Manual

EN

Appendix

SmartSolar charge controllers

MPPT 100/30 MPPT 100/50

1. General Description

1.1 PV voltage up to 100V

The charge controller is able to charge a lower nominal-voltage battery from a higher nominal voltage PV array.
The controller will automatically adjust to a 12 or 24V nominal battery voltage.

1.2 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.

1.3 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 MPPTs tend to lock to a local MPP, which may not be the optimum MPP.
The innovative SmartSolar algorithm will always maximize energy harvest by locking to the optimum MPP.

1.4 Outstanding conversion efficiency

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

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 controller will automatically adjust itself to a 12V or a 24V system one time only.
If a different system voltage is required at a later stage, it must be changed manually, for example with the Bluetooth app.

1.8 Flexible charge algorithm

Fully programmable charge algorithm, and eight preprogrammed algorithms, selectable with a rotary switch.

1.9 Adaptive three step charging

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

1.9.1. Bulk

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

1.9.2. Absorption

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 2A.

1.9.3. Float

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

When the battery voltage drops below float voltage during at least 1 minute a new charge cycle will be triggered.

1.9.4. Equalization

See section 3.8

1.10 Remote on-off

The MPPT 100/50 can be controlled remotely by a VE.Direct non inverting remote on-off cable (ASS030550300). An input HIGH (Vi > 8V) will switch the controller on, and an input LOW (Vi < 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 Configuring and monitoring

- Bluetooth Smart (built-in): connect to a smartphone or tablet running iOS or Android.
- Use the VE.Direct to USB cable (ASS030530000) to connect to a PC, a smartphone with Android and USB On-The-Go support (requires additional USB OTG cable).
- Use a VE.Direct to VE.Direct cable to connect to a MPPT Control, a Color Control panel or a Venus GX.

Several parameters can be customized with the VictronConnect app.
The VictronConnect app can be downloaded from
http://www.victronenergy.nl/support-and-downloads/software/
Use the manual – VictronConnect - MPPT Solar Charge Controllers – to get the most out of the VictronConnect App when it's connected to a MPPT Solar Charge Controller:
http://www.victronenergy.com/live/victronconnect:mppt-solarchargers

MPPT Control

Color Control

Venus GX

2. Safety instructions

SAVE THESE INSTRUCTIONS - This manual contains important instructions that shall be followed during installation and maintenance.

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 direct 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.

3. Installation

WARNING: DC (PV) INPUT NOT ISOLATED FROM BATTERY CIRCUIT.
CAUTION: FOR PROPER TEMPERATURE COMPENSATION THE AMBIENT CONDITION FOR CHARGER AND BATTERY MUST BE WITHIN 5°C,

3.1. General

● Mount vertically on a non-flammable substrate, 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).
● Improper internal temperature compensation (e.g. ambient condition battery and charger not within 5°C) can lead to reduced battery lifetime.
We recommend installing the Smart Battery Sense option if larger temperature differences or extreme ambient temperature conditions are expected.
● Battery installation must be done in accordance with the storage battery rules of the Canadian Electrical Code, Part I.
● The battery and PV connections must be guarded against inadvertent contact (e.g. install in an enclosure or install the optional WireBox M).

3.2 Grounding

● *Battery grounding:* the charger can be installed in a positive or negative grounded system.
Note: apply a single ground connection (preferably close to the battery) to prevent malfunctioning of the system.
● *Chassis grounding:* A separate earth path for the chassis ground is permitted because it is isolated from the positive and negative terminal.
● The USA National Electrical Code (NEC) requires the use of an external ground fault protection device (GFPD). These MPPT chargers do not have internal ground fault protection. The system electrical negative
should be bonded through a GFPD to earth ground at one (and only one) location.
● The charger must not be connected with grounded PV arrays (one ground connection only)

WARNING: WHEN A GROUND FAULT IS INDICATED, BATTERY TERMINALS AND CONNECTED CIRCUITS MAY BE UNGROUNDED AND HAZARDOUS.

3.3 PV configuration (also see the MPPT Excel sheet on our website)

● Provide a means to disconnect all current-carrying conductors of a photovoltaic power source from all other conductors in a building or other structure.
● A switch, circuit breaker, or other device, either ac or dc, shall not be installed in a grounded conductor if operation of that switch, circuit breaker, or other device leaves the grounded conductor in an ungrounded state while the system remains energized.
● The controller 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: 100V.

For example:
<u>12V battery and mono- or polycristalline panels</u>
● Minimum number of cells in series: 36 (12V panel).
● Recommended number of cells for highest controller efficiency: 72 (2x 12V panel in series or 1x 24V panel).
● Maximum: 144 cells (4x 12V or 2x 24V panel in series).

<u>24V battery and mono- or polycristalline panels</u>
● Minimum number of cells in series: 72 (2x 12V panel in series or 1x 24V panel).
● Maximum: 144 cells.

Remark: at low temperature the open circuit voltage of a 144 cell solar array may exceed 100V, depending on local conditions and cell specifications. In that case the number of cells in series must be reduced.

3.4 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).

3.5 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)	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)	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 1: divide all values by two in case of a 12V system.
Note 2: equalize normally off, see sect. 3.8.1 to activate (do not equalize VRLA Gel and AGM batteries)
Note 3: any setting change performed with Bluetooth or via VE.Direct will override the rotary switch setting. Turning the rotary switch will override prior settings made with Bluetooth or VE.Direct.

On all models with software version V 1.12 or higher a binary LED code helps determining the position of the rotary switch. After changing the position of the rotary switch, the LEDs will blink during 4 seconds as follows:

Switch position	LED Bulk	LED Abs	LED Float	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.

Remark: the blink function is enabled only when PV power is present on the input of the controller.

3.6 LEDs

LED indication:

● permanent on
◎ blinking
○ off

Regular operation

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

Fault situations

LEDs	Bulk	Absorption	Float
Charger temperature too high	○	○	◎
Charger over-current	◎	○	◎
Charger or PV over-voltage	○	◎	◎
Internal error (*2)	◎	◎	○

Note (*2): 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 morning, when the sun starts shining.

Default setting:

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	6h
23,8V < Vb < 24,4V	4h
24,4V < Vb < 25,2V	2h
Vb > 25,2V	1h

(divide voltages by 2 for a 12V 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 2Amps, 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.

User defined algorithm:

Any setting change performed with Bluetooth or via VE.Direct will override the rotary switch setting. Turning the rotary switch will override prior settings made with Bluetooth or VE.Direct.

3.8 Automatic equalization

Automatic equalization is default set to ‘OFF’. With the Victron Connect app (see sect 1.10) 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. The current is limited to 8% of the bulk current for the factory default battery type, and to 25% of the bulk current for a 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, and the next equalisation session will take place as determined by the day interval.

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	Set the controller manually to 24V (see section 1.11)
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

SmartSolar Charge Controller	MPPT 100/30	MPPT 100/50
Battery voltage	12/24V Auto Select	
Rated charge current	30A	50A
Nominal PV power, 12V 1a,b)	440W	700W
Nominal PV power, 24V 1a,b)	880W	1400W
Maximum PV open circuit voltage	100V	100V
Max. PV short circuit current 2)	35A	60A
Maximum efficiency	98%	98%
Self-consumption	10 mA	
Charge voltage 'absorption'	Default setting: 14,4V / 28,8V (adjustable)	
Charge voltage 'equalization' 3)	Default setting: 16,2V / 28,8V (adjustable)	
Charge voltage 'float'	Default setting: 13,8V / 27,6V (adjustable)	
Charge algorithm	multi-stage adaptive (eight preprogrammed algorithms) or user defined algrithm	
Temperature compensation	-16 mV / °C resp. -32 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	5000m (full rated output up to 2000m)	
Environmental condition	Indoor type 1, unconditioned	
Pollution degree	PD3	
Data communication port	Bluetooth and VE.Direct See the data communication white paper on our website	
ENCLOSURE		
Colour	Blue (RAL 5012)	
Power terminals	16 mm² / AWG6	
Protection category	IP43 (electronic components), IP22 (connection area)	
Weight	1,3 kg	
Dimensions (h x w x d)	130 x 186 x 70 mm	
STANDARDS		
Safety	EN/IEC 62109-1, UL 1741, CSA C22.2	

1a) If more PV power is connected, the controller will limit input power.
1b) The PV voltage must exceed Vbat + 5V for the controller to start.
Thereafter the minimum PV voltage is Vbat + 1V.
2) A higher sort circuit current may damage the controller in case of reverse polarity connection of the PV array.
3) Default setting: OFF

Estados de fallo

LED	Carga inicial	Absorción	Flotación
Charger temperature too high	○	○	◎
Charger over-current	◎	○	◎
Charger over-voltage	○	◎	◎
Internal error (*2)	◎	◎	○

Nota (*2): Por ejemplo, se ha perdido la calibración y/o los datos de ajuste, problema con el sensor de corriente.

3.7 Información sobre la carga de las baterías

El controlador de carga inicia un nuevo ciclo de carga cada mañana, cuando empieza a brillar el sol.

Valores predeterminados:

La duración máxima del periodo de absorción queda determinada por la tensión de la batería medida justo antes de que se ponga en marcha el cargador solar por la mañana:

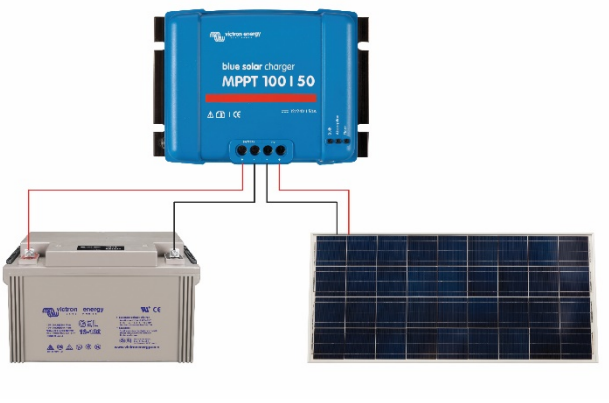
Tensión de la batería Vb (al ponerse en marcha)	Tiempo máximo de absorción
Vb < 23,8V	6 h
23,8V < Vb < 24,4V	4 h
24,4V < Vb < 25,2V	2 h
Vb > 25,2V	1 h

(dividir por 2 las tensiones en sistemas de 12 V)

Si el periodo de absorción se interrumpiera debido a la nubosidad o a una carga energívora, el proceso de absorción se reanudaría al alcanzarse la tensión de absorción más tarde ese día, hasta que se haya completado el periodo de absorción.

El periodo de absorción también se interrumpe cuando la corriente de salida del cargador solar cae por debajo de 2 amperios, no debido a que la salida de los paneles solares sea baja, sino porque la batería está completamente cargada (corte de la corriente de cola).

Figure 1: Power connections



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