victron energy
BLUE POWER

Manual EN

BlueSolar charge controllers

MPPT 150/45-Tr	MPPT 150/45-MC4
MPPT 150/60-Tr	MPPT 150/60-MC4
MPPT 150/70-Tr	MPPT 150/70-MC4
MPPT 150/85-Tr	MPPT 150/85-MC4
MPPT 150/100-Tr	MPPT 150/100-MC4

1. General Description

1.1 Ultra-fast Maximum Power Point Tracking (MPPT)
Especially in case of a clouded sky, when light intensity is changing continuously, an ultra fast MPPT controller will improve energy harvest by up to 30% compared to PWM charge controllers and by up to 10% compared to slower MPPT controllers.

1.2 Advanced Maximum Power Point Detection in case of partial shading conditions
If partial shading occurs, two or more maximum power points may be present on the power-voltage curve.
Conventional MPPT's tend to lock to a local MPP, which may not be the optimum MPP.
The innovative BlueSolar algorithm will always maximize energy harvest by locking to the optimum MPP.

1.3 Outstanding conversion efficiency
No cooling fan. Maximum efficiency exceeds 98%. Full output current up to 40°C (104°F).

1.4 Flexible charge algorithm
Eight preprogrammed algorithms, selectable with a rotary switch.

1.5 Extensive electronic protection
Over-temperature protection and power derating when temperature is high.
PV short circuit and PV reverse polarity protection.
PV reverse current protection.

1.6 Internal temperature sensor
Compensates absorption and float charge voltages for temperature.

1.7 Automatic battery voltage recognition
The controllers will automatically adjust to a 12V, 24V or a 48V system. A computer or a Color Control panel is required to set the controller to 36V.

1.8 Adaptive three step charging

The BlueSolar MPPT Charge Controller is configured for a three step charging process: Bulk – Absorption - Float.

A regular equalization charge can also be programmed: see section 3.8 of this manual.

1.8.1. Bulk stage

During this stage the controller delivers as much charge current as possible to rapidly recharge the batteries.

1.8.2. Absorption stage

When the battery voltage reaches the absorption voltage setting, the controller switches to constant voltage mode.

When only shallow discharges occur the absorption time is kept short in order to prevent overcharging of the battery. After a deep discharge the absorption time is automatically increased to make sure that the battery is completely recharged. Additionally, the absorption period is also ended when the charge current decreases to less than 2 A.

1.8.3. Float stage

During this stage, float voltage is applied to the battery to maintain it in a fully charged state.

1.9 Connectivity

See section 3.8 of this manual.

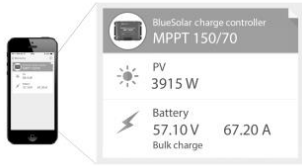
1.10 Remote on-off

VE.Direct non inverting remote on-off cable (ASS030550300) needed. An input HIGH (Vi > 8V) will switch the controller on, and an input LOW (V < 2V, or free floating) will switch the controller off.

Application example: on/off control by a VE.Bus BMS when charging Li-ion batteries.

1.11 Real-time data display on Apple and Android smartphones, tablets and other devices

VE.Direct to Buetooth Low Energy (BLE) dongle needed: see our website.



2. Safety instructions

Danger of explosion from sparking

Danger of electric shock

● please read this manual carefully before the product is installed and put into use.
● This product is designed and tested in accordance with international standards. The equipment should be used for the designated application only.
● Install the product in a heatproof environment. Ensure therefore that there are no chemicals, plastic parts, curtains or other textiles, etc. in the immediate vicinity of the equipment.
● Ensure that the equipment is used under the correct operating conditions. Never operate it in a wet environment.
● Never use the product at sites where gas or dust explosions could occur.
● Ensure that there is always sufficient free space around the product for ventilation.
● Refer to the specifications provided by the manufacturer of the battery to ensure that the battery is suitable for use with this product. The battery manufacturer's safety instructions should always be observed.
● Protect the solar modules from incident light during installation, e.g. cover them.
● Never touch uninsulated cable ends.
● Use only insulated tools.
● Connections must always be made in the sequence described in section 3.5.
● The installer of the product must provide a means for cable strain relief to prevent the transmission of stress to the connections.
● In addition to this manual, the system operation or service manual must include a battery maintance manual applicable to the type of batteries used.
● Use flexible multistranded copper cable for the battery and PV connections.
The maximum diameter of the individual strands is 0,4 mm/0,125 mm² (0.016 inch/AWG26).

A 25 mm² cable, for example, should have at least 196 strands (class 5 or higher stranding according to VDE 0295, IEC 60228 and BS6360). Also known as H07V-K cable.
An AWG2 gauge cable should have at least 259/26 stranding (259 strands of AWG26).
In case of thicker strands the contact area will be too small and the resulting high contact resistance will cause severe overheating, eventually resulting in fire.

3. Installation

3.1 General

● Mount vertically on a non-flammable surface, with the power terminals facing downwards.
● Mount close to the battery, but never directly above the battery (in order to prevent damage due to gassing of the battery).
● Grounding: the heatsink of the controller should be connected to the grounding point.

Tr models: use flexible multistranded copper cable for the battery and PV connections: see safety instructions.
MC4 models: several splitter pairs will be needed to parallel the strings of solar panels.

3.2 PV configuration

● The controllers will operate only if the PV voltage exceeds battery voltage (Vbat).
● PV voltage must exceed Vbat + 5V for the controller to start. Thereafter minimum PV voltage is Vbat + 1V.
● Maximum open circuit PV voltage: 150V.

The controllers can be used with any PV configuration that satisfies the three above mentioned conditions.
For example:
24V battery and mono- or polycristalline panels
● Minimum number of cells in series: 72 (2x 12V panel in series or one 24V panel).

● Recommended number of cells for highest controller efficiency: 144 cells (4x 12V panel or 2x 24V panel in series).
● Maximum: 216 cells (6x 12V or 3x 24V panel in series).
48V battery and mono- or polycristalline panels
● Minimum number of cells in series: 144 (4x 12V panel or 2x 24V panel in series).
● Maximum: 216 cells.
Remark: at low temperature the open circuit voltage of a 216 cell solar array may exceed 150 V, depending on local conditions and cell specifications. In that case the number of cells in series must be reduced.

3.3 Cable connection sequence (see figure 1)
First: connect the battery.
Second: connect the solar array (when connected with reverse polarity, the controller will heat up but will not charge the battery).

3.4 More about automatic battery voltage recognition
The system voltage is stored in non volatile memory.
In case of a 24 V or 48 Vbattery, a reset (to 12 V) occurs only when the output voltage decreases to less than 2 V and the voltage on the PV input exceeds 7 V. This may occur when the battery has been disconnected before PV voltage starts to rise in the early morning. When the (24 V or 48 V) battery is reconnected later during the day, the system voltage is restored to 24 V resp. 48 V after 10 seconds if the battery voltage exceeds 17,5 V resp. 35 V.
Automatic voltage recognition can be switched off and a fixed 12/24/36 or 48 V system voltage can be set with a computer or a Color Control panel.

The controller can be reset by short circuiting the output and applying a voltage exceeding 7 V on the input (for example with a small power supply, or a solar panel) during a few seconds. After a reset, the controller will automatically adjust itself to a 12V system, a 24V system (when connecting a 24 V battery with at least 17,5 V) or a 48V system (when connecting a 48 V battery with at least 35 V). A computer or a Color Control panel is required to set the MPPT to 36V.

3.5 Configuration of the controller

Fully programmable charge algorithm (see the software page on our website) and eight preprogrammed charge algorithms, selectable with a rotary switch:

Pos	Suggested battery type	Absorption V	Float V	Equalize V @%I_{nom}	dV/dT mV/°C
0	Gel Victron long life (OPzV) Gel exide A600 (OPzV) Gel MK	28,2	27,6	31,8 @8%	-32
1	Gel Victron deep discharge Gel Exide A200 AGM Victron deep discharge Stationary tubular plate (OPzS) Rolls Marine (flooded) Rolls Solar (flooded)	28,6	27,6	32,2 @8%	-32
2	**Default setting** Gel Victron deep discharge Gel Exide A200 AGM Victron deep discharge Stationary tubular plate (OPzS) Rolls Marine (flooded) Rolls Solar (flooded)	28,8	27,6	32,4 @8%	-32
3	AGM spiral cell Stationary tubular plate (OPzS) Rolls AGM	29,4	27,6	33,0 @8%	-32
4	PzS tubular plate traction batteries or OPzS batteries	29,8	27,6	33,4 @25%	-32
5	PzS tubular plate traction batteries or OPzS batteries	30,2	27,6	33,8 @25%	-32
6	PzS tubular plate traction batteries or OPzS batteries	30,6	27,6	34,2 @25%	-32
7	Lithium Iron Phosphate ($LiFePo_4$) batteries	28,4	27,0	n.a.	0

Note: divide all values by two in case of a 12V system and multiply by two in case of a 48V system.

A binary LED code helps determining the position of the rotary switch.
After changing the position of the rotary switch, the LED's will blink during 4 seconds as follows:

Switch position	LED Float	LED Abs	LED Bulk	Blink frequency
0	1	1	1	fast
1	0	0	1	slow
2	0	1	0	slow
3	0	1	1	slow
4	1	0	0	slow
5	1	0	1	slow
6	1	1	0	slow
7	1	1	1	slow

Thereafter, normal indication resumes, as described below.

3.6 LED's

LED indication:

- ● permanent on
- ◎ blinking
- ○ off

Regular operation

LEDs	Bulk	Absorption	Float
Bulk (*1)	●	○	○
Absorption	○	●	○
Automatic equalisation (*2)	○	●	●
Float	○	○	●

Note (*1): The bulk led will blink briefly every 3 seconds when the system is powered but there is insufficient power to start charging.
Note (*2): Automatic equalisation is introduced in firmware v1.16

Fault situations

LEDs	Bulk	Absorption	Float
Charger temperature too high	○	○	◎
Charger over-current	◎	○	◎
Charger or panel over-voltage	○	◎	◎
Internal error (*3)	◎	◎	○

Note (*3): E.g. calibration and/or settings data lost, current sensor issue.

3.7 Battery charging information

The charge controller starts a new charge cycle every moring, when the sun starts shining.
The maximum duration of the absorption period is determined by the battery voltage measured just before the solar charger starts up in the morning:

Battery voltage Vb (@start-up)	Maximum absorption time
Vb < 23,8V	6 h
23,8V < Vb < 24,4V	4 h
24,4V < Vb < 25,2V	2 h
Vb > 25,2V	1 h

(divide voltages by 2 for a 12 V system and multiply by two in case of a 48V system)

If the absorption period is interrupted due to a cloud or due to a power hungry load, the absorption process will resume when absorption voltage is reached again later on the day, until the absorption period has been completed.

The absorption period also ends when the output current of the solar charger drops to less than 2 Amps, not because of low solar array output but because the battery is fully charged (tail current cut off).

This algorithm prevents over charge of the battery due to daily absorption charging when the system operates without load or with a small load.

3.7.1 Automatic equalization

Automatic equalization is default set to “OFF”. By using the configuration tool mpptprefs this setting can be configured with a number between 1 (every day) and 250 (once every 250 days). When automatic equalization is active, the absorption charge will be followed by a voltage limited constant current period (see table in section 3.5). The current is limited to 8% of the bulk current for all VRLA (Gel or AGM) batteries and some flooded batteries, and to 25% of the bulk current for all tubular plate batteries and the user defined battery type. The bulk current is the rated charger current unless a lower maximum current setting has been chosen.
In case of all VRLA batteries and some flooded batteries (algorithm number 0, 1, 2 or 3) automatic equalization ends when the voltage limit maxV has been reached, or after t = (absorption time)/8, whichever comes first.
For all tubular plate batteries and the user defined battery type automatic equalization ends after t = (absorption time)/2.
When automatic equalisation is not completely finished within one day, it will not resume the next day, the next equalisation session will take place as determined by the day interval.

3.8 Connectivity

Several parameters can be customized (VE.Direct to USB cable, ASS030530000, and a computer needed). See the data communication white paper on our website.
The required software can be downloaded from
http://www.victronenergy.nl/support-and-downloads/software/

The charge controller can be connected to a MPPT Control or a Color Control panel (BPP000300100R), with a VE.Direct to VE.Direct cable.

MPPT Control

Color Control

4. Troubleshooting

Problem	Possible cause	Solution
Charger does not function	Reversed PV connection	Connect PV correctly
	Reverse battery connection	Non replacable fuse blown. Return to VE for repair
The battery is not fully charged	A bad battery connection	Check battery connection
	Cable losses too high	Use cables with larger cross section
	Large ambient temperature difference between charger and battery ($T_{ambient\_chrg} > T_{ambient\_batt}$)	Make sure that ambient conditions are equal for charger and battery
	Only for a 24V system: wrong system voltage chosen (12V instead of 24V) by the charge controller	Disconnect PV and battery, after making sure that the battery voltage is at least >19V, reconnect properly (reconnect battery first)
The battery is being overcharged	A battery cell is defect	Replace battery
	Large ambient temperature difference between charger and battery ($T_{ambient\_chrg} < T_{ambient\_batt}$)	Make sure that ambient conditions are equal for charger and battery

5. Specifications

BlueSolar charge controller	MPPT 150/45	MPPT 150/60	MPPT 150/70
Battery voltage	12/24/48 V Auto Select (36 V: manual)		
Maximum battery current	45 A	60 A	70 A
Maximum PV power, 12V 1a,b)	650 W	860 W	1000 W
Maximum PV power, 24V 1a,b)	1300 W	1720 W	2000 W
Maximum PV power, 48V 1a,b)	2600 W	3440 W	4000 W
Maximum PV open circuit voltage	150 V		
Peak efficiency	98 %		
Self consumption	Less than 35 mA @ 12 V / 20 mA @ 48 V		
Charge voltage 'absorption'	Default setting: 14,4 V / 28,8 V / 57,6 V (adjustable)		
Charge voltage 'equalization'	Default setting: 16,2 V / 32,4 V / 64,8 V (adjustable)		
Charge voltage 'float'	Default setting: 13,8 V / 27,6 V / 55,2 V (adjustable)		
Charge algorithm	multi-stage adaptive (eight preprogrammed algorithms)		
Temperature compensation	-16 mV/°C / -32 mV/°C / -64 mV/°C		
Protection	Battery reverse polarity (fuse, not user accessible) Output short circuit / Over temperature		
Operating temperature	-30 to +60°C (full rated output up to 40°C)		
Humidity	95 %, non-condensing		
Maximum altitude	2000m		
Environmental condition	Indoor, unconditioned		
Pollution degree	PD3		
Data communication port and remote on/off	VE.Direct See the data communication white paper on our website		
Parallel operation	Yes, but not synchronized		
ENCLOSURE			
Colour	Blue (RAL 5012)		
PV terminals 2)	35 mm² / AWG2 (Tr models), or dual MC4 connectors (MC4 models)		
Battery terminals	35 mm² / AWG2		
Protection category	IP43 (electronic components) IP 22 (connection area)		
Weight	3 kg		
Dimensions (h x w x d)	Tr models: 185 x 250 x 95 mm MC4 models: 215 x 250 x 95 mm		
STANDARDS			
Safety	EN/IEC 62109		

1a) If more PV power is connected, the controller will limit input power to the maximum power.
1b) PV voltage must exceed Vbat + 5V for the controller to start.
Thereafter minimum PV voltage is Vbat + 1V.
2) MC4 models: several splitter pairs will be needed to parallel the strings of solar panels

Specifications, continued

BlueSolar charge controller	MPPT 150/85	MPPT 150/100
Battery voltage	12/24/48 V Auto Select (36 V: manual)	
Maximum battery current	85 A	100 A
Maximum PV power, 12V 1a,b)	1200 W	1450 W
Maximum PV power, 24V 1a,b)	2400 W	2900 W
Maximum PV power, 48V 1a,b)	4900 W	5800 W
Maximum PV open circuit voltage	150 V	
Peak efficiency	98 %	
Self consumption	Less than 35 mA @ 12 V / 20 mA @ 48 V	
Charge voltage 'absorption'	Default setting: 14,4 V / 28,8 V / 57,6 V (adjustable)	
Charge voltage 'equalization'	Default setting: 16,2 V / 32,4 V / 64,8 V (adjustable)	
Charge voltage 'float'	Default setting: 13,8 V / 27,6 V / 55,2 V (adjustable)	
Charge algorithm	multi-stage adaptive (eight preprogrammed algorithms)	
Temperature compensation	-16 mV/°C / -32 mV/°C / -64 mV/°C	
Protection	Battery reverse polarity (fuse, not user accessible) Output short circuit / Over temperature	
Operating temperature	-30 to +60°C (full rated output up to 40°C)	
Humidity	95 %, non-condensing	
Maximum altitude	2000m	
Environmental condition	Indoor, unconditioned	
Pollution degree	PD3	
Data communication port and remote on/off	VE.Direct See the data communication white paper on our website	
Parallel operation	Yes (not synchronized)	
ENCLOSURE		
Colour	Blue (RAL 5012)	
PV terminals 2)	35 mm² / AWG2 (Tr models), or three pairs of MC4 connectors (MC4 models)	
Battery terminals	35 mm² / AWG2	
Protection category	IP43 (electronic components) IP 22 (connection area)	
Weight	4,5 kg	
Dimensions (h x w x d)	Tr models: 216 x 295 x 103 mm MC4 models: 246 x 295 x 103 mm	
STANDARDS		
Safety	EN/IEC 62109	

1a) If more PV power is connected, the controller will limit input power to the maximum power.
1b) PV voltage must exceed Vbat + 5V for the controller to start.
Thereafter minimum PV voltage is Vbat + 1V.
2) MC4 models: several splitter pairs will be needed to parallel the strings of solar panels