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Battery Monitor
BMV-700
BMV-700H
BMV-702

Safety Precautions

- Working in the 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.
- Wear eye and clothing protection. Avoid touching eyes while working near batteries. Wash your hands when done.
- If battery acid contacts skin or clothing, wash them immediately with soap and water. If acid enters an eye, immediately flood the eye with running cold water for at least 15 minutes and get medical attention immediately.
- Be careful when using metal tools in the vicinity of batteries. Dropping a metal tool onto a battery might cause a short circuit and possibly an explosion.
- 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 objects such as rings, causing severe burns.

1 QUICK START GUIDE

This quick start guide assumes that the BMV 702 is being installed for the first time, or that factory settings have been restored.

The factory settings are suitable for the average lead acid battery: flooded, GEL or AGM.
The BMV will automatically detect the nominal voltage of the battery system immediately after completion of the setup wizard *(for details and limitations of automatic nominal voltage detection, see section 3.8)*.
Therefore the only settings which need to be made are the battery capacity (BMV 700 and BMV 700H), and the functionality of the auxiliary input (BMV 702).

Please install the BMV in accordance with the quick installation guide.
After inserting the fuse in the positive supply cable to the main battery, the BMV will automatically start the setup wizard.
The setup wizard below must be completed before other settings can be made.

Remarks:
a) In case of **Li-ion batteries**, several settings may have to be changed. Please refer to section 6. The setup wizard below must be completed before other settings can be made.
b) When using a **shunt** other than the one supplied with the BMV, please refer to section 3.6. The setup wizard below must be completed before other settings can be made.

Setup wizard:

1.1 Battery capacity

a) After inserting the fuse the display will show the scrolling text
01 bAttErY CAPACItY
If this text is not shown, press SETUP and SELECT simultaneously during 3 seconds to restore factory settings or go to section 4 for full setup details (setting 64, Lock setup, must be OFF to restore factory settings, see section 4.2.5).

b) Press any button to stop scrolling and the factory default value **0200 Ah** will appear in edit mode: the first digit will blink.
Enter the desired value with the + and – buttons.

c) Press SELECT to set the next digit in the same manner.
Repeat this procedure until the required battery capacity is displayed.
The capacity is automatically stored in non-volatile memory when the last digit has been set by pressing SELECT. This is indicated with a short beep.
If a correction has to be made, press SELECT again and repeat the procedure.

d) BMV 700 and 700H: press SETUP or + or – to end the setup wizard and switch to normal operating mode.
BMV 702: press SETUP or + or – to proceed to auxiliary input setting.

1.2 Auxiliary input (BMV 702 only)
a) The display will show AUX IL IARY INPUT scrolling.

b) Press SELECT to stop scrolling and the LCD will show: START
Use the + or – key to select the required function of the auxiliary input:
START for monitoring the starter battery voltage.
MID for monitoring the mid-point voltage of a battery bank.
TEMP for using the optional temperature sensor
Press SELECT to confirm. Confirmation is indicated with a short beep.

c) Press SETUP or + or – to end the setup wizard and switch to normal operating mode.

The BMV is now ready for use.

When in normal mode the backlight of the BMV switches off after no key has been pressed for 60 seconds. Press any key to restore backlight.

The cable with integrated temperature sensor has to be purchased separately (part no: ASS000100000). This temperature sensor is not interchangeable with other Victron temperature sensors, as used with Multis/Quattros or battery chargers.

1.3 Important combined button functions

(see also section 4.1: using the menus)

a) Restore factory settings
Press and hold SETUP and SELECT simultaneously for 3 seconds

b) Manual synchronization.
Press and hold the up and down buttons simultaneously for 3 seconds

c) Silence audible alarm
An alarm is acknowledged when any button is pressed. However, the alarm icon is displayed as long as the alarm condition remains.

2 NORMAL OPERATING MODE

2.1 Read-out overview

In normal operating mode the BMV displays an overview of important parameters.
The + and – selection buttons give access to various read-outs:

Battery voltage

Auxiliary battery voltage

BMV-702 only, when the auxiliary input is set to START.

Current

The actual current flowing out of the battery (negative sign) or into the battery (positive sign).

Power

The power drawn from the battery (negative sign) or flowing into the battery (positive sign).

Consumed Amp-hours

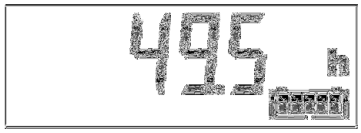
The amount of Ah consumed from the battery

Example:
If a current of 12 A is drawn from a fully charged battery for a period of 3 hours, this readout will show -36.0 Ah.
(-12 x 3 = -36)

State-of-charge

A fully charged battery will be indicated by a value of 100.0%. A fully discharged battery will be indicated by a value of 0.0%.

Time-to-go



An estimation of how long the battery can support the present load until it needs recharging.

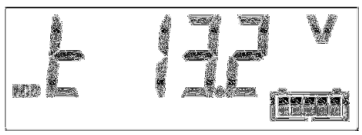
The time-to-go displayed is the time to reach the discharge floor.
See 4.2.2, setting number 16.

Battery temperature

BMV-702 only, when the auxiliary input is set to TEMP

The value can be displayed in degrees Celsius or degrees Fahrenheit.
See section 4.2.5.

Battery bank top section voltage



BMV-702 only, when the auxiliary input set to MID.

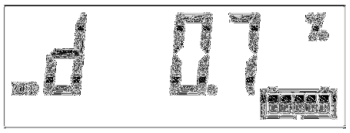
Compare with the bottom section voltage to check battery balancing.
For more about battery midpoint monitoring, see section 5.2.

Battery bank bottom section voltage

BMV-702 only, when the auxiliary input is set to MID.

Compare with the top section voltage to check battery balancing.

Battery bank mid-point deviation



BMV-702 only, when the auxiliary input is set to MID.

Deviation in percent of the measured mid-point voltage.

Battery bank mid-point deviation voltage

BMV-702 only, when the auxiliary input is set to MID.

Deviation in Volts of the mid-point voltage.

2.2 Synchronizing the BMV

For a reliable readout, the state of charge as displayed by the battery monitor has to be synchronized regularly with the true state of charge of the battery. This is accomplished by fully charging the battery.
In case of a 12 V battery, the BMV resets to “fully charged” when the following “charged parameters” are met: the voltage exceeds 13.2 V and simultaneously the (tail-) charge current is less than 4.0 % of the total battery capacity (e.g. 8 A for a 200 Ah battery) during 4 minutes.

The BMV can also be synchronized (i.e. set to “battery fully charged”) manually if required. This can be achieved in normal operating mode by holding the + and – buttons simultaneously for 3 seconds, or in setup mode by using the SYNC option (s*ee section 4.2.1, setting number 10).*

If the BMV does not synchronize automatically, the charged voltage, tail current, and/or charged time may need adjustment.
When the voltage supply to the BMV has been interrupted, the battery monitor must be resynchronized before it can operate correctly.

2.3 Common problems

No signs of life on the display
Probably the BMV is not properly wired. The UTP cable should be properly inserted at both ends, the shunt must be connected to the minus pole of the battery, and the positive supply cable should be connected to the plus pole of the battery with the fuse inserted.

The temperature sensor (when used) must be connected to the positive pole of the battery bank (one of the two wires of the sensor doubles as the power supply wire).

Charge and discharge current are inverted
Charge current should be shown as a positive value.
For example: +1.45 A.
Discharge current should be shown as a negative value.
For example: -1.45 A.
If charge and discharge current are inverted, the power cables on the shunt must swapped: *see the quick installation guide.*

The BMV does not synchronize automatically
One possibility is that the battery never reaches the fully charged state. The other possibility is that the charged voltage setting should be lowered and/or the tail current setting should be increased.
See section 4.2.1.

Sync and battery icon are blinking
This means the battery is not synchronized. Charge the batteries and the BMV should sync automatically. If that doesn't work, review the sync settings. Or, if you know the battery is full but don't want to wait until the BMV agrees: press and hold the up and down button simultaneously, until you hear a beep.
See section 4.2.1.

3 FEATURES AND FUNCTIONALITY

3.1 Features of the three BMV models

The BMV is available in 3 models, each of which addresses a different set of requirements:

		BMV-700	BMV-700H	BMV-702
1	Comprehensive monitoring of a single battery	•	•	•
2	Basic monitoring of an auxiliary battery			•
3	Battery temperature monitoring			•
4	Monitoring of the mid-point voltage of a battery bank			•
5	Use of alternate shunts	•	•	•
6	Automatic detection of nominal system voltage	•	•	•
7	Suitable for high voltage systems		•	
8	Several interface options	•	•	•

Remark 1:
Features 2, 3 and 4 are mutually exclusive.

Remark 2:
The cable with integrated temperature sensor has to be purchased separately (part no: ASS000100000).This temperature sensor is not interchangeable with other Victron temperature sensors, as used with Multis or battery chargers.

3.2 Why should I monitor my battery?

Batteries are used in a wide variety of applications, mostly to store energy for later use. But how much energy is stored in the battery? No one can tell by just looking at it.

The service life of batteries depends on many factors. Battery life may be shortened by under-charging, over-charging, excessively deep discharges, excessive charge or discharge current, and high ambient temperature. By monitoring the battery with an advanced battery monitor, important feedback is given to the user so that remedial measures can be taken when necessary. Doing this, which extends battery life, the BMV will quickly pay for itself.

3.3 How does the BMV work?

The main function of the BMV is to follow and indicate the state-of-charge of a battery, in particular to prevent unexpected total discharge.

The BMV continuously measures the current flow in and out of the battery. Integration of this current over time (which, if the current is a fixed amount of Amps, boils down to multiplying current and time) gives the net amount of Ah added or removed.
For example: a discharge current of 10A during 2 hours will take 10 x 2 = 20Ah from the battery.

To complicate matters, the effective capacity of a battery depends on the rate of discharge and, to a lesser extent, on temperature.

And to make things even more complicated: when charging a battery more Ah has to be “pumped’’ into the battery than can be retrieved during the next discharge. In other words: the charge efficiency is less than 100%.

3.3.1 About battery capacity and the rate of discharge
The capacity of a battery is rated in ampere-hours (Ah). For example, a lead acid battery that can deliver a current of 5 A during 20 hours is rated at C_{20} = 100 Ah (5 x 20 = 100).
When the same 100 Ah battery is discharged completely in two hours, it may only give C_2 = 56 Ah (because of the higher rate of discharge).
The BMV takes this phenomenon into account with Peukert’s formula: *see section 5.1.*

3.3.2 About charge efficiency (CEF)
The charge efficiency of a lead acid battery is almost 100% as long as no gas generation takes place. Gassing means that part of the charge current is not transformed into chemical energy, which is stored in the plates of the battery, but is used to decompose water into oxygen and hydrogen gas (highly explosive!). The “Amp-hours” stored in the plates can be retrieved during the next discharge, whereas the “Amp-hours” used to decompose water are lost.
Gassing can easily be observed in flooded batteries. Please note that the “oxygen only” end of charge phase of sealed (VRLA) gel and AGM batteries also results in a reduced charge efficiency.
A charge efficiency of 95% means that 10 Ah must be transferred to the battery to get 9,5 Ah actually stored in the battery. The charge efficiency of a battery depends on battery type, age and usage.
The BMV takes this phenomenon into account with the charge efficiency factor: see section 4.2.2, setting number 06.

3.4 Several battery state-of-charge display options

The BMV can display both the Amp-hours removed (“consumed Amp-hours” readout, compensated for charge efficiency only) and the actual state-of-charge in percent (“state-of-charge” readout, compensated for charge efficiency and Peukert efficiency). Reading the state-of-charge is the best way to monitor the battery.
The BMV also estimates how long the battery can support the present load: the “time-to-go” readout. This is the actual the time left until the battery is discharged to the discharge floor. The factory setting is 50% (see 4.2.2, setting number 16).
If the 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.

3.5 History data

The BMV stores events which can be used at a later date to evaluate usage patterns and battery health.
Select the history data menu by pressing ENTER when in normal mode (see section 4.3).

3.6 Use of alternative shunts

The BMV is supplied with a 500 A / 50 mV shunt. For most applications, this should be suitable; however the BMV can be configured to work with a wide range of different shunts. Shunts of up to 9999 A, and/or 100 mV can be used.

When using a shunt other than the one supplied with the BMV, please proceed as follows:

1. Unscrew the PCB from the supplied shunt.
2. Mount the PCB on the new shunt, ensuring that there is good electrical contact between the PCB and the shunt.
3. Connect the shunt and BMV as shown in the quick installation guide.
4. Follow the Setup wizard (section 1.1 and 1.2).
5. After completion of the Setup wizard, set the proper shunt current and shunt voltage according to section 4.2.5, setting number 65 and 66.
6. If the BMV reads a non-zero current even when there is no load and the battery is not being charged: calibrate the zero current reading (see section 4.2.1, setting number 09).

3.7 Automatic detection of nominal system voltage

The BMV will automatically adjust itself to the nominal voltage of the battery bank, immediately after completion of the setup wizard.
The following table shows how the nominal voltage is determined, and how the charged voltage parameter (see section 2.2) is adjusted as a result.

	Measured voltage (V)	Assumed nominal voltage (V)	Charged Voltage (V)
BMV 700 & 702	< 18	12	13,2
	18 - 36	24	26,4
	> 36	48	52,2 V8
BMV 700H	Default nominal voltage: 144 V		Default: 158,4 V

In case of another nominal battery bank voltage (32 V for example), the Charged Voltage must be set manually: see section 4.2.1, setting 02.

Recommended settings:

Nominal battery voltage	*Recommended Charged Voltage setting*
12 V	*13,2 V*
24 V	*26,4 V*
36 V	*39,6 V*
48 V	*52,8 V*
60 V	*66 V*
120 V	*132 V*
144 V	*158,4 V*
288 V	*316,8 V*

3.8 Alarm, buzzer and relay

On most of the BMV's readings an alarm can be triggered when the value reaches a set threshold. When the alarm becomes active the buzzer starts to beep, the backlight flashes and the alarm icon is visible in the display along with the current value.
The corresponding segment will also flash. *AUX when a starter alarm occurs. MAIN,MID or TEMP for the corresponding alarm.*
*(*When in the setup menu and an alarm occurs, the value causing the alarm will not be visible.)

An alarm is acknowledged when a button is pressed. However, the alarm icon is displayed as long as the alarm condition remains.

It is also possible to trigger the relay when an alarm condition occurs.
The relay contact is open when the coil is de-energized (NO contact), and will close when the relay is energized.
Factory default setting: the relay is controlled by the state-of-charge of the battery bank. The relay will be energized when the state-of-charge decreases to less than 50% (the 'discharge floor'), and will be de-energized when the battery has been recharged to 90% state-of-charge. See section 4.2.2.
The relay function can be inverted: de-energized becomes energized and vice versa. See section 4.2.2.

When the relay is energized, the current drawn by the BMV will increase slightly: see technical data.

3.9 Interface options

3.9.1 PC Software BMV-Reader
BMV-Reader will show all current readings on a computer, including history data. It can also log the data to a CSV formatted file. It is available for free, and can be downloaded from our website at the Support & Downloads section. Connect the BMV to the computer with the VE.Direct to USB interface, ASS030530000.

3.9.2 Large display and remote monitoring
The Color Control GX, a display featuring a 4.3” color display, provides intuitive control and monitoring for all products connected to it. The list of Victron products that can be connected are endless: Inverters, Multis, Quattros, MPPT solar chargers, BMV-600, BMV-700, Skylla-i, Lynx Ion and more. The BMV can be connected to the Color Control GX with a VE.Direct cable. It is also possible to connect it with the VE.Direct to USB interface. Besides monitoring and controlling locally with the Color Control GX, the information is also forwarded to our free remote monitoring website: the VRM Online Portal. For more information, see the Color Control GX documentation on our website.

3.9.3 Custom integration (programming required)
The VE.Direct communications port can be used to read data and change settings. The VE.Direct protocol is extremely simple to implement. Transmitting data to the BMV is not necessary for simple applications: the BMV automatically sends all readings every second. All the details are explained in this document:
http://www.victronenergy.com/upload/documents/VE.Direct_Protocol.pdf

3.10 Additional functionality of the BMV 702

In addition to the comprehensive monitoring of the main battery system, the **BMV-702** provides a second monitoring input. This secondary input has three configurable options, described below.

3.10.1 Auxiliary battery monitoring
Wiring diagram: see the quick installation guide. Fig 3
This configuration provides basic monitoring of a second battery, displaying its voltage. This is useful for systems with a separate starter battery.

3.10.2 Battery temperature monitoring
Wiring diagram: see the quick installation guide. Fig 4
The cable with integrated temperature sensor has to be purchased separately (part no: ASS000100000). This temperature sensor is not interchangeable with other Victron temperature sensors, as provided with Multis or battery chargers. *The temperature sensor must be connected to the positive pole of the battery bank (one of the two wires of the sensor doubles as the power supply wire).*
The temperature can be displayed in degrees Celsius or degrees Fahrenheit, see section 4.2.5, setting number 67.
The temperature measurement can also be used to adjust battery capacity to temperature, see section 4.2.5, setting number 68.
The available battery capacity decreases with temperature.
Typically, the reduction, compared to the capacity at 20°C, is 18% at 0°C and 40% at -20°C.

3.10.3 Midpoint voltage monitoring
Wiring diagram: see the quick installation guide. Fig 5 - 12
One bad cell or one bad battery can destroy a large, expensive battery bank.
A short circuit or high internal leakage current in one cell for example will result in under charge of that cell and over charge of the other cells.
Similarly, one bad battery in a 24 V or 48 V bank of several series/parallel connected 12 V batteries can destroy the whole bank.
Moreover, when cells or batteries are connected in series, they should all have the same initial state-of-charge. Small differences will be ironed out during absorption or equalise charging, but large differences will result in damage during charging due to excessive gassing of the cells or batteries with the highest initial state-of-charge.
A timely alarm can be generated by monitoring the midpoint of the battery bank. For more information, see section 5.1.

4 FULL SETUP DETAILS

4.1 Using the menus

Four buttons control the BMV. The function of the buttons depends on which mode the BMV is in.

Button	Function	
	When in normal mode	**When in setup mode**
If backlight is off, press any button to restore backlight		
SETUP	Press and hold for two seconds to switch to setup mode. The display will scroll the number and description of the selected parameter.	Press SETUP at any time to return to the scrolling text, and press again to return to normal mode. *When pressing SETUP while a parameter is out of range, the display blinks 5 times and the nearest valid value is displayed.*
SELECT	Press to switch to history menu. Press to stop scrolling and show the value. Press again to switch back to normal mode.	- Press to stop scrolling after entering the setup mode with the SETUP button. - After editing the last digit, press to end editing. The value is stored automatically. Confirmation is indicated by a short beep. - If required, press again to restart editing.
SETUP/ SELECT	Press and hold both SETUP and SELECT buttons simultaneously for three seconds to restore factory settings (disabled when setting 64, lock setup, is on, see section 4.2.5)	
+	Move upwards	When not editing, press to move up to the previous parameter.
		When editing, this button will increment the value of the selected digit.
–	Move downwards	When not editing, press to move down to the next parameter.
		When editing, this button will decrement the value of the selected digit.
+/–	Press and hold both buttons simultaneously for three seconds to manually synchronise the BMV	

When power is applied for the first time or when factory settings have been restored, the BMV will start the quick setup wizard: see section 1. Thereafter, if power is applied, the BMV will start in normal mode: see section 2.

4.2 Functions overview

The following summary describes all the parameters of the BMV.
- Press SETUP for two seconds to access these functions and use the + and – buttons to browse them.
- Press SELECT to access the desired parameter.
- Use SELECT and the + and – buttons to customize. A short beep confirms the setting.
- Press SETUP at any time to return to return to the scrolling text, and press again to return to normal mode.

4.2.1 Battery settings

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01. Battery capacity

Battery capacity in amp hours

Default	**Range**	**Step size**
200 Ah	1 – 9999 Ah	1 Ah

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02. Charged Voltage

The battery voltage must be above this voltage level to consider the battery as fully charged.

The charged-voltage-parameter should always be slightly below the end of charge voltage of the charger (usually 0.2V or 0.3V below the 'float' voltage of the charger).
See section 3.7 for recommended settings.

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Default	**Range**	**Step size**
See table, sect 3.7	0 – 95 V	0,1 V

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Default	**Range**	**Step size**
158,4 V	0 – 384 V	0,1 V

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03. Tail current

Once the charge current has dropped to less than the set tail current (expressed as percentage of the battery capacity), the battery is considered as fully charged.

Remark:
Some battery chargers stop charging when the current drops below a set threshold. The tail current must be set higher than this threshold.

Default	**Range**	**Step size**
4%	0,5 – 10%	0,1%

04. Charged detection time

This is the time the charged-parameters (**Charged Voltage** and **Tail Current**) must be met in order to consider the battery fully charged.

Default	Range	Step size
3 minutes	1 – 50 minutes	1 minute

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05. Peukert exponent

When unknown it is recommended to keep this value at 1.25 for lead acid batteries and 1.10 for Li-ion batteries. A value of 1.00 disables the Peukert compensation.

Default	Range	Step size
1,25	1 – 1,5	0,01

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06. Charge Efficiency Factor

The Charge Efficiency Factor compensates for the Ah losses during charging.
100 % means no loss.

Default	Range	Step size
95%	50 – 100%	1%

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07. Current threshold

When the current measured falls below this value it will be considered zero.
The current threshold is used to cancel out very small currents that can negatively affect the long term state-of-charge readout in noisy environments. For example if the actual long term current is 0,0 A and due to injected noise or small offsets the battery monitor measures -0,05 A,and in the long term the BMV can incorrectly indicate that the battery needs recharging. When the current threshold in this example is set to 0,1 A, the BMV calculates with 0,0 A so that errors are eliminated.
A value of 0,0 A disables this function.

Default	Range	Step size
0,1 A	0 – 2 A	0,01 A

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08. Time-to-go averaging period

Specifies the time window (in minutes) that the moving averaging filter works with.
A value of 0 disables the filter and gives an instantaneous (real-time) readout; however the displayed value may fluctuate heavily. Selecting the longest time (12 minutes) ensures that only long term load fluctuations are included in the time-to-go calculations.

Default	Range	Step size
3 minutes	0 – 12 minutes	1 minute

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09. Zero current calibration

If the BMV reads a non-zero current even when there is no load and the battery is not being charged, this option can be used to calibrate the zero reading.
Ensure that there really is no current flowing into or out of the battery (disconnect the cable between the load and the shunt), then press SELECT.

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10. Synchronize

This option can be used to manually synchronize the BMV.
Press SELECT to synchronize.
The BMV can also be synchronized when in normal operating mode by holding the + and – buttons simultaneously for 3 seconds.
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4.2.2 Relay settings
Remark: thresholds are disabled when set at 0

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11. Relay mode
DFLT Default mode. The relay thresholds Nos. 16 up to 31 can be used to control the relay.
CHRG Charger mode. The relay will close when the state-of-charge falls below setting 16 (discharge floor) **or** when the battery voltage falls below setting 18 (low voltage relay). The relay will be open when the state-of-charge is higher than setting 17 (clear state-of-charge relay) **and** the battery voltage is higher than setting 19 (clear low voltage relay).
Application example: start and stop control of a generator, together with settings 14 and 15.
REM Remote control of the relay. In this mode the relay can be controlled by another device, for example the Color Control GX.

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12. Invert relay
This function enables selection between a normally de-energized (contact open) or a normally energized (contact closed) relay. When inverted, the open and closed conditions as described in setting 11 (DFLT and CHRG), and settings 14 up to 31 are inverted.
The normally energized setting will slightly increase supply current in the normal operating mode.

Default	**Range**
OFF: Normally de-energized	OFF: Normally de-energized / ON: normally energized

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13. Relay state (read only)
Displays whether the relay is open or closed (de-energized or energized).

Range
OPEN/CLSD

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14. Relay minimum closed time
Sets the minimum amount of time that the CLOSED condition will remain present after the relay has been energized. (changes to OPEN and de-energized if the relay function has been inverted)
Application example: set a minimum generator run time (relay in CHRG mode).

15. Relay-off delay
Sets the amount of time the 'de-energize relay' condition must be present before the relay opens.
Application example: keep a generator running for a while to better charge the battery (relay in CHRG mode).

Default	**Range**	**Step size**
0 minutes	0 – 500 minutes	1 minute

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16. SOC relay (Discharge floor)
When the state-of-charge percentage has fallen below this value, the relay will close.
The time-to-go displayed is the time to reach the discharge floor.

Default	**Range**	**Step size**
50%	0 – 99%	1%

17. Clear SOC relay

When the state-of-charge percentage has risen above this value, the relay will open (after a delay, depending on setting 14 and/or 15). This value needs to be greater than the previous parameter setting. When the value is equal to the previous parameter the state-of-charge percentage will not close the relay.

Default	Range	Step size
90%	0 – 99%	1%

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18. Low voltage relay

When the battery voltage falls below this value for more than 10 seconds the relay will close.

19. Clear low voltage relay

When the battery voltage rises above this value, the relay will open (after a delay, depending on setting 14 and/or 15). This value needs to be greater than or equal to the previous parameter.

20. High voltage relay

When the battery voltage rises above this value for more than 10 seconds the relay will close.

21. Clear high voltage relay

When the battery voltage falls below this value, the relay will open (after a delay, depending on setting 14 and/or 15). This value needs to be less than or equal to the previous parameter.

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Default	Range	Step size
0 V	0 – 95 V	0,1 V

BMV-700H

Default	Range	Step size
0 V	0 – 384 V	0,1 V

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22. Low starter voltage relay - 702 only

When the auxiliary (e.g. starter battery) voltage falls below this value for more than 10 seconds the relay will be activated.

23. Clear low starter voltage relay - 702 only

When the auxiliary voltage rises above this value, the relay will open (after a delay, depending on setting 14 and/or 15). This value needs to be greater than or equal to the previous parameter.

24. High starter voltage relay - 702 only

When the auxiliary (e.g. starter battery) voltage rises above this value for more than 10 seconds, the relay will be activated.

25. Clear high starter voltage relay - 702 only

When the auxiliary voltage falls below this value, the relay will open (after a delay, depending on setting 14 and/or 15). This value needs to be less than or equal to the previous parameter.

Default	Range	Step size
0 V	0 – 95 V	0,1 V

---

26. High temperature relay - 702 only

When the battery temperature rises above this value for more than 10 seconds, the relay will be activated.

27. Clear high temperature relay - 702 only

When the temperature falls below this value, the relay will open (after a delay, depending on setting 14 and/or 15). This value needs to be less than or equal to the previous parameter.

28. Low temperature relay - 702 only

When the temperature falls below this value for more than 10 seconds, the relay will be activated.

29. Clear low temperature relay - 702 only

When the temperature rises above this value, the relay will open (after a delay, depending on setting 14 and/or 15). This value needs to be greater than or equal to the previous parameter. *See setting 67 for choosing between °C and °F.*

Default	Range	Step size
0°C	-99 – 99°C	1°C
0°F	-146 – 210°F	1°F

---

30. Mid voltage relay - 702 only

When the mid-point voltage deviation rises above this value for more than 10 seconds, the relay will be activated. *See section 5.2 for more information about the mid-point voltage.*

31. Clear mid voltage relay - 702 only

When the mid-point voltage deviation falls below this value, the relay will open (after a delay, depending on setting 14 and/or 15). This value needs to be less than or equal to the previous parameter.

Default	Range	Step size
0%	0 – 99%	0,1%

4.2.3 Alarm-Buzzer settings
Remark: thresholds are disabled when set at 0

---

32. Alarm buzzer
When set, the buzzer will sound on an alarm. After a button is pressed the buzzer will stop sounding. When not enabled the buzzer will not sound on an alarm condition.

Default	**Range**
ON	ON/OFF

---

33. Low SOC alarm
When the state-of-charge falls below this value for more than 10 seconds the low SOC alarm is turned on. This is a visual and audible alarm. It does not energize the relay.

34. Clear low SOC alarm
When the state-of-charge rises above this value, the alarm is turned off. This value needs to be greater than or equal to the previous parameter.

Default	**Range**	**Step size**
0%	0 – 99%	1%

---

35. Low voltage alarm
When the battery voltage falls below this value for more than 10 seconds the low voltage alarm is turned on. This is a visual and audible alarm. It does not energize the relay.

36. Clear low voltage alarm
When the battery voltage rises above this value, the alarm is turned off. This value needs to be greater than or equal to the previous parameter.

37. High voltage alarm - When the battery voltage rises above this value for more than 10 seconds the high voltage alarm is turned on. This is a visual and audible alarm. It does not energize the relay.

38. Clear high voltage alarm - When the battery voltage falls below this value, the alarm is turned off. This value needs to be less than or equal to the previous parameter.

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Default	**Range**	**Step size**
0 V	0 – 95 V	0,1 V

BMV-700H

Default	**Range**	**Step size**
0 V	0 – 384 V	0,1 V

---

39. Low starter voltage alarm - 702 only
When the auxiliary (e.g. starter battery) voltage falls below this value for more than 10 seconds the alarm will be activated. This is a visual and audible alarm. It does not energize the relay.

40. Clear low starter voltage alarm - 702 only
When the auxiliary voltage rises above this value, the alarm is switched off. This value needs to be greater than or equal to the previous parameter.

41. High starter voltage alarm - 702 only
When the auxiliary (e.g. starter battery) voltage rises above this value for more than 10 seconds, the alarm will be activated. This is a visual and audible alarm. It does not energize the relay.

42. Clear high starter voltage alarm - 702 only
When the auxiliary voltage falls below this value, the alarm is switched off. This value needs to be less than or equal to the previous parameter.

Default	Range	Step size
0 V	0 – 95 V	0,1 V

---

43. High temperature alarm - 702 only
When the battery temperature rises above this value for more than 10 seconds, the alarm will be activated. This is a visual and audible alarm. It does not energize the relay.

44. Clear high temperature alarm - 702 only
When the temperature falls below this value, the alarm is switched off. This value needs to be less than or equal to the previous parameter.

45. Low temperature alarm - 702 only
When the temperature falls below this value for more than 10 seconds, the alarm will be activated. This is a visual and audible alarm. It does not energize the relay.

46. Clear low temperature alarm - 702 only
When the temperature rises above this value, the alarm is switched off. This value needs to be greater than or equal to the previous parameter.
See parameter 67 for choosing between °C and °F.

Default	Range	Step size
0°C	-99 – 99°C	1°C
0°F	-146 – 210°F	1°F

47. Mid voltage alarm - 702 only
When the mid-point voltage deviation rises above this value for more than 10 seconds, the alarm will be activated. This is a visual and audible alarm. It does not energize the relay.
See section 5.2 for more information about midpoint voltage.

Default	Range	Step size
2%	0 – 99%	0,1%

48. Clear mid voltage alarm - 702 only
When the mid-point voltage deviation falls below this value, the alarm is switched off. This value needs to be less than or equal to the previous parameter.

Default	Range	Step size
1,5%	0 – 99%	0,1%

4.2.4 Display settings

49. Backlight intensity
The intensity of the backlight, ranging from 0 (always off) to 9 (maximum intensity

Default	Range	Step size
5	0 – 9	1

50. Backlight always on
When set the backlight will not automatically turn off after 60 seconds of inactivity.

Default	Range
OFF	OFF/ON

51. Scroll speed
The scroll speed of the display, ranging from 1 (very slow) to 5 (very fast).

Default	Range	Step size
2	1 – 5	1

52. Main voltage display
Must be ON to display the voltage of the main battery in the monitoring menu.

53. Current display
Must be ON to display current in the monitoring menu.

54. Power display
Must be ON to display power in the monitoring menu.

55. Consumed Ah display
Must be ON to display consumed Ah in the monitoring menu.

56. State-of-charge display
Must be ON to display state-of-charge in the monitoring menu.

57. Time-to-go display
Must be ON to display time-to-go in the monitoring menu.

58 Starter voltage display - 702 only
Must be ON to display the auxiliary voltage in the monitoring menu.

59. Temperature display - 702 only
Must be ON to display the temperature in the monitoring menu.

60. Mid-voltage display - 702 only
Must be ON to display the mid-point voltage in the monitoring menu.

Default	Range
ON	ON/OFF

4.2.5 Miscellaneous

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61. Software version (read only)
The software version of the BMV

62. Restore defaults
Resets all settings to factory default by pressing SELECT.
When in normal operating mode, factory settings can be restored by pressing SETUP and SELECT simultaneously for 3 seconds (only if setting 64, Lock setup, is off).

63. Clear history
Clears all history data by pressing SELECT.

---

64. Lock setup
When on, all settings (except this one) are locked and cannot be altered.

Default	Range
OFF	OFF/ON

---

65. Shunt current
When using a shunt other than the one supplied with the BMV, set to the rated current of the shunt.

Default	Range	Step size
500 A	1 – 9999 A	1 A

---

66. Shunt voltage
When using a shunt other than the one supplied with the BMV, set to the rated voltage of the shunt.

Default	Range	Step size
50 mV	1 mV– 100 mV	1 mV

67. Temperature unit
CELC Displays the temperature in °C.
FAHR Displays the temperature in °F.

Default	Range
CELC	CELC/FAHR

---

68. Temperature coefficient
This is the percentage the battery capacity changes with temperature, when temperature decreases to less than 20°C (above 20°C the influence of temperature on capacity is relatively low and is not taken into account). The unit of this value is "%cap/°C" or percent capacity per degree Celsius. The typical value (below 20°C) is 1%cap/°C for lead acid batteries, and 0,5%cap/°C for Lithium Iron Phosphate batteries.

Default	Range	Step size
0%cap/°C	0 – 2%cap/°C	0,1%cap/°C

---

69. Aux input
Sets the function of the auxiliary input:
START Auxiliary voltage, e.g. a starter battery.
MID Mid-point voltage.
TEMP Battery temperature.
The cable with integrated temperature sensor has to be purchased separately (part no: ASS000100000). This temperature sensor is not interchangeable with other Victron temperature sensors, as provided with Multis or battery chargers.

4.3 History data

The BMV tracks several parameters regarding the state of the battery which can be used to evaluate usage patterns and battery health.

Enter history data by pressing the SELECT button when in normal mode.
Press + or – to browse the various parameters.
Press SELECT again to stop scrolling and show the value.
Press + or – to browse the various values.
Press SELECT again to leave the historical menu and go back to normal operation mode.

The history data is stored in non-volatile memory, and will not be lost when the power supply to the BMV is interrupted.

Parameter	Description
A dEEPESt d ISCHArGE	The deepest discharge in Ah.
b LASt d ISCHArGE	The largest value recorded for Ah consumed since the last synchronisation.
C AVErAGE d ISCHArGE	Average discharge depth
d CYCLES	The number of charge cycles. A charge cycle is counted every time the state-of-charge drops below 65 %, then rises above 90 %
E d ISCHArGES	The number of full discharges. A full discharge is counted when the state of charge reaches 0 %.
F CUMULAt IVE AH	The cumulative number of Amp hours drawn from the battery.
G LOWESt VOLtAGE	The lowest battery voltage.
H HIGHESt VOLtAGE	The highest battery voltage.
I dAYS SINCE LASt CHArGE	The number of days since the last full charge.
J SYNCHrON ISAt IONS	The number of automatic synchronisations
L LOW VOLtAGE ALArMS	The number of low voltage alarms.
M HIGH VOLtAGE ALArMS	The number of high voltage alarms.
*P LOWESt AUX VOLtAGE	The lowest auxiliary battery voltage.
*Q HIGHESt AUX VOLtAGE	The highest auxiliary battery voltage.
r d ISCHArGEd ENErGY	The total amount of energy drawn from the battery in (k)Wh
S CHArGEd ENErGY	The total amount of energy absorbed by the batteryin (k)Wh

**** BMV-702 only***

5 MORE ABOUT PEUKERT'S FORMULA AND MIDPOINT MONITORING

5.1 Peukert's formula: battery capacity and discharge rate

The value which can be adjusted in Peukert's formula is the exponent n: see the formula below.
In the BMV Peukert's exponent can be adjusted from 1.00 to 1.50. The higher the Peukert exponent the faster the effective capacity "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. The default setting for the Peukert exponent is 1.25. This is an acceptable average value for most lead acid batteries. Peukert's equation is stated below:

$Cp = I^{n} \cdot t$ where Peukert's 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 calculate the Peukert exponent using these two specifications.

5 h rating

$C_{5h} = 75Ah$

$t_1 = 5h$

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

[1] Please note that the rated battery capacity can also be 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 C_{20} rating (low discharge current) a second rating with a substantially higher discharge current is chosen.

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

$t_2 = 20h$

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

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

A Peukert calculator is available at
http://www.victronenergy.com/support-and-downloads/software/

Please note that Peukert's formula is no more than a rough approximation of reality, and that at very high currents, batteries will give even less capacity than predicted from a fixed exponent.
We recommend not to change the default value in the BMV, except in case of Li-ion batteries: *See section 6.*

5.2 Midpoint voltage monitoring

Wiring diagram: see the quick installation sheet. Fig 5-12
One bad cell or one bad battery can destroy a large, expensive battery bank.
A short circuit or high internal leakage current in one cell for example will result in under charge of that cell and over charge of the other cells.
Similarly, one bad battery in a 24 V or 48 V bank of several series/parallel connected 12 V batteries can destroy the whole bank.
Moreover, when new cells or batteries are connected in series, they should all have the same initial state-of-charge. Small differences will be ironed out during absorption or equalise charging, but large differences will result in damage during charging due to excessive gassing of the cells or batteries with the highest initial state-of-charge.

A timely alarm can be generated by monitoring the midpoint of the battery bank (i. e. by splitting the string voltage in half and comparing the two string voltage halves).
Please note that the midpoint deviation will be small when the battery bank is at rest, and will increase:

a) at the end of the bulk phase during charging (the voltage of well charged cells will increase rapidly while lagging cells still need more charging),
b) when discharging the battery bank until the voltage of the weakest cells starts to decrease rapidly, and
c) at high charge and discharge rates.

5.2.1 How the % midpoint deviation is calculated

d (%) = 100*(Vt – Vb) / V

where:
d is the deviation in %
Vt is the top string voltage
Vb is the bottom string voltage
V is the voltage of the battery (V = Vt + Vb)

5.2.2 Setting the alarm level:

In case of VRLA (gel or AGM) batteries, gassing due to overcharging will dry out the electrolyte, increasing internal resistance and ultimately resulting in irreversible damage. Flat plate VRLA batteries start to lose water when the charge voltage approaches 15 V (12 V battery).
Including a safety margin, the midpoint deviation should therefore remain below 2% during charging.
When, for example, charging a 24 V battery bank at 28,8 V absorption voltage, a midpoint deviation of 2% would result in:
Vt = V*d/100* + Vb = V*d/100 + V – Vt
Therefore:
Vt = (V*(1+d/100) / 2 = 28,8*1,02 / 2 ≈ 14,7 V
And:
Vb = (V*(1-d/100) / 2 = 28,8*0,98 / 2 ≈ 14,1 V
Obviously, a midpoint deviation of more than 2% will result in overcharging the top battery **and** undercharging the bottom battery.
Two good reasons to set the midpoint alarm level at not more than d = 2%.

This same percentage can be applied to a 12 V battery bank with a 6 V midpoint.
In case of a 48 V battery bank consisting of 12 V series connected batteries, the % influence of one battery on the midpoint is reduced by half. The midpoint alarm level can therefore be set at a lower level.

5.2.3 What to do in case of an alarm during charging

In case of a new battery bank the alarm is probably due to differences in initial state-of-charge. If d increases to more than 3%: stop charging and charge the individual batteries or cells separately first, or reduce charge current substantially and allow the batteries to equalize over time.
If the problem persists after several charge-discharge cycles:

a) In case of series-parallel connection disconnect the midpoint parallel connection wiring and measure the individual midpoint voltages during absorption charging to isolate batteries or cells which need additional charging.
b) Charge and then test all batteries or cells individually.

In case of an older battery bank which has performed well in the past, the problem may be due to:

c) Systematic under charge, more frequent charging needed, or equalization charge needed (flooded deep cycle flat plate or OPzS batteries). Better and regular charging will solve the problem.
d) One or more faulty cells: proceed as suggested under a) or b).

5.2.4 What to do in case of an alarm during discharging

The individual batteries or cells of a battery bank are not identical, and when fully discharging a battery bank the voltage of some cells will start dropping earlier than others. The midpoint alarm will therefore nearly always trip at the end of a deep discharge.

If the midpoint alarm trips much earlier (and does not trip during charging), some batteries or cells may have lost capacity or may have developed a higher internal resistance than others. The battery bank may have reached the end of service life, or one of more cells or batteries have developed a fault:

a) In case of series-parallel connection, disconnect the midpoint parallel connection wiring and measure the individual midpoint voltages during discharging to isolate faulty batteries or cells.
b) Charge and then test all batteries or cells individually.

6 LITHIUM IRON PHOSPHATE BATTERIES (LiFePO4)

LiFePO4 is the most commonly used Li-ion battery chemistry.

The factory default “charged parameters” are in general also applicable to $LiFePO_4$ batteries.

Some battery chargers stop charging when the current drops below a set threshold. The tail current must be set higher than this threshold.

The charge efficiency of Li-ion batteries is much higher than of lead acid batteries: We recommend to set the charge efficiency at 99 %.

When subjected to high discharge rates, $LiFePO_4$ batteries perform much better than lead-acid batteries. Unless the battery supplier advizes otherwise, we recommend settingPeukert’s exponent to 1.10.

Important warning

Li-ion batteries are expensive and can be irreparably 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 positive 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 shut down has occurred. After shutdown due to low cell voltage, a capacity reserve of approximately 1 Ah per 100 Ah battery capacity is left in a Li-ion battery. The battery will be damaged if the remaining capacity reserve is drawn from the battery. A residual current of 4 mA for example may damage a 100 Ah battery if the system is left in discharged state during more than 10 days (4 mA x 24 h x 10 days = 0,96 Ah).

A BMV draws 4 mA from a 12 V battery. The positive supply must therefore be interrupted if a system with Li-ion batteries is left unattended during a period long enough for the current draw by the BMV to completely discharge the battery.