victron energy VE.Bus BMS Battery Management System User Manual

VE.Bus BMS

Contents

General Description

Protects each individual cell of a Victron lithium iron phosphate ($LiFePO_4$) battery
Each individual cell of a $LiFePO_4$ battery must be protected against over voltage, under voltage and over temperature.
Victron $LiFePO_4$ batteries have integrated Balancing, Temperature and Voltage control (acronym: BTV) and connect to the VE.Bus BMS with two M8 circular connector cord sets.
The BTVs of several batteries can be daisy chained. Please see our LiFePO4 battery documentation for details.
The BMS will:
– shut down or disconnect loads in case of imminent cell under voltage,

– reduce charge current in case of imminent cell overvoltage or over temperature (VE.Bus products, see below), and
– shut down or disconnect battery chargers in case of imminent cell overvoltage or over temperature.

Protects 12V, 24V and 48V systems

Operating voltage range of the BMS: 9 to 70V DC.

Communicates with all VE.Bus products

The VE.Bus BMS connects to a MultiPlus, Quattro or Phoenix inverter with a standard RJ45 UTP cable.
Products without VE.Bus can be controlled as shown below:

Note: AC Detector for MultiPlus and Quattro (included in VE.Bus BMS delivery) not needed for MultiPlus-II models

Load Disconnect

The Load Disconnect output is normally high and becomes free floating in case of imminent cell under voltage. Maximum current: 2A.
The Load Disconnect output can be used to control
– the remote on/off of a load, and/or
– the remote on/off of an electronic load switch (BatteryProtect, preferred low power consumption solution).

Pre-alarm

The pre-alarm output is normally free floating and becomes high in case of imminent cell under voltage (default 3,1V/cell, adjustable on the battery between 2,85V and 3,15V per cell). Maximum current: 1A (not short circuit protected).
The minimum delay between pre-alarm and load disconnect is 30 seconds.

Charge Disconnect

The Charge Disconnect output is normally high and becomes free floating in case of imminent cell over voltage or over temperature. Maximum current: 10mA.
The Charge Disconnect output can be used to control
– the remote on/off of a charger and/or
– a Cyrix-Li-Charge relay and/or
– a Cyrix-Li-ct Battery Combiner.

LED indicators

– Enabled (blue): VE.Bus products are enabled.
– Cell>4V or temperature (red): charge disconnect output low because of imminent cell over voltage or over temperature.
– Cell>2,8V (blue): load disconnect output high.
Load disconnect output low when off, due to imminent cell under voltage (Vcell≤2,8V).

Safety instructions

Installation must strictly follow the national safety regulations in compliance with the enclosure, installation, creepage, clearance, casualty, markings and segregation requirements of the end-use application. Installation must be performed by qualified and trained installers only. Switch off the system and check for hazardous voltages before altering any connection.

- Do not open the Lithium Ion Battery.
- Do not discharge a new Lithium Ion Battery before it has been fully charged first.
- Charge only within the specified limits.
- Do not mount the Lithium Ion Battery upside down.
- Check if the Li-Ion battery has been damaged during transport.

Things to consider

3.1 Important warning

Li-ion batteries are expensive and can be damaged due to over discharge or over charge.
Damage due to over discharge 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 by opening the battery switch, pulling the battery fuse(s) or disconnecting the battery plus when the system is not in use.
A residual discharge current is especially dangerous if the system has been discharged completely and a low cell voltage shutdown has occurred. After shutdown due to low cell voltage, a capacity reserve of approximately 1Ah per 100Ah battery capacity is left in the 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 200Ah battery if the system is left in discharged state during more than 8 days.
3.2 AC Detector Li-ion software assistant for MultiPlus and Quattro (not needed for MultiPlus-II models)
The AC Detector is a small add-on that can be built in a MultiPlus or Quattro when used together with a $LiFePO_4$ battery and a VE.Bus BMS. Every VE.Bus BMS is delivered with one AC Detector.
The purpose of the AC Detector is to restart the MultiPlus or Quattro when AC supply becomes available, in case it has been switched off by the BMS due to low cell voltage.
Without the AC Detector the MultiPlus or Quattro would remain off and therefore would not start recharging the battery after shut down due to low battery voltage.
The AC detector needs the Li-ion software assistant or the Self-consumption ESS assistant to operate as intended.
Inverters (DC to AC only) with VE.Bus can be connected directly to the MultiPlus/Quattro input of the BMS, no AC Detector or assistant needed.

3.3 DC loads with remote on/off terminals

DC loads must be switched off or disconnected in case of imminent cell under voltage.
The Load Disconnect output of the VE.Bus BMS can be used for this purpose.
The Load Disconnect is normally high (equal to battery voltage) and becomes free floating (= open circuit) in case of imminent cell under voltage (no internal pull down in order to limit residual current consumption in case of low cell voltage).
DC loads with a remote on-off terminal that switches the load on when the terminal is pulled high (to battery plus) and switches it off when the terminal is left free floating can be controlled directly with the Load Disconnect output. See appendix for a list of Victron products with this behavior.
For DC loads with a remote on/off terminal that switches the load on when the terminal is pulled low (to battery minus) and switches it off when the terminal is left free floating, the Inverting remote on-off cable can be used. See appendix.
Note: please check the residual current of the load when in off state. After low cell voltage shutdown a capacity reserve of approximately 1Ah per 100Ah battery capacity is left in the battery. A residual current of 10mA for example may damage a 200Ah battery
if the system is left in discharged state during more than 8 days.

3.4 DC load: disconnecting the load with a BatteryProtect

A Battery Protect will disconnect the load when:
– input voltage (= battery voltage) has decreased below a preset value, or when
– the remote on/off terminal is pulled low. The VE.Bus BMS can be used to control the remote on/off terminal.

3.5 Charging the $LiFePO_4$ battery with a battery charger

Battery charging must be reduced or stopped in case of imminent cell over voltage or over temperature.
The Charge Disconnect output of the VE.Bus BMS can be used for this purpose.
The Charge Disconnect is normally high (equal to battery voltage) and switches to open circuit state in case of imminent cell over voltage.
Battery chargers with a remote on-off terminal that activates the charger when the terminal is pulled high (to battery plus) and deactivates when the terminal is left free floating can be controlled directly with the Charge Disconnect output.
See appendix for a list of Victron products with this behavior.
Battery chargers with a remote terminal that activates the charger when the terminal is pulled low (to battery minus) and deactivates when the terminal is left free floating, the Inverting remote on-off cable can be used. See appendix.
Alternatively, a Cyrix-Li-Charge can be used:
The Cyrix-Li-Charge is a unidirectional combiner that inserts in between a battery charger and the $LiFePO_4$ battery. It will engage only when charge voltage from a battery charger is present on its charge-side terminal. A control terminal connects to the Charge Disconnect of the BMS.

3.6 Charging the $LiFePO_4$ battery with an alternator See figure 6.

The Cyrix-Li-ct is recommended for this application.
The microprocessor controlled Cyrix-Li-ct includes a timer and voltage trend detection. This will prevent frequent switching due to a system voltage drop when connecting to a discharged battery.

Installation

4.1 AC Detector for MultiPlus and Quattro (included in VE.Bus BMS delivery). Not needed for MultiPlus-II models.
The purpose of the AC Detector is to restart the MultiPlus or Quattro when AC supply becomes available, in case it has been switched off by the BMS due to low cell voltage (so that it can recharge the battery).
Note 1: The AC Detector is not needed in case of an inverter.
Note 2: In systems consisting of several units configured for parallel, three phase or split phase operation, The AC Detector should be wired in the master or leader unit only.
Note 3: The VE.Bus BMS assistant or the Self-consumption ESS assistant must be loaded in all units.

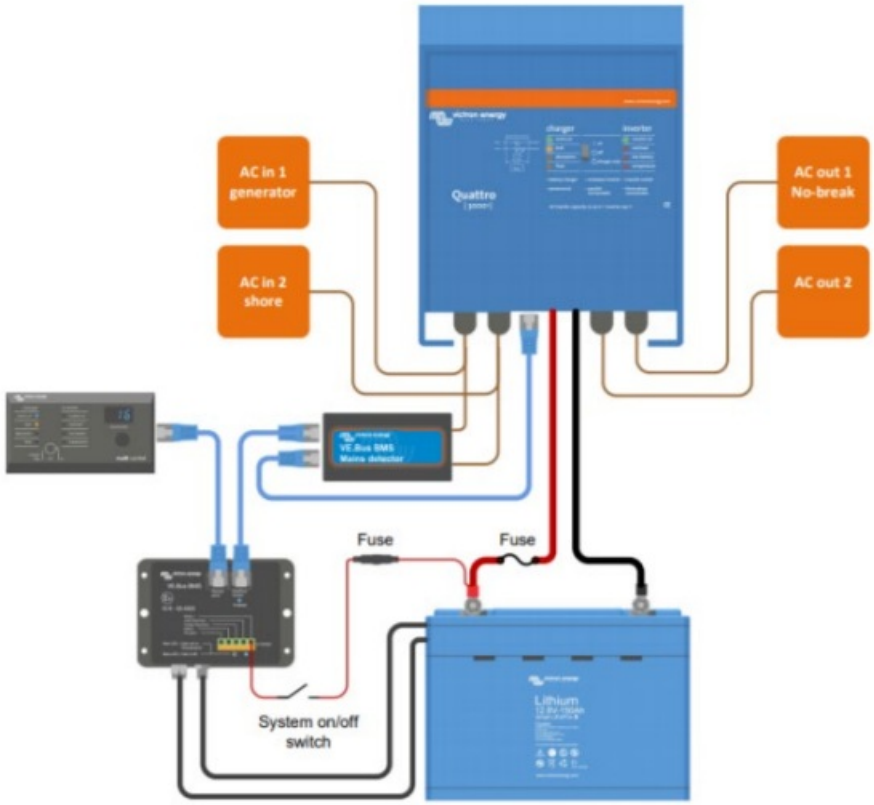


Figure 1: Block diagram with AC Detector in a Quattro

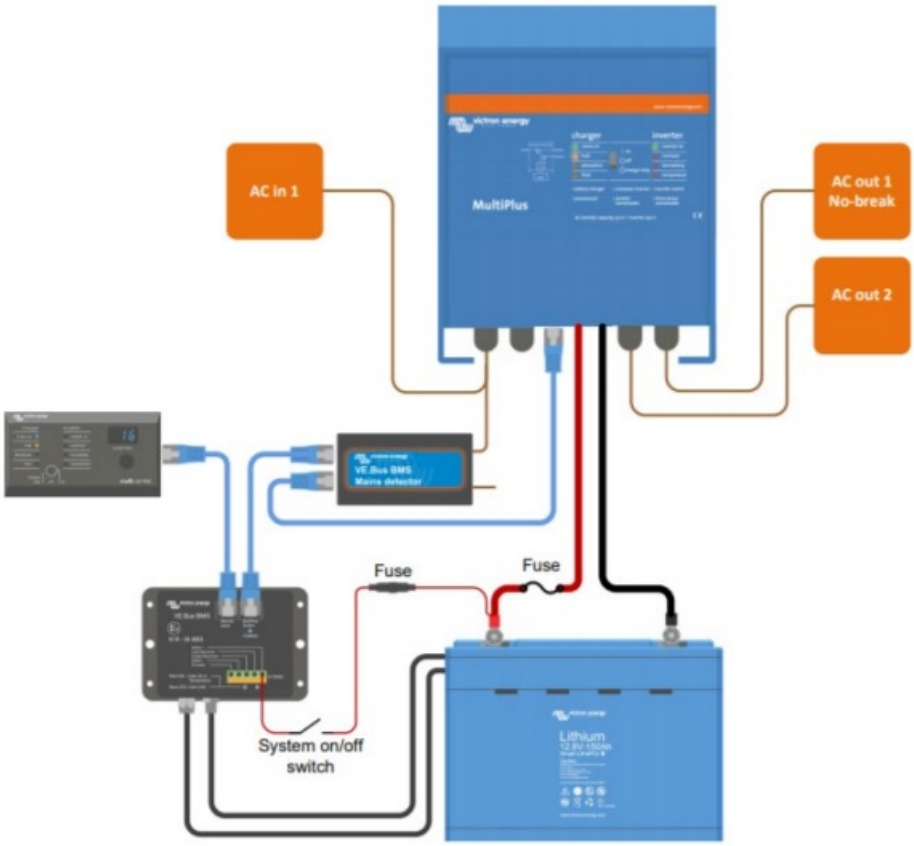


Figure 2: Block diagram with AC Detector in a MultiPlus

Installation procedure (see figure 3)

1. Connect the brown and blue input wires to the neutral and phase of the AC-in-1 input.
2. Quattro: connect the brown and blue output wires to the neutral and phase of the AC-in-2 input.

MultiPlus: no AC-in-2 input available. Please cut the AC2 wires close to the AC Detector

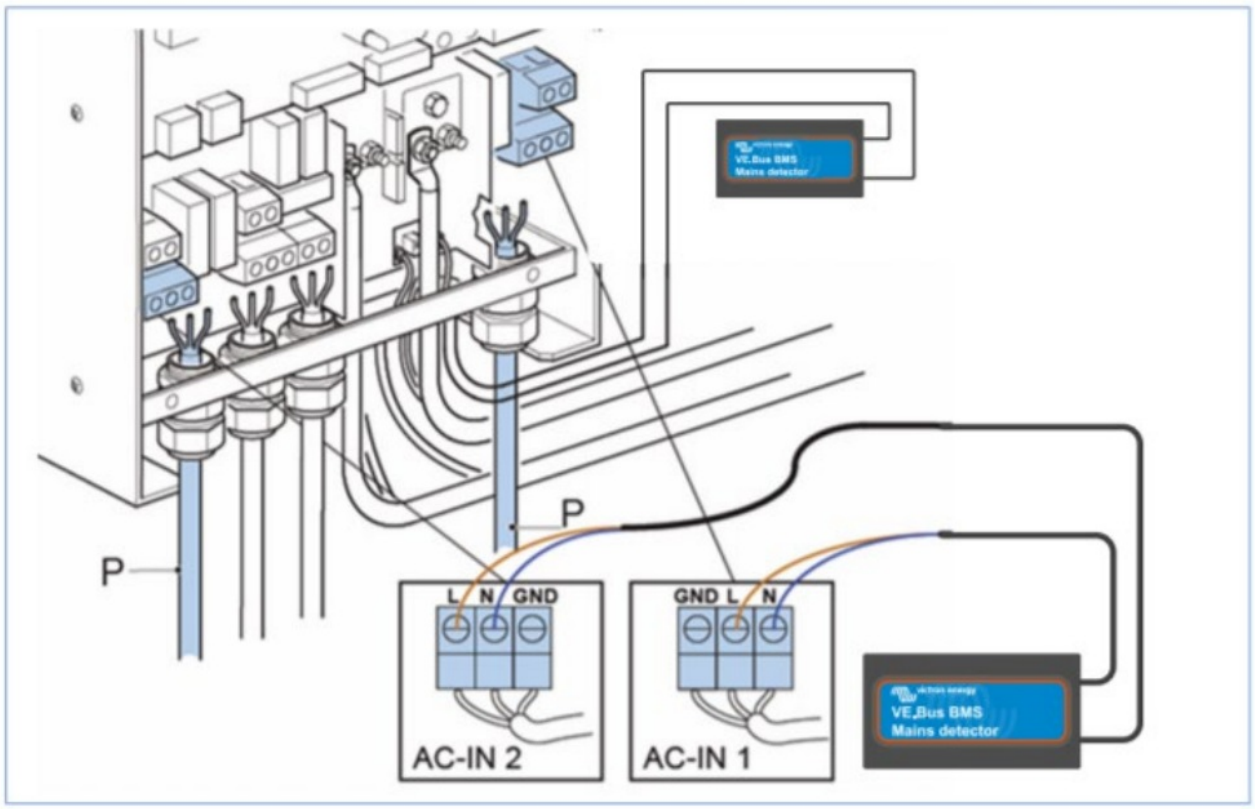


Figure 3: Connecting the AC Detector

3. Use the short RJ45 UTP cable to connect the AC Detector to one of the two the VE.Bus sockets in the MultiPlus or Quattro (see figure 4).
4. Connect the VE.Bus BMS to the AC Detector with a UTP cable (not included).
5. A Digital Multi Control panel must be connected to the VE.Bus BMS. Do not connect a Digital Multi Control panel directly to a Multi or Quattro (signals from the control panel may be in conflict with signals from the VE.Bus BMS).
6. The ColorControl panel must be connected directly the Multi or Quattro.

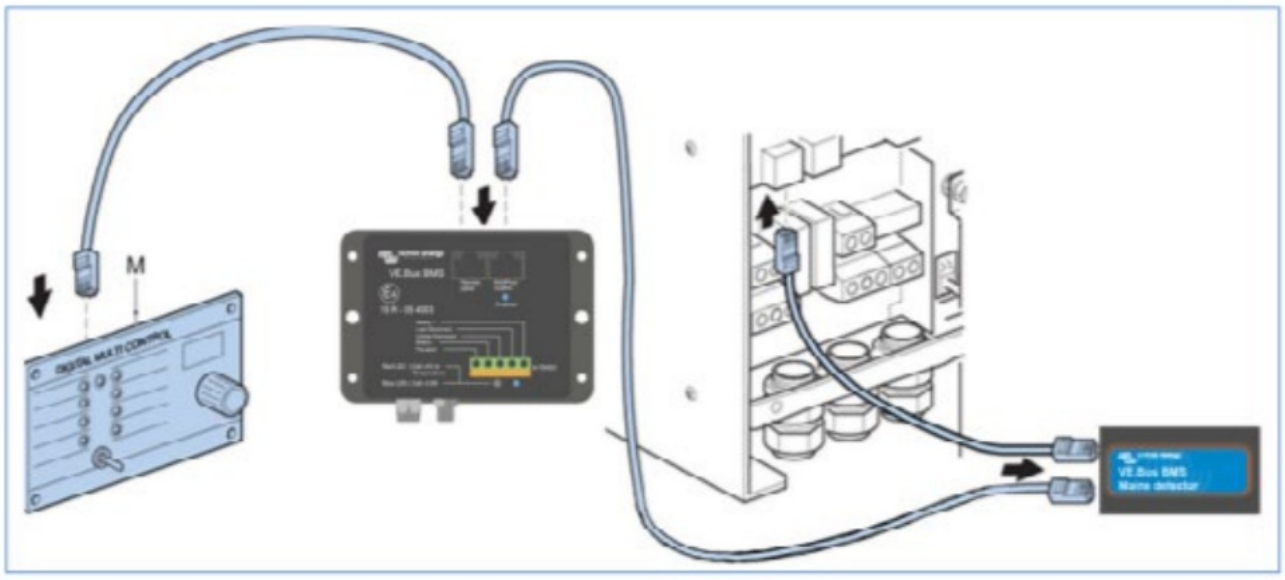


Figure 4: VE.Bus connections

4.2 Wire the system: see system examples below

Do not connect to the battery plus at this stage (alternatively: do not insert the battery fuse(s)).

Important:

1. The UTP cable to the inverter or inverter/charger also connects the battery minus to the BMS.
   In this case, in order to prevent ground loops, do not wire the battery minus connector of the BMS.
2. Wire the positive supply input of the VE.Bus BMS to the system positive. A system on-off switch in the positive supply wire will disable the system when opened.

4.3 Battery

In case of several batteries in parallel and or series configuration, the two M8 circular connector cord sets of each battery should be connected in series (daisy chained).
Connect the two remaining cords to the BMS.

4.4. Powering up

In case of a DC only system: connect the battery plus. The system is now ready for use.
In case of a system with Multis, Quattros or inverters with VE.Bus:
4.4.1. After completion of the installation, disconnect the BMS from the VE.Bus and replace by a Victron Interface MK2 and a computer.
4.4.2. Connect the battery plus.
4.4.2. Configure inverter/charger(s) or inverter(s) for parallel or three phase configuration if applicable.
Inverter/chargers: the AC Detector should be installed only in the master or leader of a parallel or three phase system.
Inverters: AC detector not needed.
4.4.3. Load the VE.Bus BMS assistant or a ESS assistant in all units (must be done for each unit separately)
4.4.4. Remove the MK2 and reconnect to the BMS.
4.4.5. The system is now ready for use

System examples

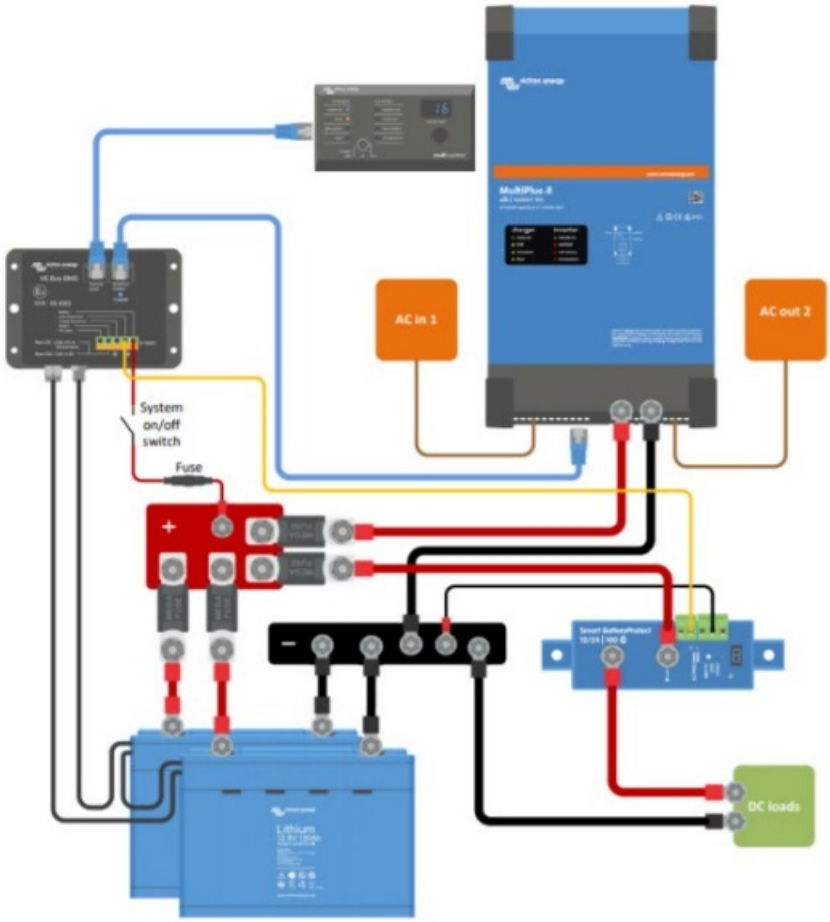


Figure 5: System with MultiPlus-II and DC loads

Note: the BMS is connected to the battery minus by the UTP cable between the BMS and the inverter/charger. Therefore, in order to prevent ground loops, do not wire the BMS minus connector.

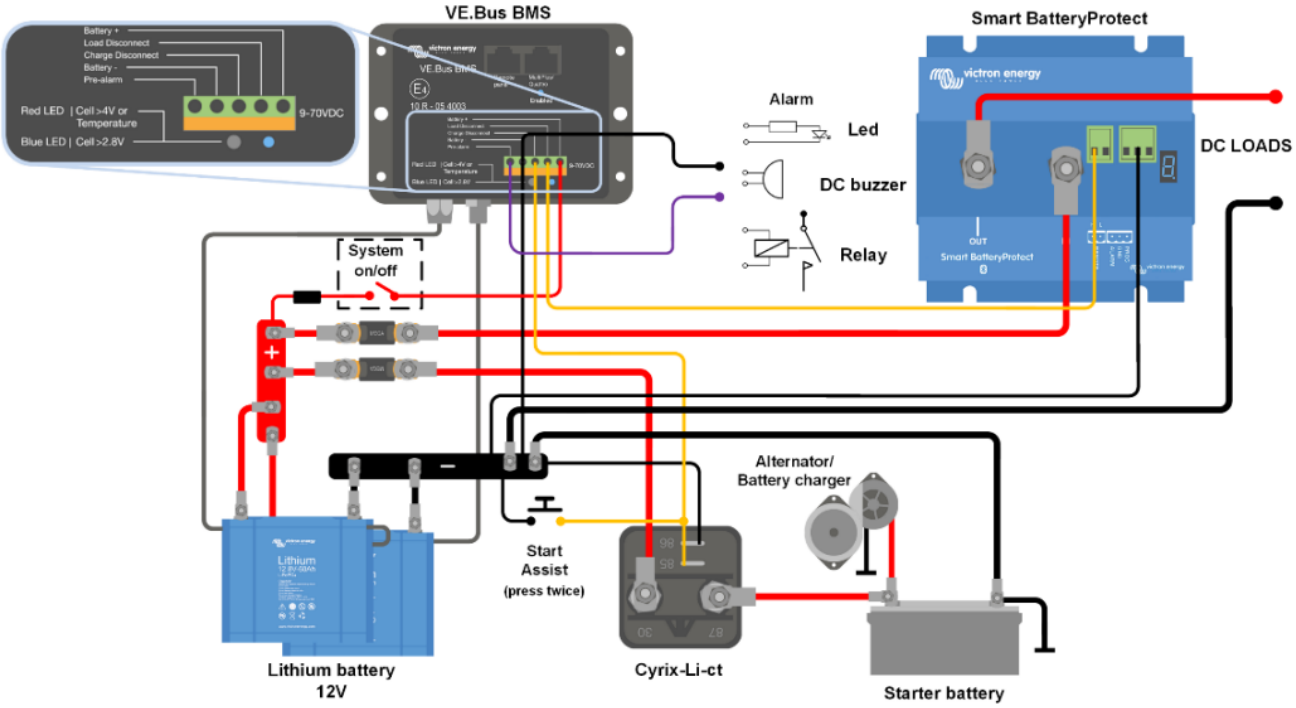


Figure 6: DC only system for a boat or vehicle with parallel connection of the starter- and Li-ion battery

Note: in this case the battery minus of the BMS must be wired.

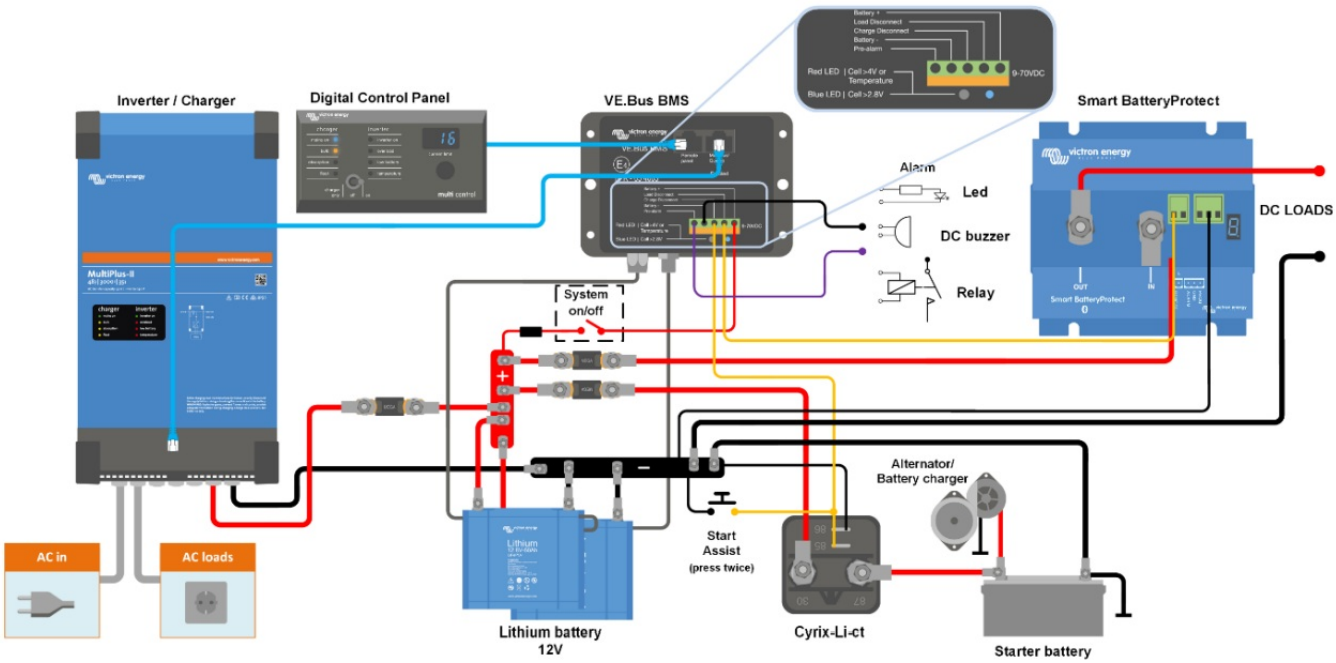


Figure 7: System for a boat or vehicle with a MultiPlus-II inverter/charger

Note: the BMS is connected to the battery minus by the UTP cable between the BMS and the inverter/charger. Therefore, in order to prevent ground loops, do not wire the BMS minus connector.

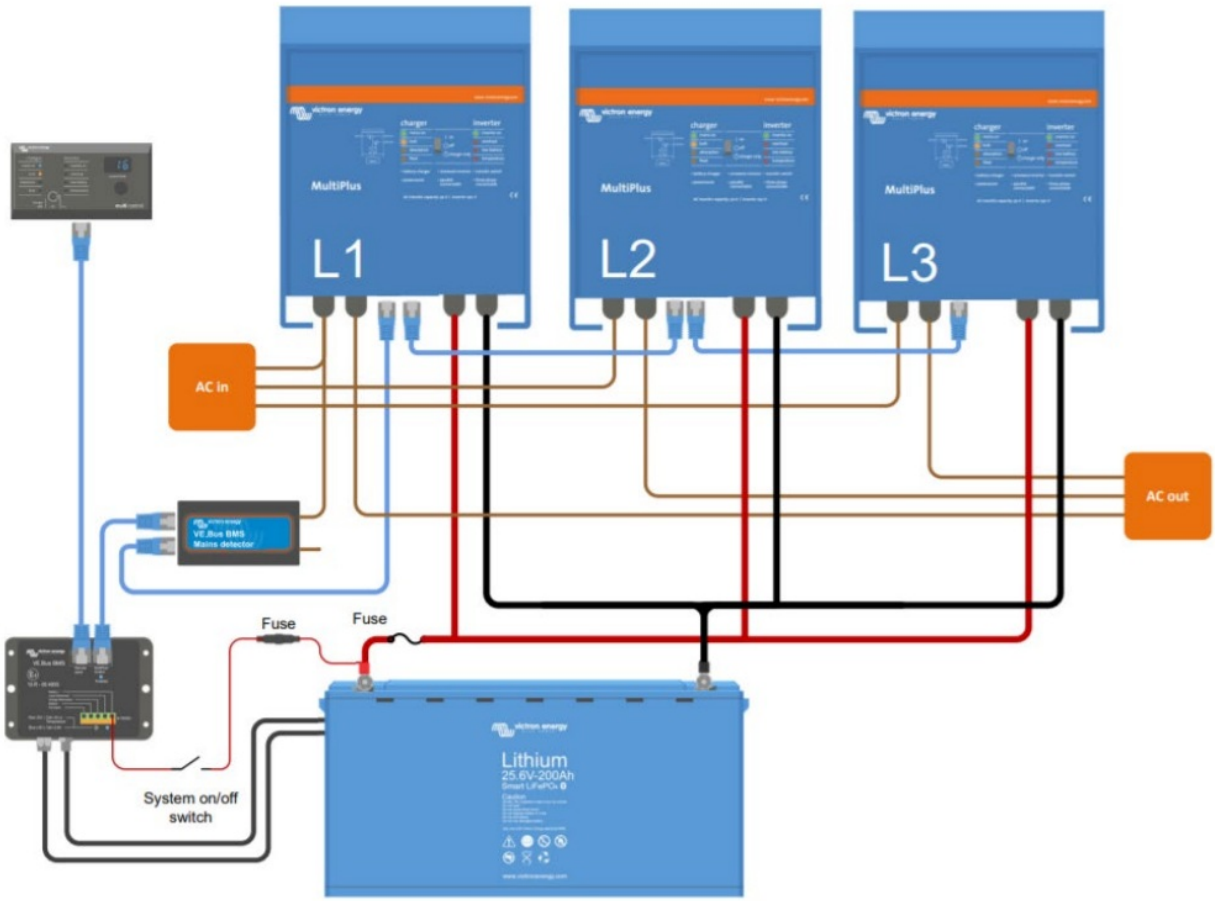


Figure 8: System example for a boat or vehicle with a three phase inverter/charger configuration (DC fuses not shown, except for the the Li-ion battery fuse)

Note 1: the AC Detector is installed in the leader only.

Note 2: the BMS is connected to the battery minus by the UTP cable between the BMS and the inverter/charger. Therefore, in order to prevent ground loops, do not wire the BMS minus connector.

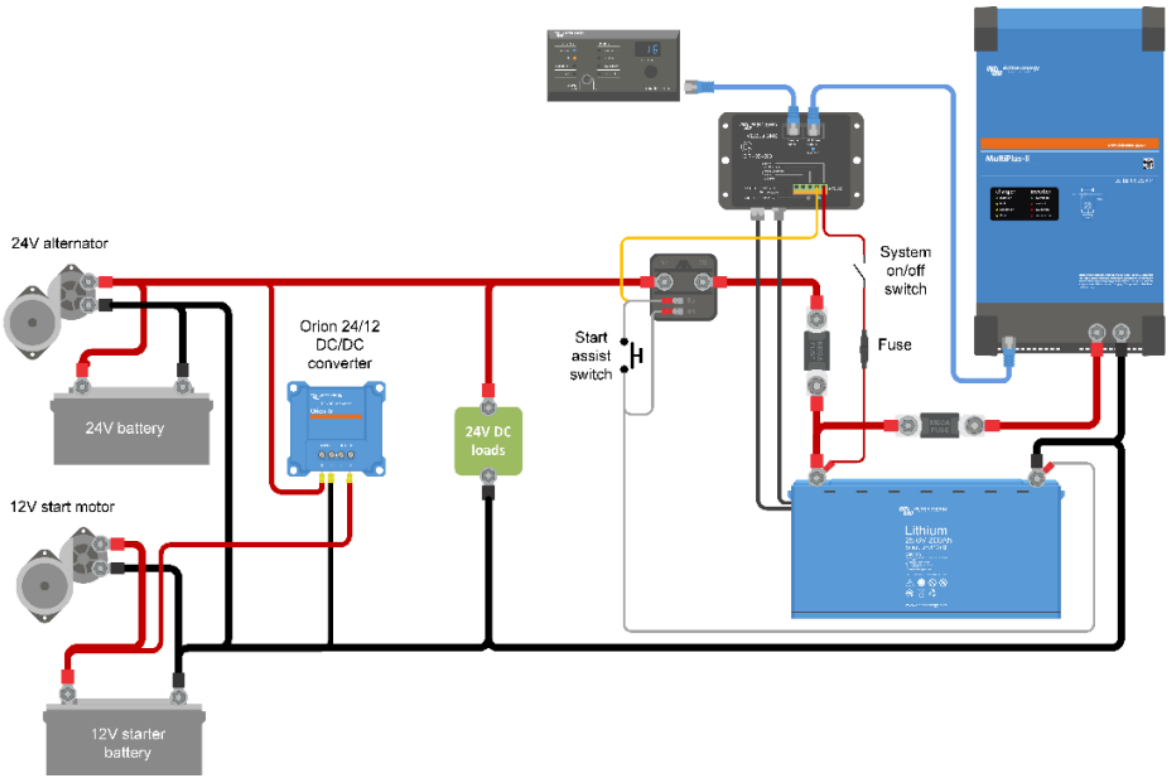


Figure 9: System example for a boat or vehicle with a 24V Li-ion system, a 24V alternator and a 12V starter battery.

To charge the starter battery: use a DC-DC converter or a small battery charger connected to the Multi or Quattro. Alternators which need DC voltage on the B+ output to start charging can be started by pushing the Start Assist push button once the engine is running.
Note: the BMS is connected to the battery minus by the UTP cable between the BMS and the inverter/charger. Therefore, in order to prevent ground loops, do not wire the BMS minus connector.

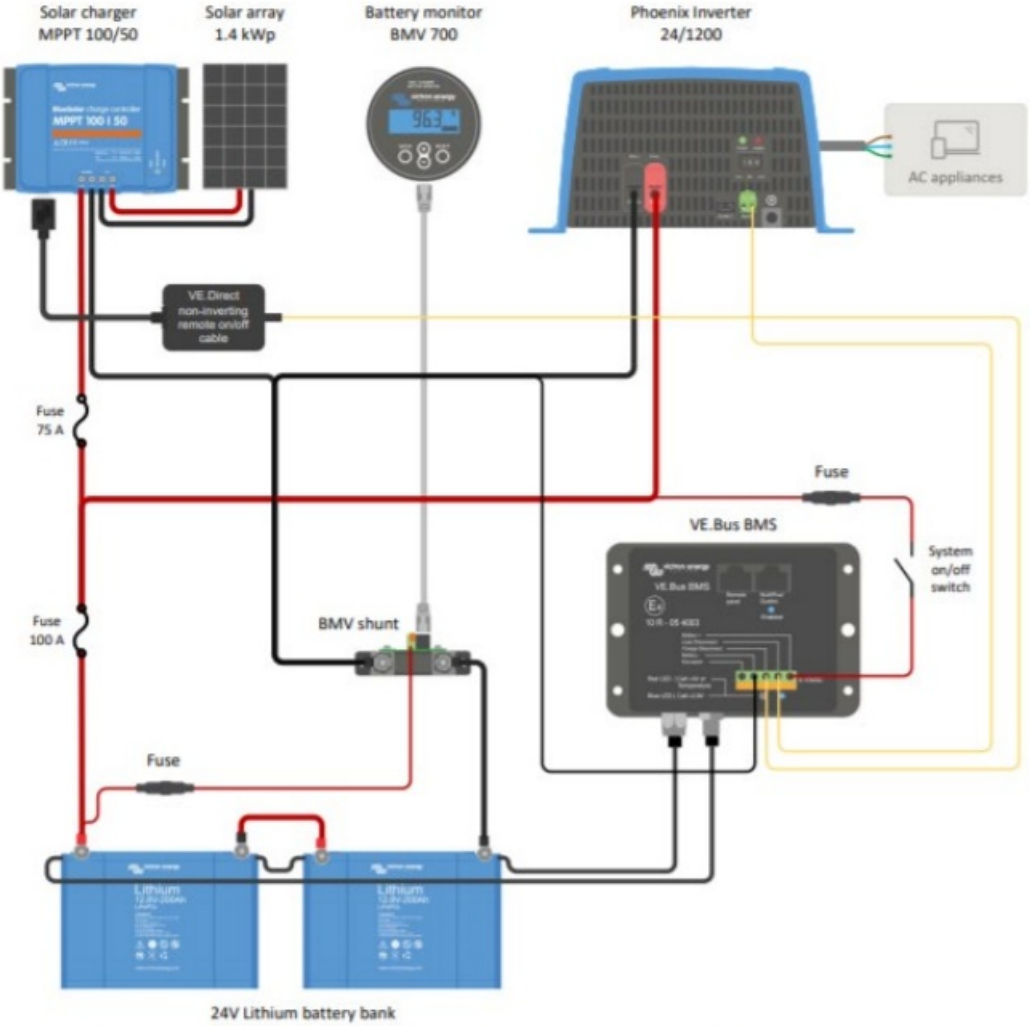


Figure 10: Solar application with an MPPT with VE.Direct port and a Phoenix Inverter 24/1200 VE.Direct.

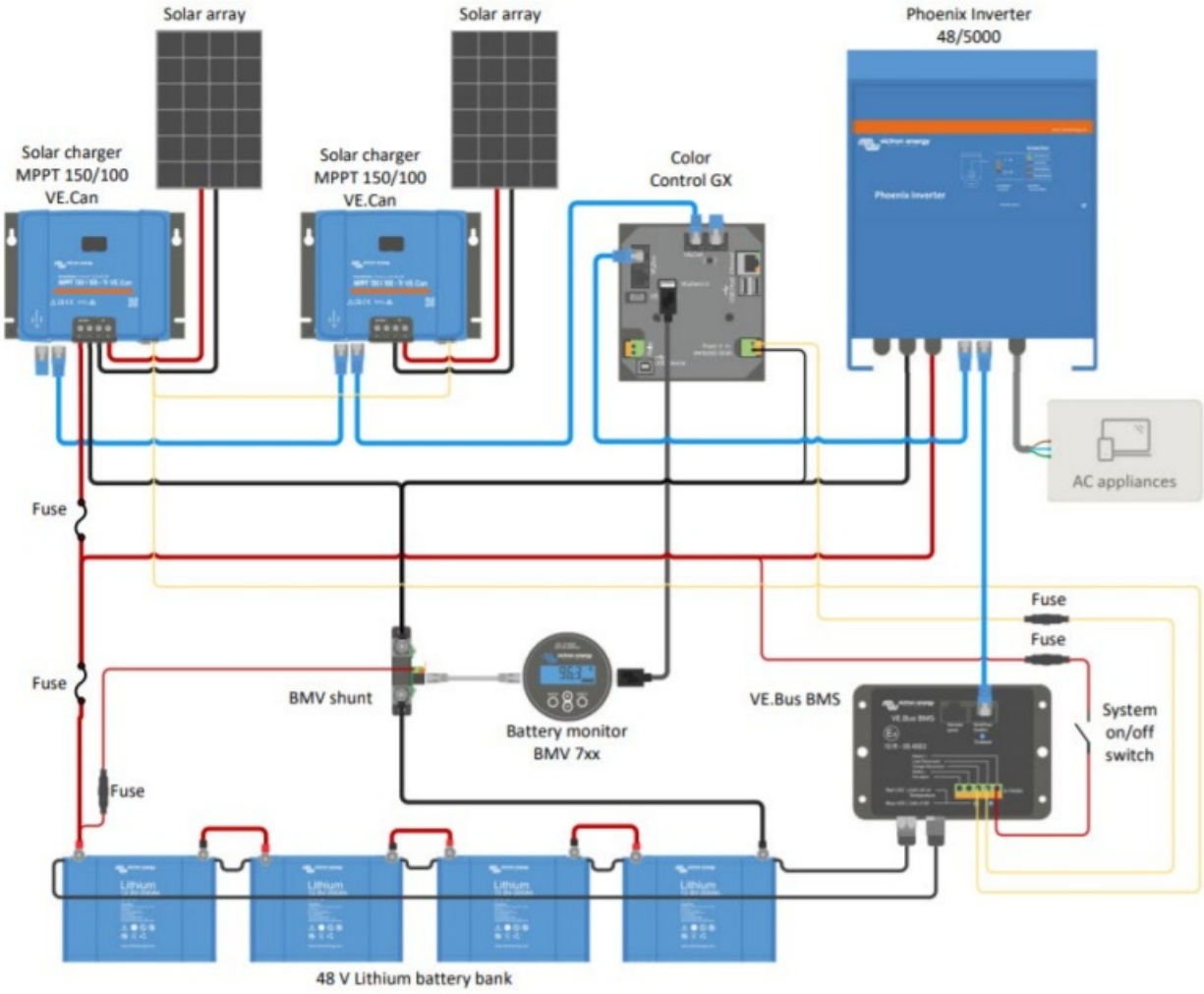
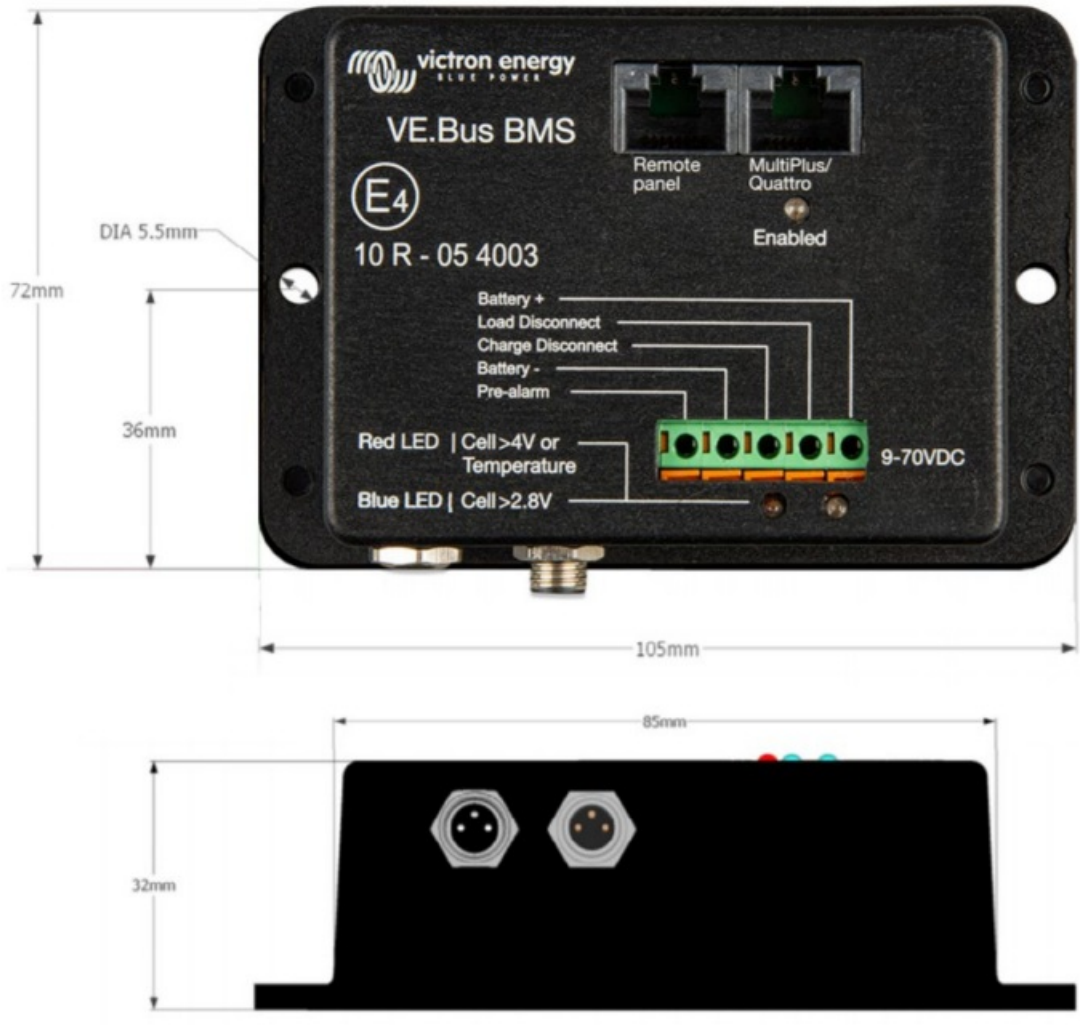


Figure 11: Solar application with two MPPT 150/100-Tr VE.Can

Note: the BMS is connected to the battery minus by the UTP cable between the BMS and the inverter/charger. Therefore, in order to prevent ground loops, do not wire the BMS minus connector.



Frequently asked questions

Q1: I have disconnected the VE.Bus BMS, and now my Multi or Quattro will not switch on, why?

A Multi or Quattro programmed with the VE.Bus BMS assistant, and unable to find a VE.Bus BMS on the bus, will go into an emergency mode. In this mode it will charge the batteries with 5 Ampère max, up to 12V, 24V or 48V, depending on system voltage. Note that in this mode, the only LED which is on is the Mains On LED. If you disconnect the AC input from the Multi/Quattro, it will switch off. It will not start to invert since it cannot get verification on the battery health from the VE.Bus BM Note that, when the batteries are depleted or disconnected, Quattros need to be powered from AC input 1. Supplying power toAC Input 2 will not make a Quattro switch on and start charging.

Q2: The batteries are empty and the Multi/Quattro will not start to charge, how to get the system up and running again.

When lithium batteries are depleted (the voltage is around 9V or even lower) the battery voltage might be below the operating window of the VE.Bus BMS. In that case the VE.Bus BMS will not be able to start the Multi/Quattro, even if an AC Detector is installed. To start the system again, disconnect the VE.Bus BMS from the Multi, and refer to Q1. Note that it might be necessaryto disconnect any Blue Power Panels, NMEA2000 interfaces or other similar smart products. As long as they are not switched on themselves, they can prevent the Multi/Quattro from starting up. A simpler option to revive a depleted system might be to connect a small battery charger, for example 5 Ampère, and wait for the battery voltage to get back up to 12 Volt.

Q3: What happens with the Multi/Quattro when the BMS gives a low cell voltage signal?

The Multi/Quattro will be in charger only mode: when AC input is present, it will charge the batteries. And when the AC input is not present, it will switch off.

Q4: What happens with the Multi/Quattro when the BMS gives a high cell voltage signal?

The high cell voltage signal will only be given when there are unbalanced cells. The Multi/Quattro will switch to bulk, and starts charging with a reduced charge current. This allows the balancing system to rebalance the cells.

Specifications

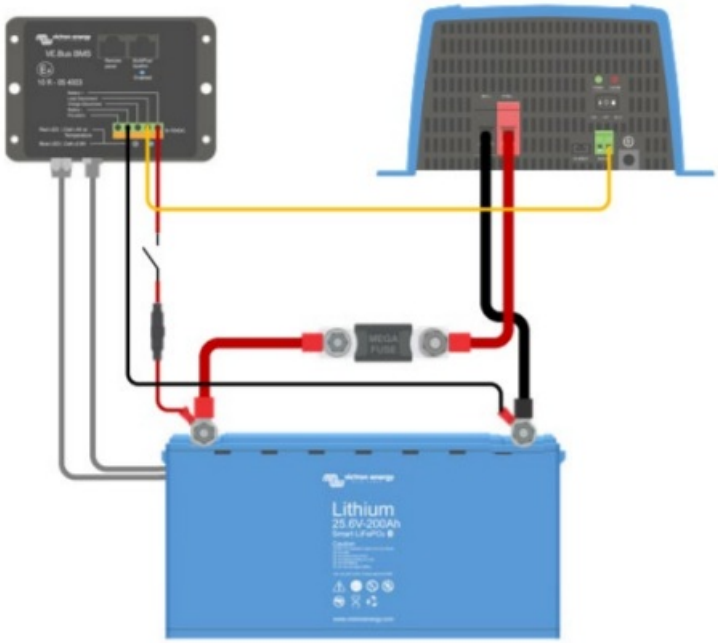
VE.Bus BMS	
Input voltage range	9 – 70VDC
Current draw, normal operation	10mA (excluding Load Disconnect current)
Current draw, low cell voltage	2mA
Load Disconnect output	Normally high (output voltage ≈ supply voltage – 1V) Floating when load needs to be disconnected Source current limit: 2A Sink current: 0A
Charge Disconnect output	Normally high, (output voltage ≈ supply voltage – 1V) Floating when charger should be disconnected Source current limit: 10mA Sink current: 0A
GENERAL	
VE.Bus communication port	Two RJ45 sockets to connect to all VE.Bus products
Operating temperature	-20 to +50°C 0 – 120°F
Humidity	Max. 95% (non-condensing)
Protection grade	IP20
ENCLOSURE	
Material and colour	ABS, matt black
Weight kg	0,1
Dimensions (hxwxd) in mm	105 x 78 x 32
STANDARDS	
Standards: Safety Emission Immunity Automotive Directive	EN 60950 EN 61000-6-3, EN 55014-1 EN 61000-6-2, EN 61000-6-1, EN 55014-2 EN 50498

Cyrix Li-ion ct (see Cyrix Li-ion dat asheet for more information)	12/24-120	24/48-120
Continuous current	120A	
Connect voltage	From 13,7V to 13,9V and 27,4V to 27,8V with intelligent trend detection	

Disconnect voltage	From 13,2V to 13,4V and 26,4V to 26,8V with intelligent trend detection	
Start Assist	Yes (The Cyrix remains engaged during 15 seconds after the control input has been pulled twice to battery minus.)	
Cyrix Li-ion load	12/24-120	24/48-120
Please use a Battery Protect instead: much lower power consumption		
Cyrix Li-ion Charge	12/24-120	24/48-120
Continuous current	120A	120A
Connect voltage	Engages when voltage on the charger side exceeds 13,7V to 13,9V and 27,4V to 27,8V with intelligent trend detection	Engages when voltage on the charger side exceeds 27,4V to 27,8V and 54,8V to 55,6V with intelligent trend detection
Disconnect voltage	From 13,2V to 13,4V and 26,4V to 26,8V with intelligent trend detection	From 26,4V to 26,8V and 52,8V to 53,6V with intelligent trend detection
Charge not active detection	The Cyrix disengages every hour and remains open in case of low voltage on the charger side	
General	12/24-120	24/48-120
Over voltage disconnect	16V / 32V	32V / 64V
Over temperature disconnect	Yes	
Current consumption when open	<4mA	
Current consumption when closed	<220mA / < 110mA	< 110mA / <60mA
Operating temperature range	-20 to +50°C	
Protection category	IP54	
Weight kg (lbs)	0,11 (0.24)	
Dimensions h x w x d in mm (h x w x d in inches)	46 x 46 x 80 (1.8 x 1.8 x 3.2)	

Appendix:

Loads which can be controlled directly by the Load Disconnect output of the BMS
Inverters:
All Phoenix inverters VE.Direct 250/375/500/800/1200
Phoenix 12/800 Phoenix 24/800
Phoenix 12/1200 Phoenix 24/1200
Phoenix 48/800 Phoenix 48/1200

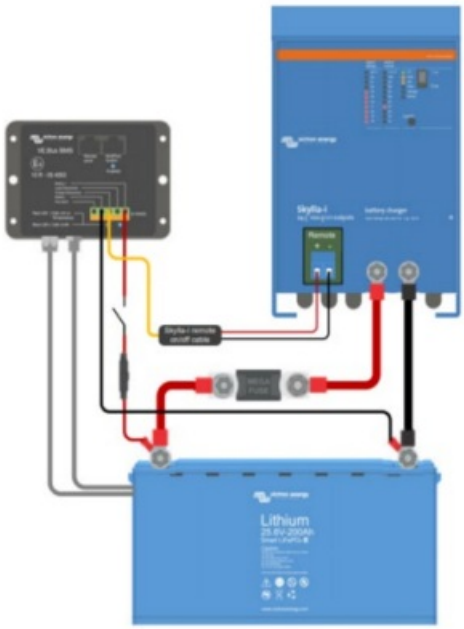


DC-DC converters:
All Tr type DC-DC converters
Orion 12/24-20
Orion 24/12-25
Orion 24/12-40
Orion 24/12-70

Loads for which a Inverting remote on-off cable is needed
(article number ASS030550100)
Inverters:
Phoenix 12/180
Phoenix 24/180
Phoenix 12/350
Phoenix 24/350
All Phoenix inverters rated at 3kVA and more

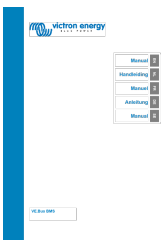
For Skylla TG battery chargers a Non inverting remote on-off cable Is needed
(article number ASS030550200)

For Skylla-i battery chargers a Skylla-i remote on-off cable Is needed
(article number ASS030550400)



victron energy

Documents / Resources

	victron energy VE.Bus BMS Battery Management System [pdf] User Manual VE.Bus BMS Battery Management System, VE.Bus BMS, Battery Management System, Management System

References

- User Manual