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BLUE POWER

Manual

VE.Net Battery Controller (70-385V model)
VBC-HV

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1   INTRODUCTION

Victron Energy has established an international reputation as a leading designer and manufacturer of energy systems. Our R&D department is the driving force behind this reputation. It is continually seeking new ways of incorporating the latest technology in our products. Each step forward results in value-added technical and economical features.

1.1   The VE.Net Battery Controller (VBC-HV)

The VBC-HV is a device that monitors your battery status. It constantly measures the battery voltage, battery temperature, and battery current, and uses this information to calculate the actual state of charge of your battery.

1.2   Introduction to VE.Net

VE.Net stands for Victron Energy Network. It allows all VE.Net compatible devices to communicate with each other. This means that the charger for example can get information from the battery monitor to optimize the charge current. It is possible to control and monitor all your VE.Net devices from a single VE.Net compatible control panel. This saves space and allows you to control all your devices from one place. It is however, not necessary to be limited to a single panel. Multiple panels can be used on the network, allowing full control and monitoring capabilities of all devices in multiple locations.

1.3   Why should you monitor your batteries?

The lifetime of your batteries depends on many factors. If the batteries and the load process are monitored you can prevent your batteries from being under- or over charged, or from being discharged too deeply. A battery controller warns you if there is something wrong with the charge current or with the general condition of the batteries.

1.4   How does the VE.Net Battery Controller work?

The capacity of a battery is rated in Amp hours (Ah). For example, a battery that can deliver a current of 5 Amps for a period of 20 hours is rated at 100 Ah (5 * 20 = 100). The VBC-HV continuously measures the net current flow into or out of the battery. This way it can calculate the amount of energy removed from or added to the battery. But since battery age, discharge current and temperature all influence the battery's capacity; you cannot rely simply on an Amp hours reading. When the same 100 Ah battery is discharged completely in two hours, it may only give you 56 Ah (because of the higher rate of discharge).

As you can see the battery's capacity is almost halved. This phenomenon is called Peukert efficiency (see chapter 4.1.2). Also, when the temperature of the battery is low, its capacity is decreased even more. This is why simple Amp hour counters or Voltmeters give you far from an accurate state-of-charge indication.

The VBC-HV can display both the Amp hours removed (not compensated) and the actual state of charge (compensated by Peukert efficiency and charge efficiency). Reading the state-of-charge is the best way to read your battery. This parameter is shown as a percentage, where 100% represents a fully charged battery and 0% represents a completely flat battery. You can compare this with a fuel-gauge in a car.

The VBC-HV also makes an estimation of how long the battery can support the present load (time to go readout). This is actually the time left until the battery needs to be charged again. If the battery load is fluctuating heavily it is best not to rely on this reading too much since it is a momentary readout and must be used as a guideline only. We always encourage the use of the state-of-charge readout for accurate battery monitoring.

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2   INSTALLATION OF YOUR BATTERY MONITOR

2.1   *Safety Precautions!*

1. Working in vicinity of a lead acid battery is dangerous. Batteries can generate explosive gases during operation. Never smoke or allow a spark or flame in the vicinity of a battery. Provide sufficient ventilation around the battery.

2. Wear eye and clothing protection. Avoid touching eyes while working near batteries. Wash your hands when done.

3. If battery acid contacts skin or clothing, wash immediately with soap and water. If acid enters eye, immediately flood eye with running cold water for at least 15 minutes and get medical attention immediately.

4. Be careful when using metal tools in vicinity of batteries. Dropping a metal tool onto a battery might cause a short-circuit and, possibly an explosion.

5. Remove personal metal items such as rings, bracelets, necklaces, and watches when working with a battery. A battery can produce a short-circuit current high enough to melt such items, leading to severe burns.

6. The VBC-HV contains no user serviceable parts, and operates at dangerously high voltages. Never remove the housing, as this causes a risk of electric shock.

To install your battery controller you will need:

1. Wired VBC-HV and shunt in housing. The standard supplied shunt is 500A / 50mV, but any shunt with a current indication up to 100mV can be used.
2. Standard supplied VE.Net power cable.
    RJ45 Cat5 cable to two wire insulated flexible connection cable AWG21/0.4 mm² with inline fuse holder and 1 Amp slow blow fuse.
3. Standard supplied temperature sensor.
4. Cat5 cable with two RJ45 connectors (to connect a VE.Net Panel or other VE.Net device) available in 5, 10, 15, 20, 25 and 30 meters.

2.2   Mounting

The VBC-HV box can be mounted using the 4 mounting holes. To ensure the best read out we recommend that you use the standard supplied cables and place the controller as close as possible to the batteries.

During prolonged periods of high current, the shunt will become hot. It is therefore recommended that the box is mounted so that the blades of the shunt are oriented vertically to allow optimal air-flow.

2.3   Wiring

Turn off the power from the batteries and remove the fuse before you start installation. Connect the wiring as shown in figure 1. The thick lines represent the main current path cables; these should be of a heavy duty type. Most of the connections are already made to the VBC-HV. You will only need to connect the battery minus and system ground wires to the shunt and the Battery+ wire to the battery. Optionally you can connect the wires coming from the alarm relay.

Connect the Battery Controller to a VE.Net Panel or other VE.Net device using a standard straight Cat5 cable. The total length of Cat5 cables used in a VE.Net network should not exceed 100m.

After installation, and checking all the connections place the fuse to power the battery controller.

Note: The VBC-HV cannot provide power to other VE.Net devices. In order to power other VE.Net devices (such as the VPN), use either the VE.Net power cable or connect another device to the network that is capable of supplying power. Such devices include the VE.Net Battery Controller 12/24/48V (VBC000300000), the VE.Net to VE Bus Converter (VVC000200000), the VE.Net Tank Monitor, current model (VCS000100000) and the VE.Net Tank Monitor, voltage model (VVC000100000).

Note: The shunt and temperature sensor should be the only wires connected to the negative terminal of the battery. The negative connections of all other devices (including chargers) must be made to the load side of the shunt (system ground). If devices are connected directly to the negative terminal of the battery the VBC-HV will be unable to measure their current consumption, and will give incorrect readings.

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Note: Do not connect any other wires to the shunt measurement output, as this will affect the accuracy of the readings.

VE.Net Vin max 70V

Relay connection

Fuse 100mAT

Battery Vin max 385V

V+   VBC   I +
GND   I -
               T-
       VE.Net T+

Temperature sensor

Battery negative
(System ground)
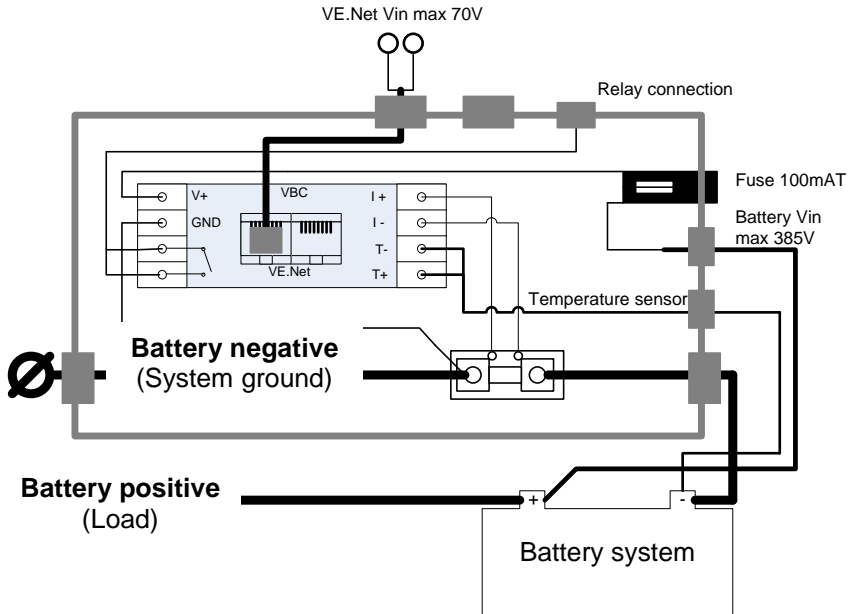
Battery positive
(Load)

Battery system

Figure 1

- ***Read the Safety precautions in chapter 2.1 before installing your VBC-HV.***

- ***Make sure that you first connect the system before placing the fuse.***

3   USING YOUR BATTERY MONITOR

All control of the VBC-HV is provided through the VPN. To switch on the
VPN, hold down one of the buttons until the VPN beeps. When the VPN
has finished starting up, the device list will be displayed. If there are other
VE.Net devices connected, it may be necessary to press "▼" until the
Battery Controller is displayed. For more information on using the VPN,
refer to the VPN manual.

3.1   Quick status line

In the root menu of the VPN you will see this screen, which consists of
the name of the battery controller and the "quick status" line.

```
Battery Monitor
157V  -0.5A  99%
```

Battery voltage   Battery current   State of charge
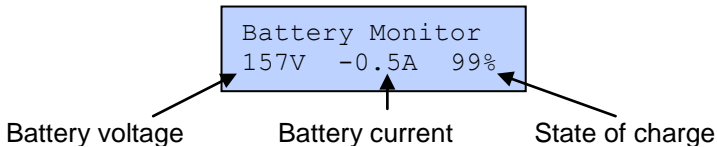
Notes:
1. You can always return to this position by pressing "Cancel"
   repeatedly.
2. The state of charge is only displayed when the Battery Controller is
   synchronised (see chapter 4.1.3 for more information).

3.2   Main menu

To view more detailed information, press the "Enter" button to enter the
Battery Controller menu.

Name	Description	Units
Battery voltage	Displays the voltage of the battery.	Volts.
Battery current	Displays the DC current that flows into or out of the battery.	Amps.
Consumed Ah	Displays the energy consumed since the battery was last fully charged.	Amp hours.
State of charge	The state of charge indicates the percentage of the battery capacity that is still available for consumption. A full battery will show 100%, and an empty battery will show 0%. This is the best way to see when the batteries need to be recharged.	Percent.
Time to go	Displays the estimated time, based on the current load, before the batteries need to be recharged.	Hours and minutes.
Bat. temperature	Displays the battery temperature.	Degrees Celsius.
Software version	The software version of this device.	

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3.3 Historic data

The VBC-HV will keep track of historical data to enable you to get more information about the state and the past use of the batteries.

3.3.1 Where to find the "Historical data" menu

```
Battery Monitor
157V  -0.5A  99%
```

Step 1) Press "Enter" to enter the VBC-HV menu.

```
Battery voltage
        157.40V
```

Step 2) Press "▼" to scroll through the menu until you see 'Historic data".

```
Historic data
   [Press enter]
```

Step 3) Press "Enter" to enter the "Historic data" menu

3.3.2 Historical data explained

<table>
<tr><th colspan="3">Historic data</th></tr>
<tr><th>Name</th><th>Description</th><th>Unit</th></tr>
<tr><td>Deepest discharge</td><td>The deepest discharge in Ah.</td><td>Amp hours.</td></tr>
<tr><td>Depth last disch.</td><td>The depth of the last discharge in Ah. This value will be reset to 0 when the State of Charge reaches 100% again.</td><td>Amp hours.</td></tr>
<tr><td>Average discharge</td><td>The average discharge over all the cycles counted</td><td>Amp hours.</td></tr>
<tr><td>Number of cycles</td><td>Every time the battery is discharged below 65% of its rated capacity and charged back to at least 90%, one cycle is counted.</td><td></td></tr>
<tr><td>Full discharges</td><td>The number of times the battery has been discharged to a 0% state of charge.</td><td></td></tr>
<tr><td>Cumulative Ah</td><td>Records the total energy consumed over all charge cycles.</td><td>Amp hours.</td></tr>
<tr><td>Last full charge</td><td>The time that has elapsed since the battery was last fully charged.</td><td>Days.</td></tr>
<tr><td>Maximum voltage</td><td>Maximum measured voltage. Can be used to check for faulty chargers and alternators.</td><td>Volts.</td></tr>
<tr><td>Minimum voltage</td><td>Lowest measured voltage. Can be used to check if the batteries have been excessively discharged.</td><td>Volts.</td></tr>
</table>

4   SETUP

4.1   Background information

4.1.1   Charge Efficiency Factor (CEF)

During battery charging, not all of the energy transferred into the battery is available when the battery is being discharged. The charge efficiency factor (CEF) of a brand new battery is approximately 90 %. This means that 10 Ah must be transferred to the battery to get 9 Ah actually stored in the battery. The CEF of a battery will decrease as the battery ages.

4.1.2   Peukert's exponent

As mentioned in chapter 1.4, the Peukert efficiency describes how, when you discharge a battery faster than the 20 h rating, its Ah capacity decreases. The amount of battery capacity reduction is called the 'Peukert exponent' and can be adjusted from 1.00 to 1.50. The higher the Peukert exponent the faster the battery size shrinks with increasing discharge rate. An ideal (theoretical) battery has a Peukert exponent of 1.00 and has a fixed capacity; regardless of the size of the discharge current. Of course such batteries do not exist, and a setting of 1.00 in the VBC-HV is only implemented to bypass Peukert compensation. The default setting for the Peukert exponent is 1.25, and is an acceptable average value for most types of lead acid battery. However for precise battery monitoring, entering the right Peukert exponent is essential. If the Peukert exponent is not provided with your battery, you can calculate it by using other specifications which should be provided with your battery.

The Peukert equation is stated below:

$Cp = I^n \cdot t$ where the Peukert exponent, n = $\dfrac{\log t_2 - \log t_1}{\log I_1 - \log I_2}$

The battery specifications needed for calculation of the Peukert exponent, are the rated battery capacity (usually the 20 h discharge rate[1]) and for example a 5 h discharge rate[2]. See below for an example of how to define the Peukert exponent using these two specifications.

---

[1] Please note that the rated battery capacity can also be defined as the 10 h or even 5 h discharge rate.
[2] The 5 h discharge rate in this example is just arbitrary. Make sure that besides the C20 rating (low discharge current) you choose a second rating with a substantially higher discharge current.

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5 h rating

$$C_{5hr} = 75Ah$$

$$t_1 = 5h$$

$$I_1 = \frac{75Ah}{5h} = 15A$$

20 h rating,

$$C_{20hr} = 100Ah \text{ (rated capacity)}$$

$$t_2 = 20h$$

$$I_2 = \frac{100Ah}{20h} = 5A$$

Peukert exponent, $n = \dfrac{\log 20 - \log 5}{\log 15 - \log 5} = \underline{1.26}$

When no ratings are given at all, you can measure your battery using a 'constant load bank'. In this way a second rating can be obtained, together with the 20 h rating which represents the rated battery capacity in most cases. This second rating can be determined by discharging a fully charged battery with a constant current; until the battery reaches 1.75 V per cell (which is 10.5 V for a 12 V battery or 21 V for a 24 V battery). A calculation example is shown below:

A 200 Ah battery is discharged with a constant current of 20 A and after 8.5 hours 1.75 V/cell is reached.

So,

$$t_1 = 8.5h$$

$$I_1 = 20A$$

20 h rating,

$$C_{20h} = 200Ah$$

$$t_2 = 20h$$

$$I_2 = \frac{200Ah}{20h} = 10A$$

Peukert exponent, $n = \dfrac{\log 20 - \log 8.5}{\log 20 - \log 10} = \underline{1.23}$

A Peukert calculator is available at www.victronenergy.com.

4.1.3   Synchronising the VBC-HV

For a reliable readout of the state of charge of your battery, the battery monitor has to be synchronised regularly with the battery and charger.

This is accomplished by fully charging the battery. When the charger is operating in the 'float' stage, the charger considers the battery full. At this moment the VBC-HV must also determine that the battery is full. Now the Amp hour count can be reset to zero and the state-of-charge reading can be set to 100.0 %. By precisely adjusting the charged-parameters in the VBC-HV, the battery monitor can automatically synchronise with the charger when the 'float' stage is reached. The range of the charged parameters is wide enough to adjust the VBC-HV to most battery charging methods.

When the voltage supply to the VBC-HV has been interrupted, the battery monitor must be resynchronised before it can operate correctly.

Please note that regularly (at least once per month) fully charging your battery not only keeps it in sync with the VBC-HV, but also prevents substantial capacity loss of your battery which limits its lifetime.

4.1.4   Synchronisation parameters

Based on increasing charge voltage and decreasing charge current, a decision can be made whether the battery is fully charged or not. When the battery voltage is above a certain level during a predefined period while the charge current is below a certain level for the same period, the battery can be considered fully charged. These values are called synchronisation parameters. In general for a 144 V lead acid battery, the synchronisation voltage is 158.4 V and the synchronisation current is 4.0 % of the total battery capacity (e.g. 8 A with a 200 Ah battery). A synchronisation time of 4 minutes is sufficient for most battery systems. Please note that these parameters are very important for correct operation of your VBC-HV, and must be set appropriately in the corresponding menu items.

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4.2 General settings

4.2.1 Where to find the "Setup monitor" menu

```
Battery Monitor
157V  0.0A 100%
```

Step1) Press "Enter" to enter the VBC-HV menu.

```
Battery voltage
        157.40V
```

Step 2) Press "▼" to scroll through the menu until you see "Setup controller".

```
Setup controller
   [Press enter]
```

Step 3) Press "Enter" to enter the "Setup monitor "menu.

Note: If you can't find the "Setup monitor" menu, make sure that your VE.Net Panel is in "user and install" mode.

4.2.2 Setup parameters explained:

Setup monitor				
Name	**Description**	**Default Value**	**Range**	**Step size**
Battery capacity	The battery capacity in amp hours (Ah) at a 20h discharge rate.	200 Ah	20-65535	5
Sync. voltage	The battery controller considers the battery as fully charged if the voltage is above this level.	158.4 V	96-384	0.1
Sync. current	If the charge current is below this percentage of the battery capacity, the battery can be considered as fully charged.	4 %	1-10	1
Sync. time	The minimum time that the above two parameters must be met to consider the battery as fully charged.	4 min	1-4	1
Bat. temperature	If the connection to the temperature sensor is lost, this value is used in the calculations.	20 °C	0-50	1
Resync. to 100%?	Resets the state of charge manually to 100%.			
Device name	The name of the battery controller that is used in the VE.Net Panel.	Battery Monitor		

The settings on the advanced menu allow fine control of the battery monitoring calculations performed by the VBC-HV. The default values are suitable for most battery systems, so do not adjust these settings without fully understanding the consequences.

Advanced				
Name	Description	Default Value	Range	Step size
Charge eff. fact	When a battery is charged, energy is lost. The charge efficiency factor compensates for the lost energy, where 1 is no loss of energy and 0.5 is a 50 % loss of energy.	0.9	0.5-1	0.05
Peukert exponent	The Peukert exponent for your battery (refer to chapter 4.1.2 for more information). Set to 1.00 to disable the Peukert compensation. Contact your battery manufacturer for the Peukert exponent.	1.25	1-1.5	0.01
Temperature coef	This is the percentage the battery capacity changes with temperature.	0.5	0.5-0.95	0.05
Current threshold	This value will be considered as zero amps, to ensure that errors are eliminated.	0.1 A	0-5	0.1
Shunt current	The maximum current rating of the shunt.	500 A	5-50000	5
Shunt voltage	The output voltage of the shunt at the maximum rated current.	50 mV	1-100	1
Current offset	Used to compensate for small errors in current measurement caused by unwanted offsets picked up by the measurement cables.	0 A	-60000 - 60000	0.01
Battery current	Duplicates the current reading from the top level menu. This allows the effects of changes to the current offset to be observed without having to navigate the menu hierarchy.			

4.3   Alarms

The VBC-HV is equipped with a relay that can be programmed to signal alarms; or when connected to a generator, to automatically start and stop a generator. Alarms can also be sent to the VPN, which can be configured to sound an alarm, or control another relay. Each alarm type can be configured to activate the relay, send a panel alarm, or both. They can also be completely disabled.

4.3.1   Where to find the "Setup alarms" menu

```
Battery Monitor
157V  0.0A  100%
```
Step 1.)   Press "Enter" to enter the VBC-HV menu.

```
Battery voltage
        157.40V
```
Step 2.)   Press "▼" to scroll through the menu until you see "Setup Alarms".

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```
Setup alarms
   [Press Enter]
```

Step 3.) Press "Enter" to enter the "Setup alarms" menu.

Note: If you can not find the "Setup alarms" menu, make sure that your VPN is in "user and install" mode.

4.3.2   Alarm options explained

Setup alarms				
Name	Description	Default Value	Range	Step size
Low voltage	The battery voltage has to be below this threshold to trigger the low voltage alarm.	126 V	96-384	0.1
Low voltage clr	The threshold that has to be reached again to cancel an active low voltage alarm.	126 V	96-384	0.1
Low volt. action	The type of action to take when the alarm condition is met.	None	None, Relay, Panel, Both	
High voltage	The battery voltage has to be above this threshold to trigger the high voltage alarm.	192 V	96-384	0.1
High voltage clr	The threshold that has to be reached again to cancel an active high voltage alarm.	192 V	96-384	0.1
High volt. action	The type of action to take when the alarm condition is met.	None	None, Relay, Panel, Both	
Low SOC	The low state of charge threshold that will activate the alarm.	50 %	0-100	1
Low SOC clr	The state of charge threshold that has to be reached to cancel an active state of charge alarm.	80 %	0-100	1
Low SOC action	The type of action to take when the alarm condition is met.	None	None, Relay, Panel, Both	
Low current	The level below which a low current alarm will be triggered.	-100 A	-30000 – 0	5
Low current clr.	The level above which a low current alarm will be cleared.	-90 A	-30000 – 0	5
Low current action	The type of action to take when a low current alarm is active.	None	None, Relay, Panel, Both	
High current	The level above which a high current alarm will be triggered.	100	0 – 30000	5
High current clr	The level below which a high current alarm will be cleared.	90	0 – 30000	5
High cur. action	The type of action to take when a high current alarm is active.	None	None, Relay, Panel, Both	
Enable delay	The amount of time an alarm condition must be present in order to trigger the alarm.	0 s	0 – 255	1
Disable delay	The amount of time an alarm clear condition must be present in order to disable the alarm.	0 s	0 – 255	1
Min. enable time	The minimum amount of time the relay may remain closed once an alarm condition has occurred.	0 min	0 – 255	1

4.4 Menu structure

Root menu
- Historic data
- Setup alarms
- Setup controller
    - Advanced
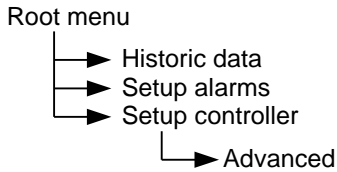
5 TECHNICAL DATA

Supply voltage range	70 ... 385VDC
Supply current (relay inactive):	
@144V	<5mA
@288V	<5mA
Operating temperature range	0 ... 50°C
Potential free alarm contact:	
Mode	Normally open
Rating	30V/3A max.
Dimensions:	
VBC-HV	75 x 110 x 23mm
Housing	230x140x110mm
Net weight:	
VBC-HV	95 gram
Housing (total)	1350 gram
Material:	
VBC-HV body	ABS
Housing	PC (10% glass fibre)
Cover	PC
Cover screws	PA

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Victron Energy Blue Power

Distributor:

Serial number:

Version : 06
Date : 5 March 2010

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