can be damaged due to over discharge. This can occur if small loads, such as: alarm systems, relays, standby current of certain loads, back current drain of battery chargers or charge regulators, slowly discharge the battery when the system is not in use.

In case of any doubt about possible residual current draw, isolate the battery when the system is not in use. Do this by opening the battery switch, by pulling the battery fuse(s) or by disconnecting the battery positive cable.

A residual discharge current is especially dangerous if the system has been discharged completely and a low cell voltage shutdown has occurred. At 2.8V cell voltage there is approximately 3% remaining capacity and at 2.6V there is about 1% remaining capacity.

After shutdown due to low cell voltage, a capacity reserve of 1% corresponds with 1Ah left in a 100Ah capacity battery. The battery will be damaged if the remaining capacity reserve is drawn from the battery. A residual current of 10mA for example may damage a 100Ah battery if the system is left in discharged state during more than 4 days (100 hours).

If all cells are 2.8V, this means that the battery terminal voltage is 11.2V (22.4V) and if all cells are 2.6V the battery terminal voltage is 10.4V (20.8V). Be aware that the BMS will turn the loads off as soon as one cell drops below the low voltage threshold. This might not necessarily correspond with the battery terminal voltage. So, if investigating low voltage scenarios, always use VictronConnect to look at the actual cell voltages and do not just rely on the battery terminal voltage.

7.4. Cell under voltage pre-alarm

The battery sends a signal to the BMS in case of imminent cell under voltage. This is used by the BMS to generate a pre-alarm signal. This signal will give an advanced warning that the BMS is about to generate a "load disconnect" signal and that the loads are going to be turned off. This happens at a default cell voltage of 3.10V and the range is 2.80V to 3.15V.

Please note that older batteries do not support pre-alarm.

8. Troubleshooting, support and warranty

Consult this chapter in case of unexpected battery behaviour or if you suspect a battery fault.

The troubleshooting and support process is to first consult the common battery issues as described in this chapter. Should this fail to resolve the issue, follow the advice in the technical support paragraph.

8.1. VictronConnect issues


Cannot connect with the VictronConnect App

It is highly unlikely that the Bluetooth interface in the battery is faulty. These are some pointers to try before seeking support:

- Is the battery a Smart Lithium battery? The older non-Smart Lithium batteries do not support Bluetooth.
- Is the battery voltage still high enough? The batteries Bluetooth module is turned off as a precaution as soon as the battery terminal voltage drops below 8V or when one of the cells drop below 2V. The Bluetooth module will power up again once the battery is charged. When recharging the battery after a low voltage event, use the low voltage charge procedure as described in paragraph: "Battery very low terminal voltage".
- Is there already another phone or tablet connected to the battery? Only one phone or tablet can be connected to the battery at any given time. Make sure no other devices are connected and try again.
- Are you close enough to the battery? In open space the maximum distance is about 20 meters.
- Are you using the Windows version of the VictronConnect App? The Windows version cannot use Bluetooth. Use an Android, iOS or macOS device instead.
- Has Bluetooth been disabled in the VictronConnect battery settings? **IMPORTANT:** Disabling Bluetooth is an irreversible process. Once Bluetooth has been disabled, it can never be re-enabled.
- Does VictronConnect have an issue? Try to connect to another Victron product, does this work? If that also does not work, then there probably is an issue with the phone or tablet. Refer to the troubleshooting section of the [VictronConnect manual](#).

Pin code lost

If you have lost the PIN code, you will need to reset the PIN code to its default PIN code. This is done in the VictronConnect App.

- Navigate to the device list of the VictronConnect App. Click on the option symbol  next to the Smart Lithium battery listing.
- A new window will open which allows you to reset the PIN code back to its default: 000000.
- Enter the batteries unique PUK code as printed on the product information sticker on the back of the battery.
- More information and specific instructions can be found in the [VictronConnect manual](#).

Interrupted firmware update

This is recoverable, just try to update the firmware again.

8.2. Battery issues

8.2.1. Cells out of balance

Imbalance between the cells reduces the usable capacity of a battery. It does not cause permanent battery life reduction.

There are a number of reasons that can cause cell imbalance:

- The battery has not spent enough time in the absorption charge stage. A certain amount of imbalance will always arise, due to differences in self-discharge between cells as well as difference in internal resistance. These are corrected during the absorption charge stage: battery voltage above 14V, cell voltage above 3.5V by the balancing circuitry. A minimum of 2 hours, for a lightly operated system such as in a back-up application, up to 4 or 8 hours a month for a daily fully cycled system.
- The battery is old and near its maximum cycle life.
- The battery has been too far discharged and one or more cells in the battery have been damaged. This is not covered by warranty and also be aware that this might not be recoverable.

How to recognise cell imbalance

The indication of imbalance is that the BMS frequently disables the charger. On a well-balanced battery the charger would not be disabled – not even once the batteries are fully charged.

More details can be seen with the VictronConnect App. Be aware that checking the cell balance can be done only near the end of a charge cycle. It's best to wait for the battery voltage to reach 14.2V, and then check the individual cell voltages. They should all be between 3.50 and 3.60V. And over time they will all become equal at 3.55V. By that time the battery will be completely charged and balanced.

In case the charger is already in its float cycle, and because of that, the voltage has dropped to 13.5V (27V), restart the charger to lift the battery voltage back up to 14.2V (28.4V).

The screenshot below shows a fully balanced battery. Note the two above explained indications: (a) the battery voltage is 14.2V, meaning that it is OK to now check the balance, and (b) the cell voltages are each exactly one fourth of that value: 3.55V and are all equal.



A balanced battery

How to re-balance a battery

To re-balance, fully charge the battery once more. The balancing occurs at the end of the charge cycle. This is when the charger is in the “fixed” 2-hour length absorption stage.

Once all cells show 3.55V, the battery is properly balanced again.

Restart the charger in case the charger already finishes its absorption stage before the cell balance is restored.

8.2.2. Less capacity than expected

If the battery capacity is less than its rated capacity these are the possible reasons for that:

- The battery has a cell imbalance, causing premature low voltage alarms, which in turn cause the BMS to turn loads off. Please refer to paragraph “Charge battery before use”.
- The battery is old and is near its maximum cycle life. Check how long the system has been in operation, check how many cycles the battery has gone through and to what average depth of discharge the battery has been discharged? A way to find this information is to look at the history of a battery monitor (if available).
- The battery has been too far discharged and one or more cells in the battery are permanently damaged. These bad cells will have a low cell voltage faster than the other cells and this will cause the BMS to turn loads off prematurely. Has the battery perhaps been through a very deep discharge event?

8.2.3. Battery very low terminal voltage

If the battery has been discharged too far, the voltage will fall well below 12V (24V). If the battery has a voltage of less than 10V (20V) or if one of the battery cells has a cell voltage below 2.5V, the battery will have permanent damage. This will invalidate the warranty. The lower the battery or cell voltage is, the bigger the damage to the battery will be.

If the voltage has dropped below 8V, the battery will not communicate via Bluetooth anymore. The Bluetooth module is turned off when the battery terminal voltage drops below 8V or if a cell voltage drops below 2V.

You can try to recover the battery by using the below low voltage recharge procedure. Be aware that this is not a guaranteed process, recovery might be unsuccessful and there is a realistic chance that the battery has permanent cell damage resulting in a moderate to severe capacity loss after the battery has been recovered.

Charge procedure for recovery after low voltage event:

This recovery charge procedure is performed on an individual battery. If the system contains multiple batteries, repeat this procedure for each individual battery.

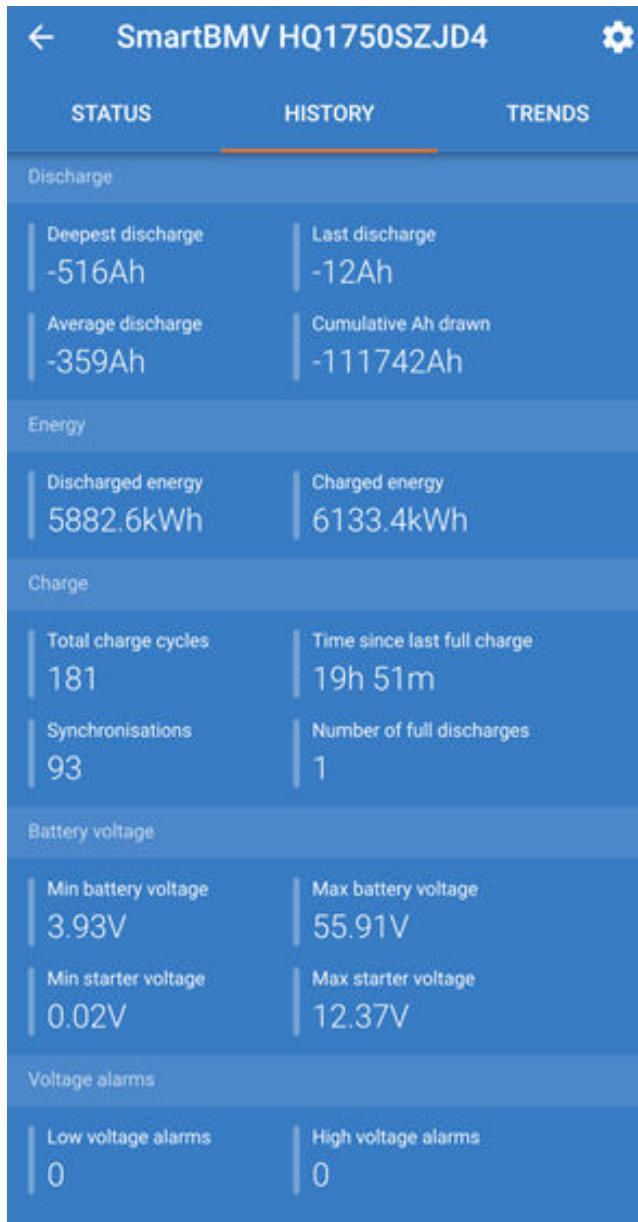
**WARNING**

This process can be risky. A supervisor must be present at all times.

- Set a charger or power supply to 13.8V (27.6V).
- In case any of the cell voltages is below 2.0V, charge the battery with 0.1A until the voltage of the lowest cell increases to 2.5V. A supervisor must monitor the battery and stop the charger as soon as the battery is getting hot or is bulging. If this is the case the battery is unrecoverable damaged.
- Once the voltage of the lowest cell has increased above 2.5V, increase the charge current to 0.1C. For a 100Ah battery this is a charge current of 10A.
- Connect the battery to a BMS and ensure that the BMS has control over the battery charger.
- Make note of the initial battery terminal voltage and battery cell voltages.
- Start the charger.
- The BMS might turn the charger off, then on again for a short time and then off again. This can occur many times over and is normal behaviour in case there is a significant cell imbalance.
- Make note of the voltages at regular intervals.
- The cell voltages should increase during the first part of the charge process. If the voltage of any of the cells does not increase in the first half hour, consider the battery as unrecoverable and abort the charge procedure.
- Check the battery temperature at regular intervals. If you see a sharp increase of temperature, consider the battery as unrecoverable and abort the charge procedure.
- Once the battery has reached 13.8V (27.6) increase the charge voltage to 14.2V (28.4V) and increase the charge current to 0.5C. For a 100Ah battery this is a charge current of 50A.
- The cell voltages will increase more slowly, this is normal during the middle part of the charge process.
- Leave the charger connected for 6 hours.
- Check the cell voltages, they should all be within 0.1V of each other. If one or more cells has a much bigger voltage difference, consider the battery as damaged.
- Let the battery rest for a few hours.
- Check the voltage of the battery. It should comfortably sit above 12.8V (25.6V) like 13.2V (26.4V) or higher. And the cell voltages should still be within 0.1V of each other.
- Let the battery rest for 24 hours.
- Measure the voltages again. If the battery voltage is below 12.8V (25.6V) or if there is a noticeable cell imbalance, the battery is unrecoverable damaged.

8.2.4. Battery is close to end of cycle life or battery has been misused

It is hard to tell what has happened to the battery. But there are a few ways to get around this. You can check the battery settings in VictronConnect and check if the BMS is functional. You can also check the system voltages and cycle history in case there is a battery monitor in the system, or if the system is connected to VRM.



VictronConnect BMV history

To check if the battery is close to its cycle life:

- Find out how many charge-discharge cycles the battery has been subjected to? Battery lifetime is correlated to the number of cycles.
- How deep has the battery been discharged on average? The battery will last for less cycles if deeply discharged, compared to more cycles if discharged less deep.
- For more info on the life cycle see chapter: "Technical data".

To check if the battery has been misused:

- Is the BMS connected and functional? Not using the battery with a Victron Energy approved BMS voids the warranty.
- Is there mechanical damage to the battery, its terminals or the BMS cables. Mechanical damage voids the warranty.
- Has the battery been mounted upright? The battery can only be used in an upright position.
- Check the "allowed to charge minimum temperature" setting in VictronConnect? Also check if the battery temperature offset has not been set to an unrealistic value. Charging the battery below 5°C voids the warranty.
- Is the battery wet? The battery is not waterproof and is not suitable for outdoor use.
- Is there an indication that the battery has been totally discharged? Look at the battery monitor settings or VRM. Inspect the deepest discharge, minimum battery voltage and number of full discharge in the battery monitor. Total and very deep discharge voids the warranty.
- Is there an indication the battery has been charged with too high voltage? check the maximum battery voltage and the high voltage alarms in the battery monitor.

8.3. BMS issues

8.3.1. The BMS frequently disables the battery charger

A well-balanced battery does not disable the charger, even when the batteries are fully charged. But when the BMS frequently disables the charger, this is an indication of cell imbalance.

In case of moderate or large cell imbalance it is an expected behaviour that BMS frequently disables the battery charger. This is the mechanism behind this behaviour:

As soon as one cell reaches 3.75V the BMS disables the charger. Whilst the charger is disabled the cell balancing process still continues, moving energy from the highest cell into adjacent cells. The highest cell voltage will drop, and once it has fallen below 3.6V the charger will be enabled again. This cycling typically takes between one and three minutes. The voltage of the highest cell will rise again quickly (this can be in a matter of seconds) after which, the charger will be disabled again, and so forth. This does not indicate a problem with the battery or the cells. It will continue with this behaviour until all cells are fully charged and balanced. This process might take several hours. It depends on the level of imbalance. In case of serious imbalance this process can take up to 12 hours. Balancing will continue throughout this process and balancing even takes place when the charger is disabled. The continued enabling and disabling of the charger can appear strange but rest assured that there is no problem. The BMS is merely protecting the cells from over voltage.

8.3.2. The BMS is prematurely turning chargers off

This could be because of a cell imbalance. One cell in the battery has a cell voltage above 3.75V. Check the cell voltages of all the batteries that are connected to the BMS.

8.3.3. The BMS is prematurely turning loads off

This could be because of a cell imbalance. One cell has a cell voltage below 2.6V. Check the cell voltages with VictronConnect of all the batteries connected to the BMS. Once the loads have been turned off due to low cell voltage, the cell voltage of all cells need to be 3.2V or higher before the BMS will turn the loads back on.

8.3.4. The pre-alarm setting is missing in VictronConnect

Pre-alarm is only available if the battery supports it. The current battery models all support it, but older batteries do not have the hardware necessary for the pre-alarm feature.

8.3.5. BMS is displaying alarm while all cell voltages are within range

A possible cause is a loose or damaged BMS cable or connector. Check all BMS cables and their connections.

First rule out that the cell voltages and temperature of all connected batteries are in range. If they are all in range, then follow one of the following procedures.

Also consider that once there has been a cell under voltage alarm, the cell voltage of all cells need to be increased to 3.2V before the battery clears the under voltage alarm.

A way to rule out if a fault is originating from a faulty BMS or from a faulty battery, is to check the BMS using one of the following BMS test procedures:

Single battery and BMS check:

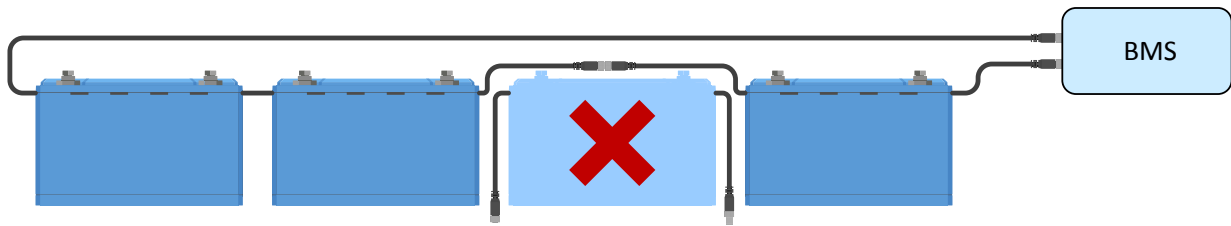
- Disconnect both BMS cables from the BMS.
- Connect a BMS extension cable to both BMS connectors. The BMS cable should be connected in a loop, as in below diagram. The loop tricks the BMS in thinking that there is a battery connected without any alarms.
- If the alarm is still active after the loop has been placed, the BMS is faulty.
- Testing a BMS by connecting an BMS extension cable If the BMS cleared its alarm after the loop has been placed, the battery is faulty.



Testing a BMS by connecting an BMS extension cable

Multiple batteries and BMS check:

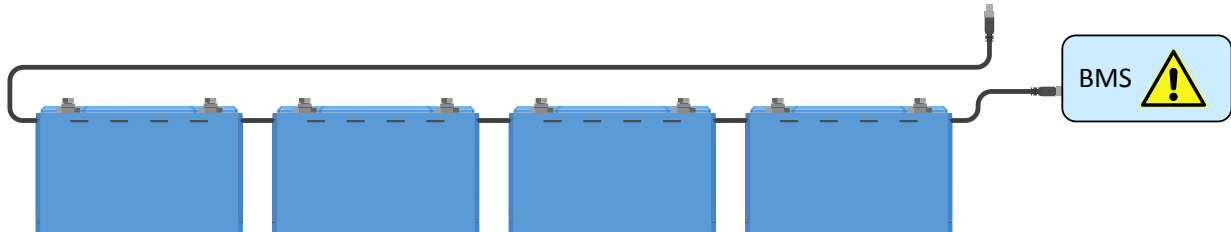
- Bypass one of the batteries by disconnecting both its BMS cables
- Connect the BMS cables of the neighbouring batteries (or battery and BMS) to each other, effectively bypassing the battery.
- Check if the BMS has cleared its alarm.
- If the alarm has not been cleared, repeat this for the next battery.
- If the alarm is still active after all batteries have been bypassed, the BMS is faulty.
- If the BMS cleared its alarm when a particular battery was bypassed, that particular battery is faulty.



Eliminating a BMS error by bypassing a suspect battery

8.3.6. How to test if the BMS is functional

To test if the BMS is functional, disconnect one of the BMS cables and see if the BMS will go into alarm mode.



Check BMS functionality by deliberately loosening a BMS cable

8.4. Technical support

For technical support contact the point of purchase. If the point of purchase is unknown, refer to the [Victron Energy Support web page](#).

8.5. Warranty

This product has a 3-year limited warranty. This limited warranty covers defects in materials and workmanship in this product and lasts for three years from the date of original purchase of this product. To claim warranty the customer must return the product together with the receipt of purchase to the point of purchase.

This limited warranty does not cover damage, deterioration or malfunction resulting from alteration, modification, improper or unreasonable use or misuse, neglect, exposure to excess moisture, fire, improper packing, lightning, power surges, or other acts of nature.

This limited warranty does not cover damage, deterioration or malfunction resulting from repairs attempted by anyone unauthorized by Victron Energy to make such repairs.

Non-compliance with the instructions in this manual will render the warranty void.

Victron Energy is not liable for any consequential damages arising from the use of this product. The maximum liability of Victron Energy under this limited warranty shall not exceed the actual purchase price of the product.

9. Technical data

| Battery specification | | | | | | | |
|--|---|---------------------|---------------------|-----------------------|-----------------------|---------------------|---------------------|
| VOLTAGE AND CAPACITY | LFP- Smart 12.8/60 | LFP- Smart 12.8/100 | LFP- Smart 12.8/150 | LFP- Smart 12.8/160-a | LFP- Smart 12.8/200-a | LFP- Smart 12.8/300 | LFP- Smart 25.6/200 |
| Nominal voltage | 12.8V | 12.8V | 12.8V | 12.8V | 12.8V | 12.8V | 25.6V |
| Nominal capacity @ 25°C* | 60Ah | 100Ah | 150Ah | 160Ah | 200Ah | 300Ah | 200Ah |
| Nominal capacity @ 0°C* | 48Ah | 80Ah | 125Ah | 130Ah | 160Ah | 240Ah | 160Ah |
| Nominal capacity @ -20°C* | 30Ah | 50Ah | 75Ah | 80Ah | 100Ah | 150Ah | 100Ah |
| Nominal energy @ 25°C* | 768Wh | 1280Wh | 1920Wh | 2048Wh | 2560Wh | 3840Wh | 5120Wh |
| *Discharge current ≤1C | | | | | | | |
| CYCLE LIFE (capacity ≥ 80% of nominal) | | | | | | | |
| 80% DoD | 2500 cycles | | | | | | |
| 70% DoD | 3000 cycles | | | | | | |
| 50% DoD | 5000 cycles | | | | | | |
| DISCHARGE | | | | | | | |
| Maximum continuous discharge current | 120A | 200A | 300A | 320A | 400A | 600A | 400A |
| Recommended continuous discharge current | ≤60A | ≤100A | ≤150A | ≤160A | ≤200A | ≤300A | ≤200A |
| End of discharge voltage | 11.2V | 11.2V | 11.2V | 11.2V | 11.2V | 11.2V | 22.4V |
| OPERATING CONDITIONS | | | | | | | |
| Operating temperature | Discharge: -20°C to +50°C Charge: +5°C to +50°C | | | | | | |
| Storage temperature | -45°C to +70°C | | | | | | |
| Humidity (non-condensing) | Max. 95% | | | | | | |
| Protection class | IP 22 | | | | | | |
| CHARGE | | | | | | | |
| Charge voltage | Between 14V/28V and 14.4V/28.8V (14.2V/28.4V recommended) | | | | | | |
| Float voltage | 13.5V/27V | | | | | | |
| Maximum charge current | 120A | 200A | 300A | 320A | 400A | 600A | 400A |
| Recommended charge current | ≤30A | ≤50A | ≤75A | ≤80A | ≤100A | ≤150A | ≤100A |
| OTHER | | | | | | | |
| Max storage time @ 25°C* | 1 year | | | | | | |
| BMS connection | Male + female cable with M8 circular connector, length 50cm | | | | | | |
| Power connection (threaded inserts) | M8 | M8 | M8 | M8 | M8 | M10 | M8 |
| Dimensions (h x w x d) mm | 240 x 285 x 132 | 197 x 321 x 152 | 237 x 321 x 152 | 237 x 321 x 152 | 237 x 321 x 152 | 347 x 425 x 274 | 317 x 631 x 208 |
| Weight | 12kg | 15kg | 20kg | 20kg | 22kg | 51kg | 56kg |
| *When fully charged | | | | | | | |

10. Appendix

10.1. Initial charge procedure without BMS

If, for a specific reason, the initial charge procedure needs to be performed without a BMS, this is the procedure for it. Please note that this is not something we recommend because this process can be risky. A supervisor must be present, who will need to watch their phone continuously for hours as the battery cell voltages must be checked continuously to safeguard that the voltage of the highest cell never exceeds 4V.

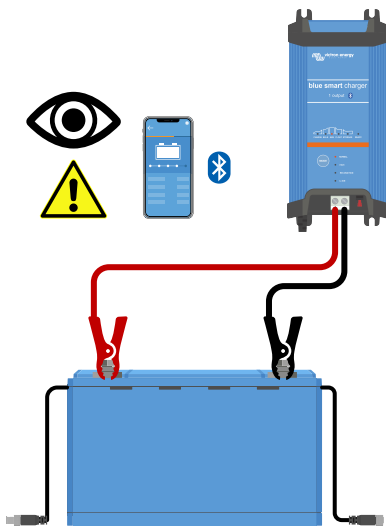


WARNING

Charging without BMS is not the preferred method. It can be risky, and a supervisor must be present at all times.

These are the charger or inverter/charge settings when the battery is charged without a BMS:

| Recommended charger settings when performing an initial charge without a BMS | | | | | | |
|--|---------------------|----------------|--------------------|-----------------|---------------|-----------------|
| WARNING: Use these settings only during the initial charge process | | | | | | |
| Battery model | Max. charge current | Charge profile | Absorption voltage | Absorption time | Float voltage | Storage voltage |
| 12.8V - 60Ah | 20A | Lithium, fixed | 13.8V | 12h | 14.2V | 13.5V |
| 12.8V - 100Ah | 30A | Lithium, fixed | 13.8V | 12h | 14.2V | 13.5V |
| 12.8V - 160Ah | 50A | Lithium, fixed | 13.8V | 12h | 14.2V | 13.5V |
| 12.8V - 200Ah | 60A | Lithium, fixed | 13.8V | 12h | 14.2V | 13.5V |
| 12.8V - 300Ah | 100A | Lithium, fixed | 13.8V | 12h | 14.2V | 13.5V |
| 25.6V - 200Ah | 60A | Lithium, fixed | 27.0V | 12h | 27.6V | 27.0V |



Initial charge without using a BMS

Charge procedure:

- Use a battery charger that is suitable for Li-ion, such as a BluePower charger.
- Set the charger to the charge profile as indicated in above table.
- The supervisor connects with the VictronConnect app to the battery.
- The supervisor monitors the individual cell voltages at all times.
- The supervisor interrupts the battery charge process immediately should a battery cell voltage exceeds 4 Volt.
- The process is complete when all cell voltages are between 3.5V and 3.6V