User Description: MPP-Solar Charge Controller

SMR500, SMR1000, SMR1500, SMR2000, SMR2500

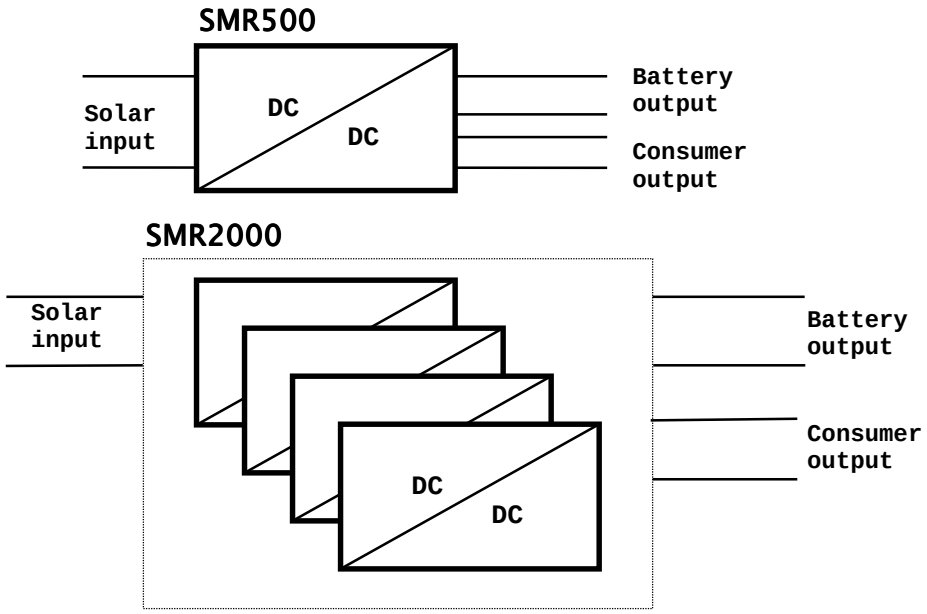
Version: SMR-MS_110202_EN

A. Principal description

The MPP (Maximum Power Point)-Solar Charge Controllers show a very high degree of efficiency (ca 96% at 24V) and higher charge currents (10-40%) as compared to shunt charge controllers.

Through modern hardware design, it is possible to achieve high efficiency and remain within the limits of EMC rules also at high input voltages.

The modular concept consists of 20A MPP-modules, **which are switched parallel as well at the input as at the output**. The SMR500 consist of only one modul. The SMR2000 consists of 4 modules.



- ⇨ The micro controller system consists of buck converters being regulated to maintain the optimal solar voltage while temperature and solar radiance changes. (Powertracking). It is about 16-18V in a 36 cells solarmodul and a temperature of 20°C. This results in winter in an average increase of charging current of 15%.
- ⇨ Due to powertracking the charging current increases further at sinking battery voltage.
- ⇨ At low radiance (solar current lower 1% of maximum charging current) the powertracker switches off and the charger works similar to a linear charger.
- ⇨ To protect the battery from overloading, the regulation starts at the maximum charging voltage of the battery. The trickle charging controll moves the solarvoltage towards off-load voltage, so that the charging current is minimized. With a temperature sensor, the charging end voltage can be changed. The higher the temperature is, the lower the charging end voltage will be.
- ⇨ To protect the battery from total discharge, a MOSFET throws off the load at the Minus-output.

⇨ The reverse current diode is nearly powerless (MOSFET).

⇨ The fine lightning protection consists of a varistor at the solar input.

⇨ The device has a transistor inverse-polarity protection.

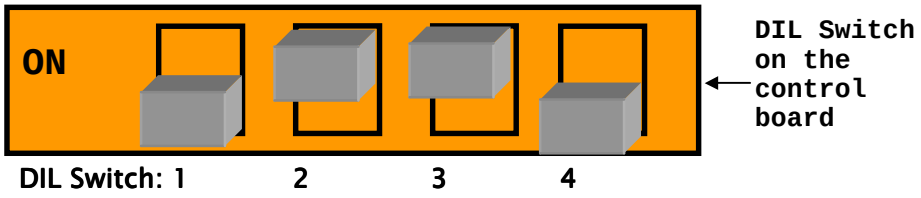
B. Operation and Function

A 12V, 24V, or a 48V lead accumulator can be used. For this, only the DIL-switch of the controller has to be changed.

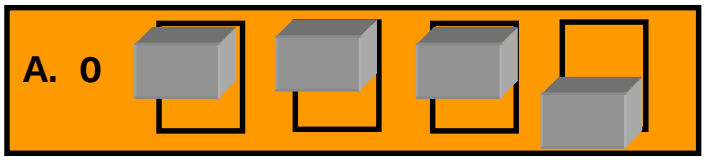
B.1 12V/24V/48V Change Over Switch

DIL-switch 1 "OFF", 2 and 3 "ON" : 12V Battery voltage
DIL-switch 1, 2 and 3 "ON" : 24V Battery voltage
DIL-switch 1 "ON", 2 and 3 "OFF" : 48V Battery voltage

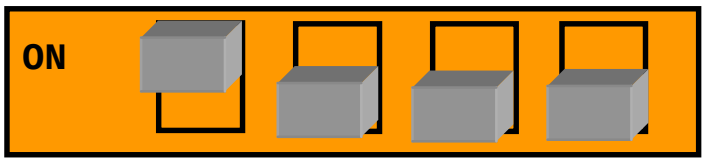
12V adjustment:



24V adjustment:

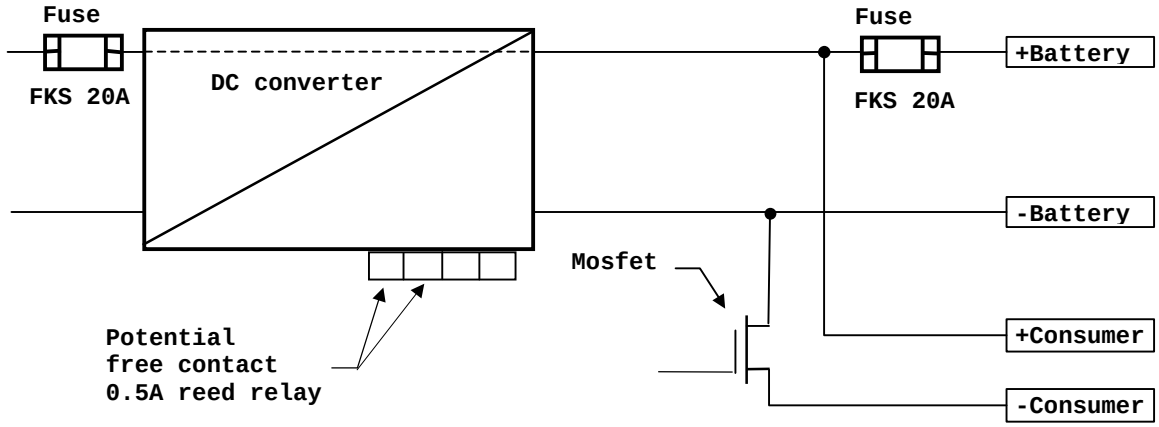


48V adjustment:



B.2 Total Discharge Protection

The consumer will be charged directly by the battery voltage via a MOSFET. At high consumer currents, a small drop in voltage at the MOSFET occurs (ca 0.2-0.3V).



If the battery voltage will be smaller than 11.3V/22.6V for ca 60 sec., a 0.5A relay will be activated. With this, a control line can be set in order to start a diesel generator for example. At 10.8V/21.6V (at 20°C) the MOSFET finally disconnects the consumer from the battery. (Load control)

This is indicated through the red light emitting diode in the middle.

Only if the battery has regained the voltage of ca 12.5V/25V, or through pressing the "reset" button, the current load will be connected.

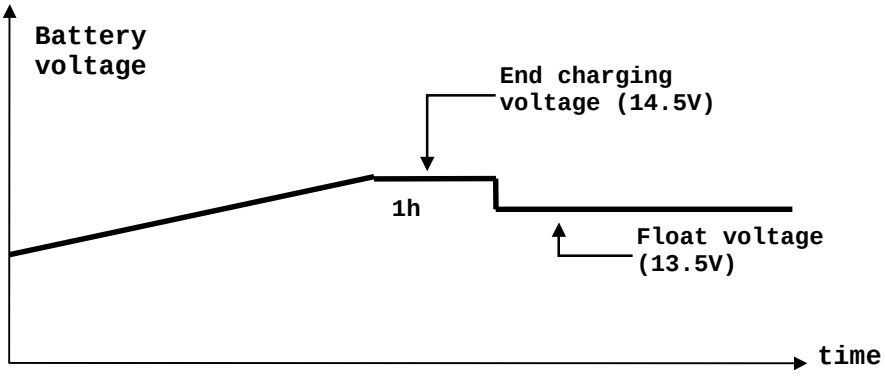
The load control is temperature sensitive. That means, the temperature, reported by battery temperature sensor, decides the interrupting voltage of the load control as well as the reconnection voltage.

The influence is -4mV/°C/battery cell.

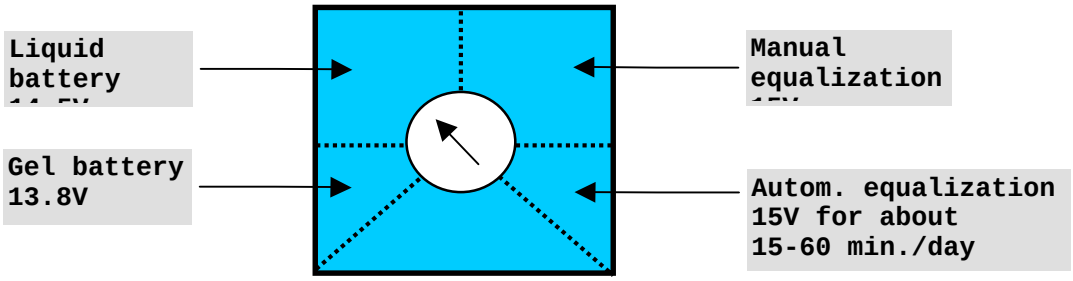
Please refer to section: B.6 Temperature Sensor KTY10-5.

B.3 Charging characteristics

The charging of the batteries proceeds according to an IU characteristics. At first, a maximum current is charged into the batteries. As soon as the end charging voltage reaches 14.5V/28.2V, the micro controller controls end charging voltage. At the same time the yellow LED display is turned on. After 1 hour, the end charging voltage will be limited to 13.5V/27.0V. Only if the voltage drops below 13.6/27.2V, the controlling will be turned off. This charging characteristic always guarantees a maximum charging current until the end charging voltage is reached.



B.4 Functional Switch



The switch is located at the control device.

Gel Batteries

If the pointer of the potentiometer is at the left arrester, the device adjusts at 13.8V/27.6V battery voltage.

Liquid Batteries

If the pointer of the potentiometer is located in the 2nd quarter, the device adjusts at 14.5V/29V battery voltage

Manual Equalization

If the pointer of the potentiometer is located in the 3rd quarter, the manual equalization is switched on and the yellow LED display is blinking. The equalization voltage is limited to 15V

Automatic Equalization

If the pointer of the potentiometer is located at the right arrester, the automatic equalization is switched on. As soon as the end charging voltage exceeds 14.5V, the yellow LED display is blinking and the equalization time is switched on. The equalization time varies according to how much the end charging voltage is exceeded. If exceeded by 0.1V, the equalization time is 120min/day. If exceeded by 0.9V, the equalization time is only 25min/day.

The maximum equalization voltage is 15.0V. If the equalization is interrupted because of a weak solar input, the equalization is continued later. However during night time, the equalization timer will be set back.

B.5 Reset

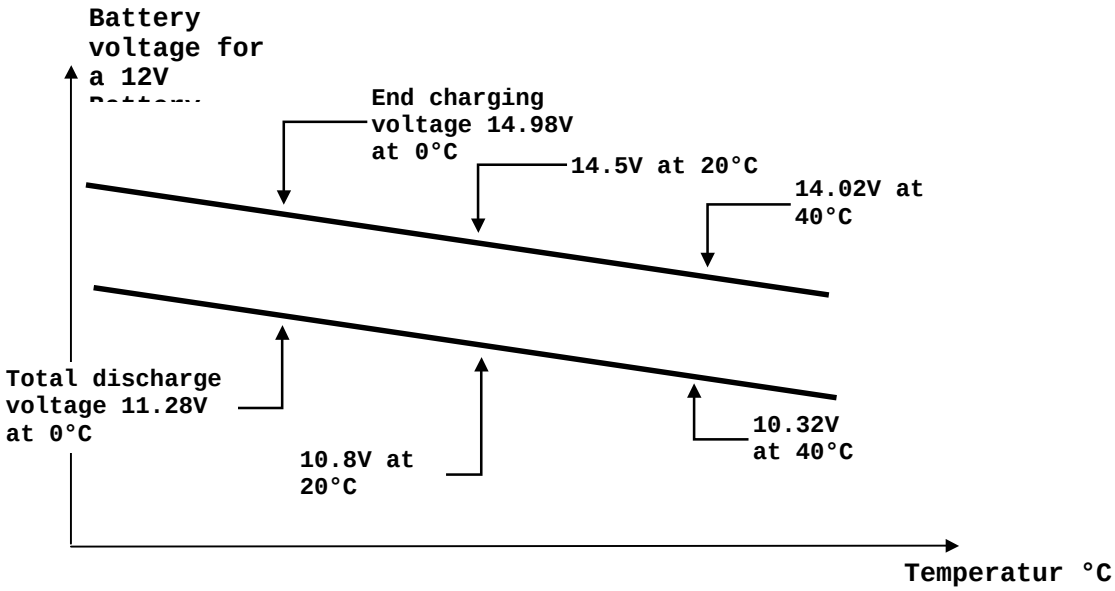
Pressing the "reset" button at the control device has the following effect:

- ⇨ Reset of the total discharge protection at a voltage below 12.5V/25V.
- ⇨ Reset of the MPP-controlling to the level of the battery voltage. When pressing for a longer time, the operating point increases up to the off-load voltage.
- ⇨ Reset of the end charging voltage control (the yellow LED display is off)
- ⇨ Fast blinking of the green LED display indicates that the "reset" button is pressed.

B.6 Temperature Sensor KTY10-5

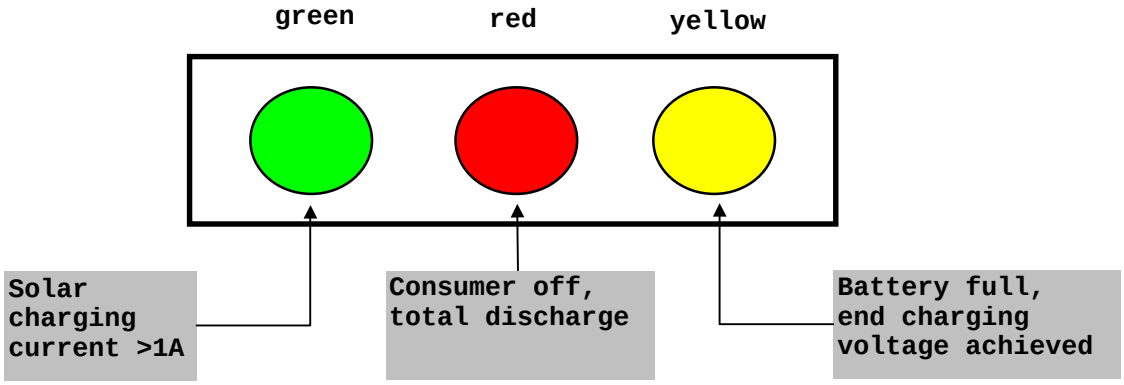
The temperature sensor controls the end charging voltage of the battery and therefore it has to be mounted on the battery. It will be 20°C at 14.5V. Is the temperature sensor waived, the sensor entrance has to be replaced by a fixed resistor of 1.9kOhm. This resembles to an battery temperature of 20°C. The influence on the end charging voltage is -4mV/°C/ battery cell.

At a battery temperature of 45°C, the controller disconnects the consumer- and charging current in order to protect the battery.



B.7 LED Displays

The LED displays are located on the control device (circuit board in the upright position).



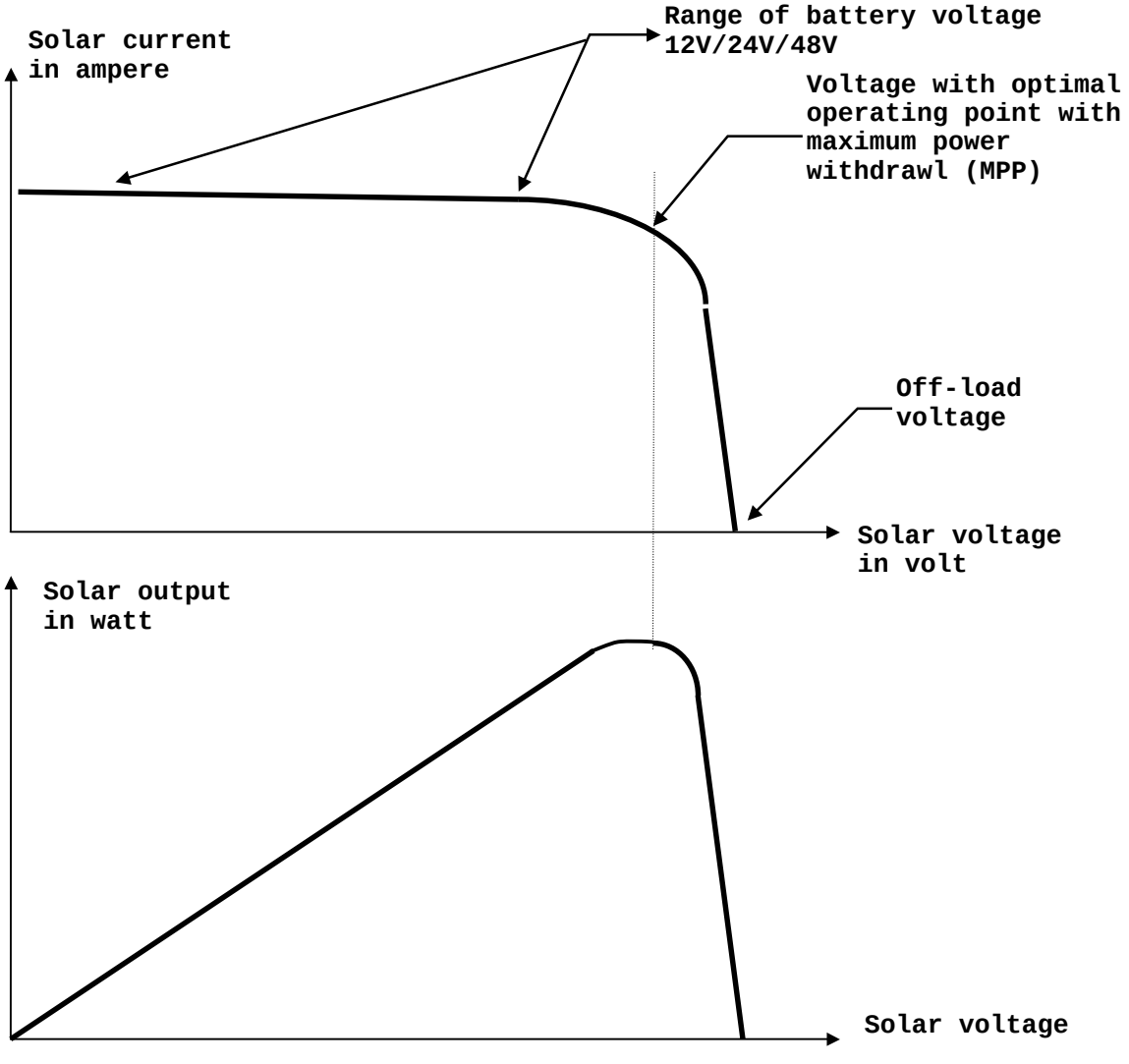
Continuously yellow:	end charging voltage achieved
Blinking yellow:	manual equalization on, autom. equalization
Continuously red:	load throw-off
Continuously green:	Solar current charging (starting from ca 0.5A/MPP-Modul)
1sec blinking green:	Reset button pressed
Green off:	charging current too low in order to start the MPP-controlling
Green, on to off:	as LED display is off, MPP-controlling switched on (at 8sec intervals)

B.8 Safety Devices

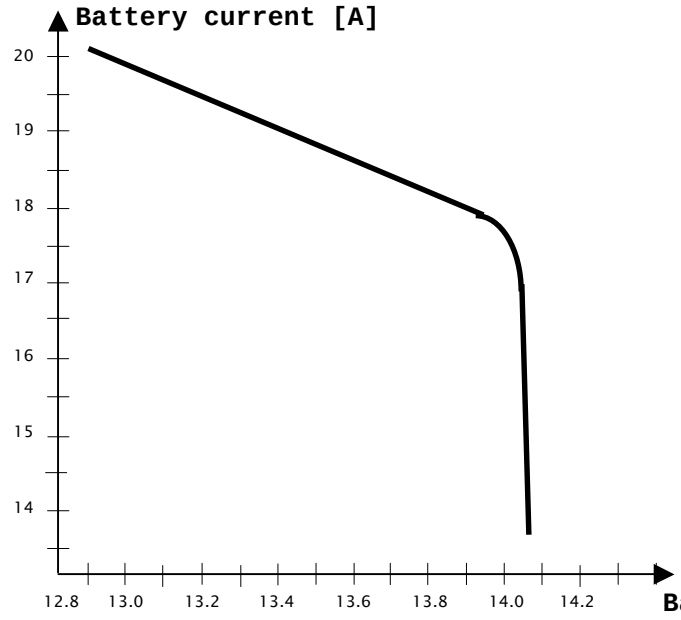
- ⇨ A fuse at the +battery exit protects the device from significant mechanical damage at excessive currents. The fuse disconnects the battery from the consumer and solar generator.
- ⇨ A fuse at the +solar entry disconnects the charge controller from the solar generator at excessive currents.
- ⇨ The battery output is protected from inverse-polarity. A transistor separates the battery from the charge controller, in case of inverse-polarity.
- ⇨ A temperature sensor within the device prevents an overload of the electronic parts and reverses the output as soon as the inside temperature of the box reaches 70°C.
- ⇨ In connection with the use of a KTY10-5 battery temperatur sensor, the controller is switched off at 45°C battery temperature.

B.9 MPP Controlling

Solar modules up to an off-load voltage of 150V may be connected. The battery voltage can be 12V/24V/48V. The MPP-controlling works in intervals of 8 secs for about 0.2-1sec. It automatically searches for the ideal operating point between 15V and 130V solar generator voltage. If the battery current is below 2% of the maximum allowed device current, the controller switches the solar voltage to 75% of the MPP-voltage. At 1%, the solar voltage is switched to the battery voltage.



The function of the solar module (solar current via solar voltage and power and solar power via solar voltage below) show, that there is a voltage at a solar modul, where optimal power is available. This voltage is tracked automatically by the MPP-Solar charge controller.



The left function shows that the battery current rises with lower battery voltage. This is another advantage or the MPP charge controller, which independently of the charge state always charges with maximum power.

B.10 Potential free contact

A potential free contact is closed via a relais (0.5A, 12V), as soon the battery voltage goes below

11.3V at 12V battery,
22.6V at 24V battery,
45.2V at 48V battery.

By means of 2 terminals these contacts are available for the user.
Please refer to section D. Connection Diagram.

B.11 Efficiency

The diagrams below show the efficiency with respect to 2 different battery voltages 28V/56V and solar voltages from 33V up to 99V. The curves show the higher the battery voltage is, the higher the efficiency. But they also show that at higher difference between solar voltage and battery voltage the efficiency is slightly deminished. Optimal efficiency would be at 56V battery voltage and 66V solar voltage. (Diagram 2)

Diagram 1: function of efficiency at 28V battery voltage and 33V to 82V solar voltage

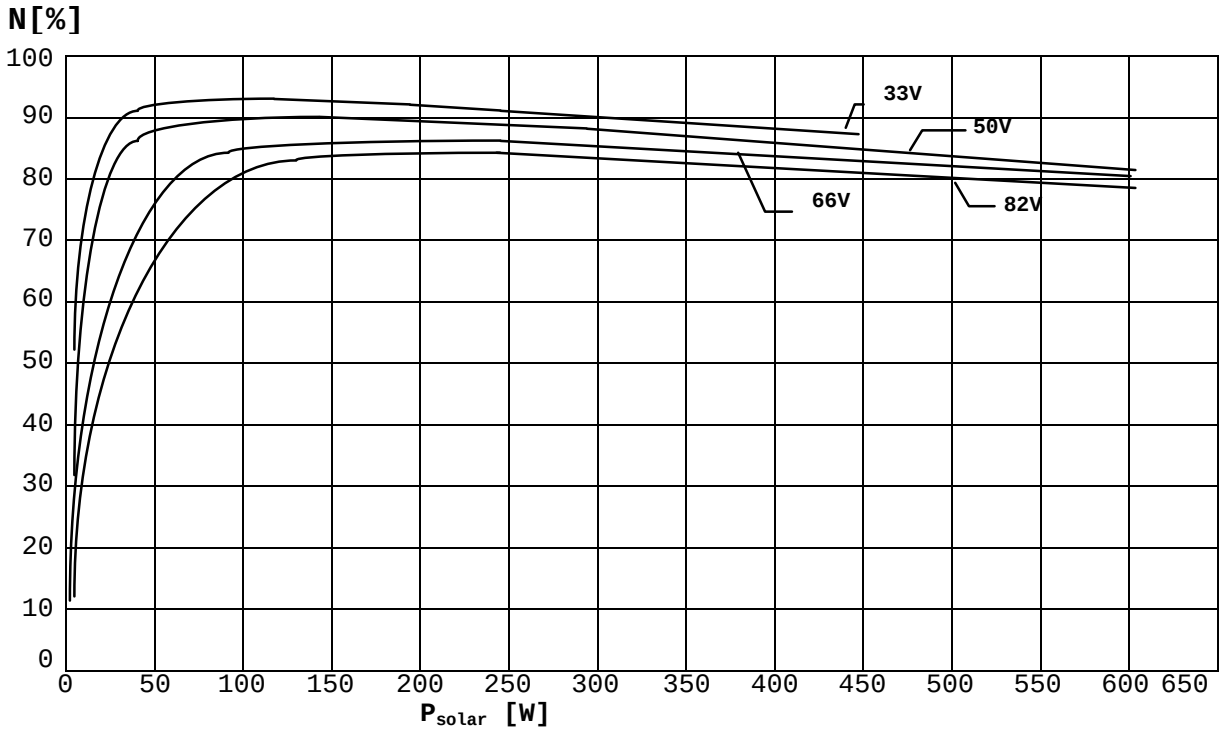
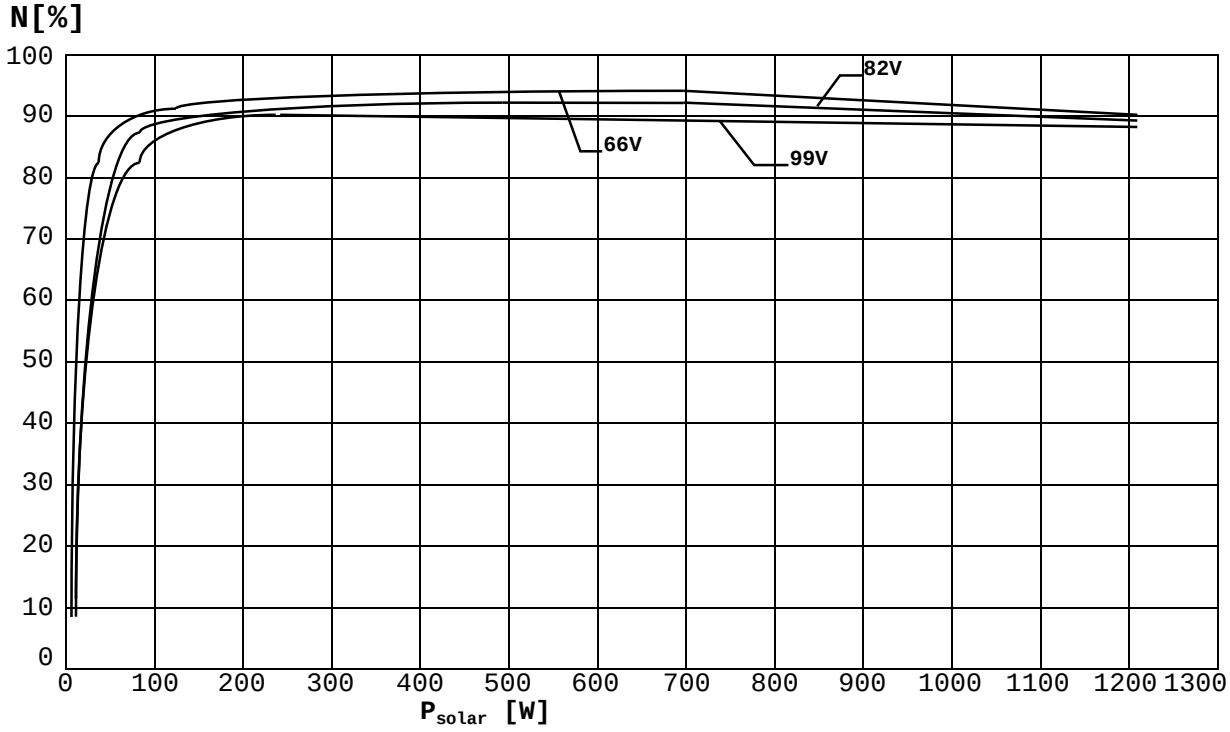


Diagram 2: function of efficiency at 56V battery voltage and 66V to 99V solar voltage



C. Technical Data

C.1 48V Configuration

Typ		SMR500	SMR1000	SMR1500	SMR2000	SMR2500
Number of MPP-Modules		1	2	3	4	5
Ventilation		no	no	yes	yes	yes
Max. solar power **Pnom**		750W	1500W	2250W	2800W	3750W
Max. charge current, Ia		12.5A	25A	37.5A	50A	62.5A
Max. Solar voltage ,**Usol**		150V				
Max. batt. voltage. At 20°C, **Ua**		58.0V				
Float voltage, **Ufl**		54.0V				
Max. consumer current, **Iv**		20A	40A	60A	80A	100A
Deep discharge protection	Switch off voltage., **Uta**	43.2V at 20°C				
	Switch off delay	60s				
	Switch on voltage, **Ute**	50.0V at 20°C				
	Volt.drop at Mosfet at Imax	0.24V				
Temperature sensor	Input	terminal for a 1.9kOhm resistor or a temperature sensor KTY10-5				
	Switch off temperature	45°C				
	Effect on charge end voltage and on deep discharge voltage	-96mV/°C				
Current consumption on battery side, **Io**		5mA	10mA	15mA	20mA	25mA
Efficiency at half load		96%	96%	96%	96%	96%
Fuses		2x20A FKS	4x20A FKS	6x20A FKS	8x20A FKS	10x20A FKS
LED Displays: Left green Middle red Right yellow		Charge current, MPP-Tracking active Load off Battery full, when equalization is on it is blinking				
Housing: material		Alu casting	sheetsteel	sheetsteel	sheetsteel	sheetsteel
Housing: measures in mm wxhxd		260x91x160	300x300x150	300x400x150	500x500x210	500x500x210
Weight		2.5kg	11kg	12.5kg	17kg	17.5kg
Protection category		IP65	IP65	IP54	IP54	IP54
Certification		**CE**	**CE**	**CE**	**CE**	**CE**
Admissible operating temperature		-20°C to +60°C				
Admissible relative humidity		90%				
Connecting terminals		Lizz 10sq.mm, single wire 16sq.mm				
Cable glands		3xPG16, 1xPG7, 1xPG9				

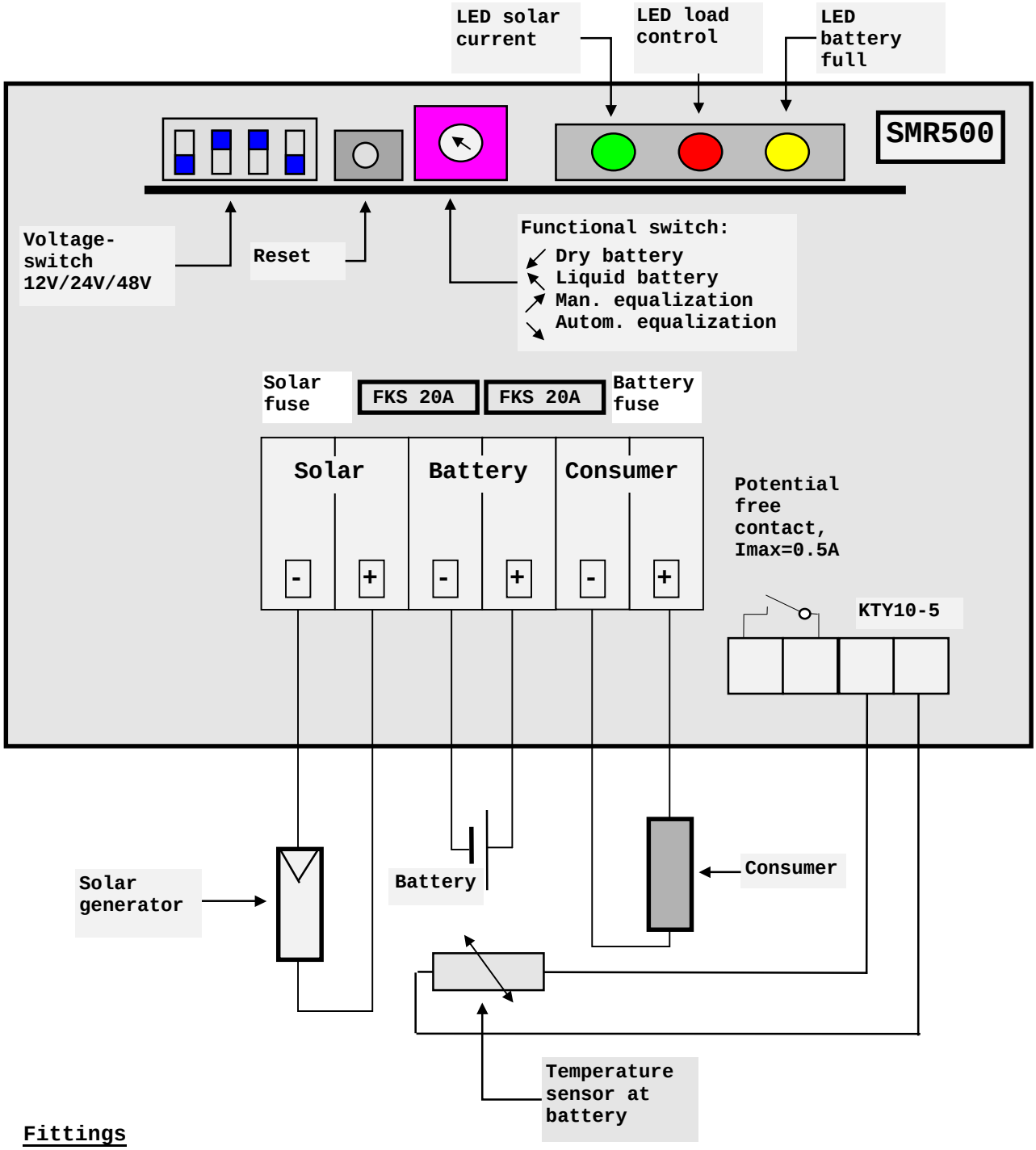
C.2 24V Configuration

Typ		SMR500	SMR1000	SMR1500	SMR2000	SMR2500
Number of MPP-Modules		1	2	3	4	5
Ventilation		no	no	yes	yes	yes
Max. solar power Pnom		560W	1120W	1680W	2240W	2800W
Max. charge current, Ia		20A	40A	60A	80A	100A
Max. Solar voltage ,Usol		150V				
Max. batt. voltage. At 20°C, Ua		29.0V				
Float voltage, Ufl		27.0V				
Max. consumer current, Iv		20A	40A	60A	80A	100A
Deep discharge protection	Switch off voltage, Uta	21.6V at 20°C				
	Switch off delay	60s				
	Switch on voltage, Ute	25.0V at 20°C				
	Volt.drop at Mosfet at Imax	0.24V				
Temperature sensor	Input	terminal for a 1.9kOhm resistor or a temperature sensor KTY10-5				
	Switch off temperature	45°C				
	Effect of charge end voltage and on deep discharge voltage	-48mV/°C				
Current consumption on battery side, Io		5mA	10mA	15mA	20mA	25mA
Efficiency at half load		96%	96%	96%	96%	96%
Fuses		2x20A FKS	4x20A FKS	6x20A FKS	8x20A FKS	10x20A FKS
LEDs: Left green Middle red Right yellow		Charge current, MPP-Tracking active Load off Battery full, when equalization is on it is blinking				
Housing: Material		Alu casting	sheetsteel	sheetsteel	sheetsteel	sheetsteel
Housing: Measures in mm wxhxd		260x91x160	300x300x150	300x400x150	500x500x210	500x500x210
Weight		2.5kg	11kg	12.5kg	17kg	17.5kg
Protection category		IP65	IP65	IP54	IP54	IP54
Certification		**CE**	**CE**	**CE**	**CE**	**CE**
Admissible operating temperature		-20°C bis +60°C				
Admissible relative humidity		90%				
Connecting terminals		Lizz 10sq.mm, single wire 16sq.mm				
Cable glands		3xPG16, 1xPG7, 1xPG9				

C.3 12V Configuration

Typ		SMR500	SMR1000	SMR1500	SMR2000	SMR2500
Number of MPP-Modules		1	2	3	4	5
Ventilation		no	no	yes	yes	yes
Max. solar power **Pnom**		280W	560W	840W	1180W	1400W
Max. charge current, Ia		20A	40A	60A	80A	100A
Max. Solar voltage ,**Usol**		150V				
Max. batt. voltage. At 20°C, **Ua**		14.5V				
Float voltage, **Ufl**		13.5V				
Max. consumer current, **Iv**		20A	40A	60A	80A	100A
Deep discharge protection	Switch off voltage, **Uta**	10.8V at 20°C				
	Switch off delay	60s				
	Switch on voltage, **Ute**	12.5V at 20°C				
	Volt.drop at Mosfet at Imax	0.24V				
Temperature sensor	Input	terminal for a 1.9kOhm resistor or a temperature sensor KTY10-5				
	Switch off temperature	45°C				
	Effect of charge end voltage and on deep discharge voltage	-24mV/°C				
Current consumption on battery side, **Io**		5mA	10mA	15mA	20mA	25mA
Efficiency at half load		93%	93%	93%	93%	93%
Fuses		2x20A FKS	4x20A FKS	6x20A FKS	8x20A FKS	10x20A FKS
LEDs: Left green Middle red Right yellow		Charge current, MPP-Tracking active Load off Battery full, when equalization is on it is blinking				
Housing: Material		Alu casting	sheetsteel	sheetsteel	sheetsteel	sheetsteel
Housing: Measures in mm wxhxd		260x91x160	300x300x150	300x400x150	500x500x210	500x500x210
Weight		2.5kg	11kg	12.5kg	17kg	17.5kg
Protection category		IP65	IP65	IP54	IP54	IP54
Certification		**CE**	**CE**	**CE**	**CE**	**CE**
Admissible operating temperature		-20°C to +60°C				
Admissible relative humidity		90%				
Connecting terminals		Lizz 10sq.mm, single wire 16sq.mm,				
Cable glands		3xPG16, 1xPG7, 1xPG9				

D. Connection Diagram



Fittings

Solar, battery, Consumer: PG16
Temp. sensor: PG7

E. Assembly Guidelines

For better cooling, it is advisable to mount the box on a steel or aluminum plate.

For connection, the cover has to be removed. The fasteners for the solar cells, battery, and consumer are found inside the box.

Please refer to section D. Connection Diagram.

1. Connect the battery cable (however without having connected the battery). The minus cable to the fastener **-battery**, the plus cable to **+battery**.

   Attention: Reverse polarity can destroy the device!

2. Now connect the consumer.
   The minus cable to **-consumer**, and the plus cable to **+consumer**.
3. Now connect the solar generator cables.
   The minus cable to **-solar**, and the plus cable to **+solar**. Also in this case, the solar generator should not be connected yet.
4. Now connect the battery to the battery cable.
   Normally, the LED display shows "battery empty" (red). The battery voltage is still below 12.5V/25V. Only when the solar generator starts charging, the voltage increases above 12.5V/25V and the red LED display goes off.
5. Now connect the solar generator to the cable.
   The left light emitting diode (green) indicates that the charging current flows. Shortly after, the red LED display goes off and the consumer is connected.
6. About every 8 seconds, the green LED display briefly goes off, or the LED display goes on in case it was off before. This indicates that the device is currently determining the MPP.

The PG fittings serve as a pull relief for the cables at the same time. In order to achieve this, the cable has to be strong enough, so that the gasket inside the PG fittings presses on the cable while tightening the fittings.

Please check this by trying to move the cable after tightening the fittings. It should not move anymore.

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