User Description: MPPT Solar Power Charge Controller

SMR500, SMR1000, SMR1500, SMR2000, SMR2500

Version: SMR-MS_171210_EN

Content

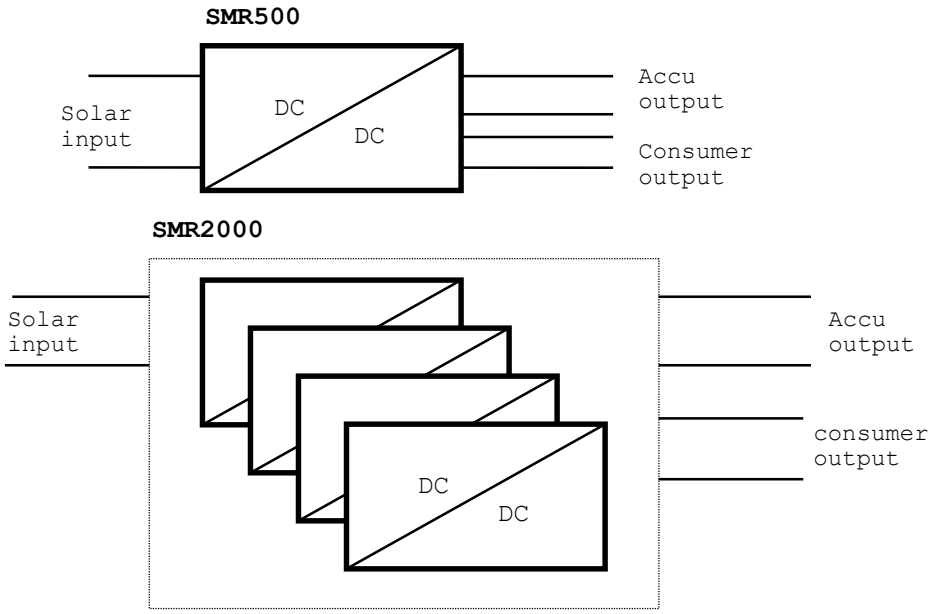
Attention:
The positive pole of solar and battery are connected through.
GND side is switched. Solar minus and battery minus are not on the same level and are not allowed to be connected to each other.

A. Function

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.

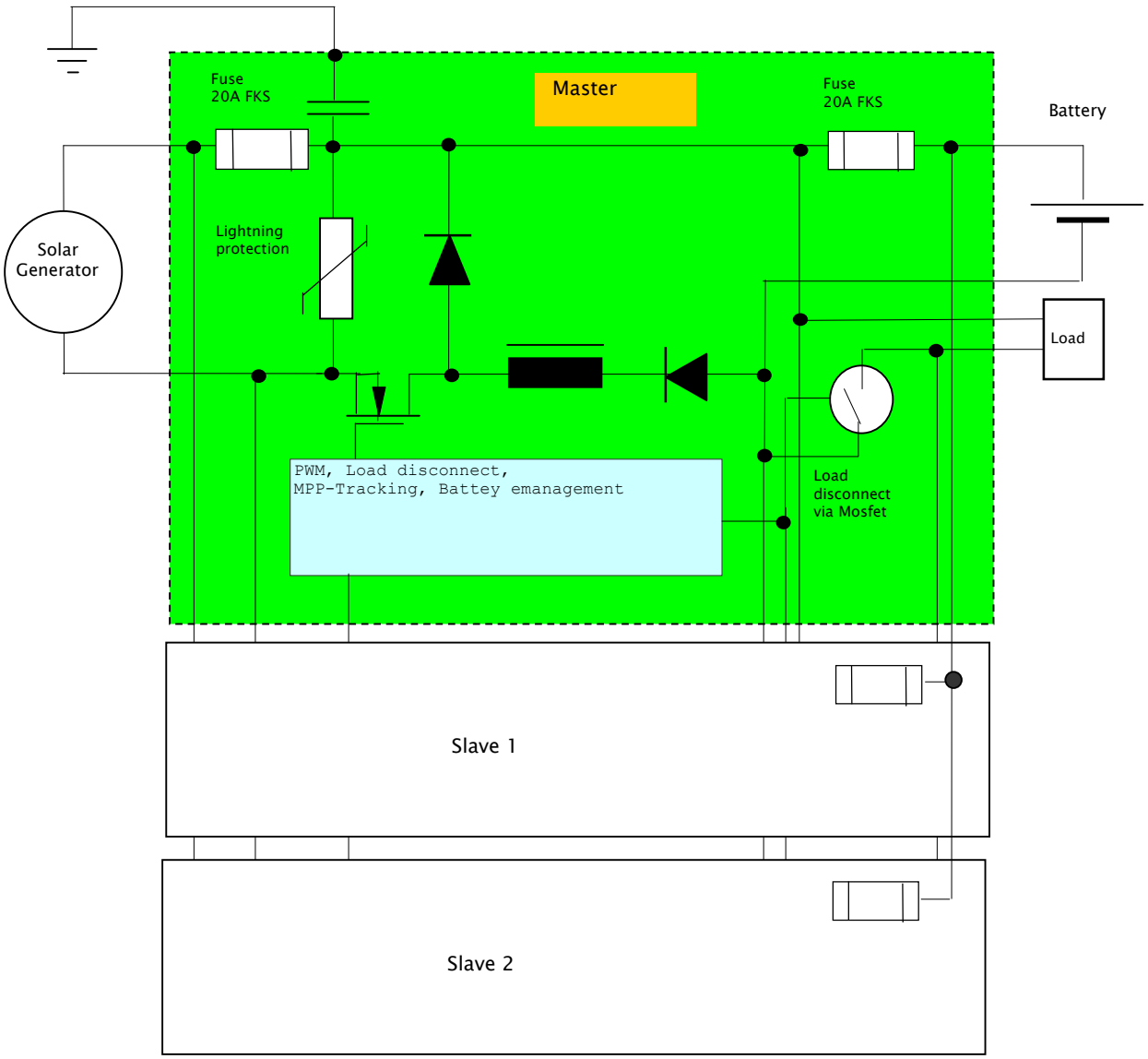


- ⇨ The micro controller system consists of buck converters being regulated to maintain the optimal solar voltage while temperature and solar radiance changes. (Powertracking). It is about 16-18V in a 36 cells solarmodul and a temperature of 20°C. This results in winter in an average increase of charging 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 accu from overloading, the regulation starts at the maximum charging voltage of the accu. 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 accu 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.

Block circuit diagram



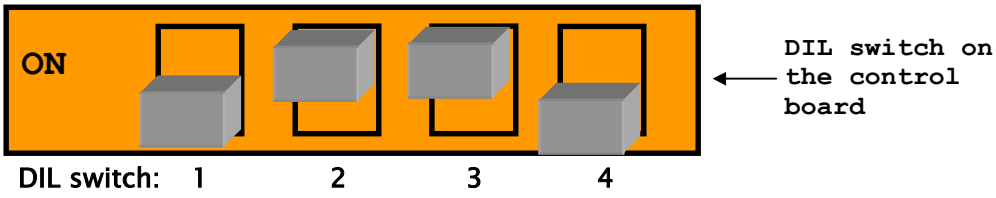
B. Operation

A 12V, 24V or a 48V lead battery can be used. For this the DIL switch on the controller board has to be switched. Fault battery setting is recognized by the software. The red and green leds are blinking and charge current is disrupted.

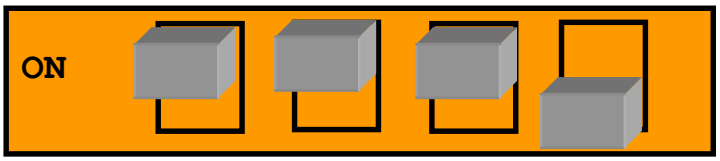
B.1 12V/24V/48V Change Over Switch

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

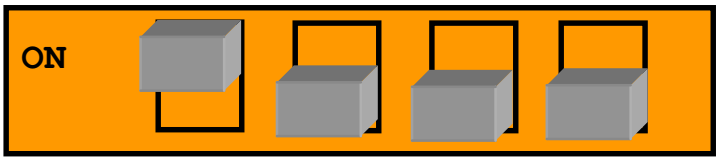
12V settings:



24V settings:

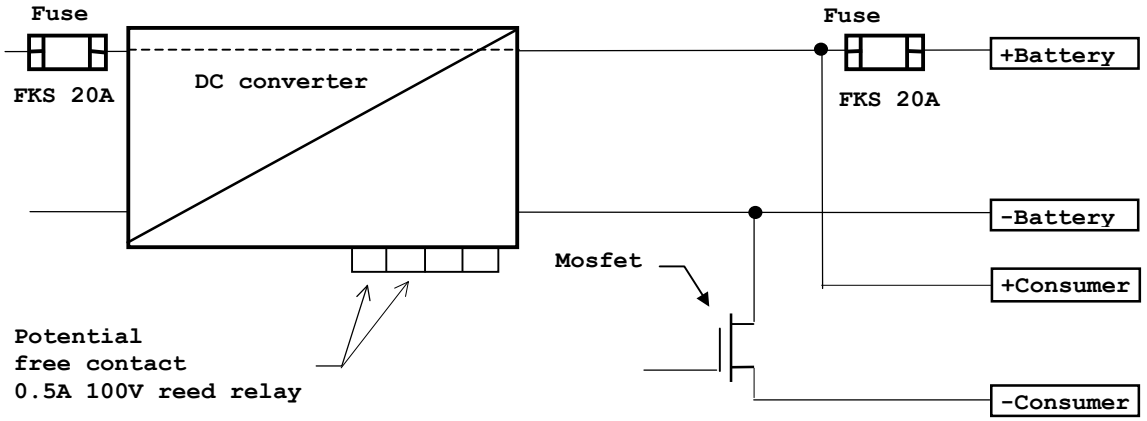


48V settings:



B.2 Total Discharge Protection

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



If the accu voltage will be smaller than 11.3V/22.6V for ca. 60 sec., a reed contact will be activated. In this way a diesel generator can be controlled.

At 10.8V/21.6V (at 20°C) the MOSFET finally disconnects the consumer from the accu. (Load control)

This is indicated through the red light emitting diode.

Only if the accu 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 accu temperature sensor, decides the interrupting voltage of the load control as well as the reconnection voltage.

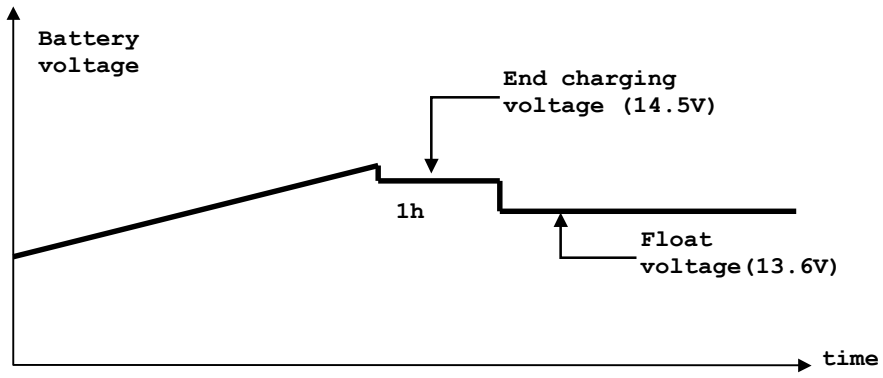
The influence is -4mV/°C/accu cell (please see also the section: "temperature sensor").

At shortcut, the mosfet switches off immediately (Shortcut proof output). Further operation is only possible, if the charge controller is disconnected from battery and solar generator for a short time.

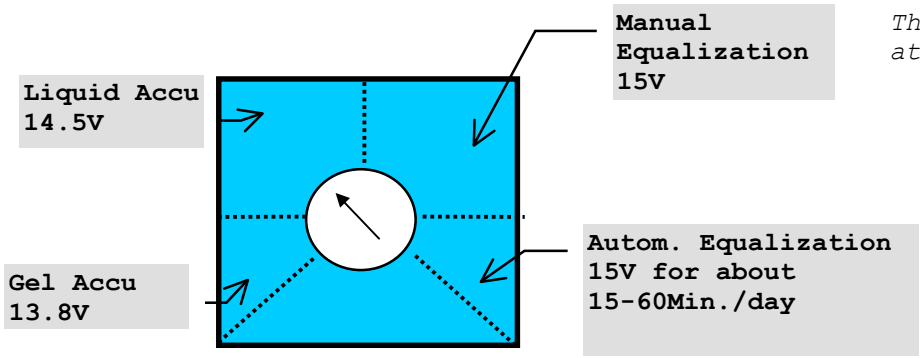
At overload (current>18A/powermodul) the consumer output switches off and on in millisecond period.

B.3 Charging characteristics

The charging of the batteries proceeds according to an IU characteristics. At first, the battery is charged by a maximum current. As soon as the charging voltage exceeds 14.5V/29.0V, the micro controller switches to end charge voltage controlling, the yellow LED flashes. After 1 hour, the end charging voltage will be limited to 13.6V/27.2V maintance charging. Only if the voltage drops below 13.5V/27.0V the controlling will be deactivated. This charging characteristic always guarantees a maximum charging current, until the end charging voltage is reached.



B.4 Function 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 end charging voltage.

Manual equalization

If the pointer of the potentiometer is located in the 3rd quarter, the manual equalization is activated and the yellow LED display flashes. 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/50V.

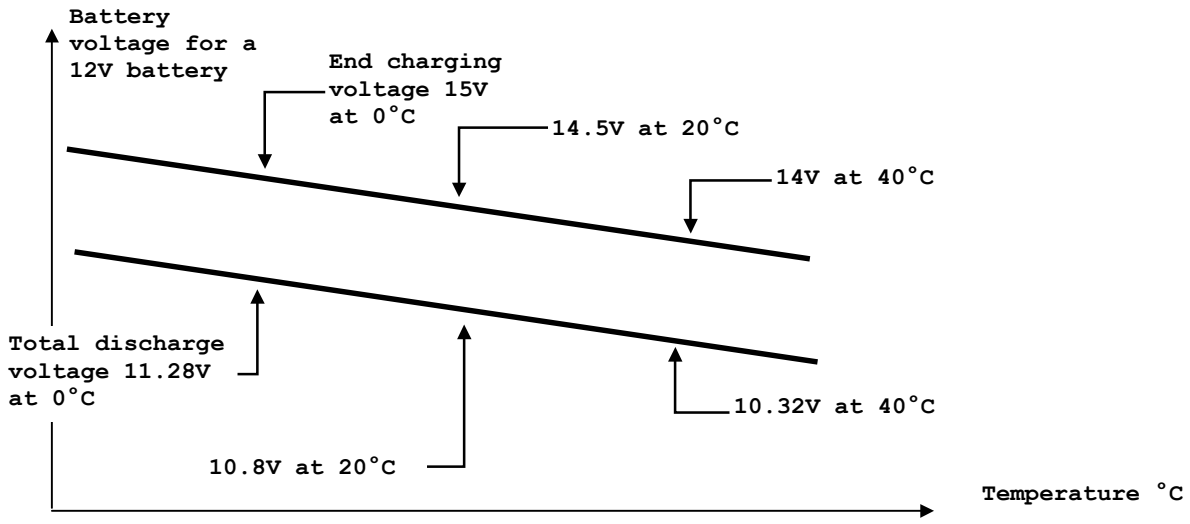
⇨ Continously pressing: the green LED is blinking, the operating point=solar generator voltage, Ugen) increases for about 0.5V per second. The dilswitch 4 should be in “On” Position.

⇨ After release of pressing the solar voltage remains at this level.

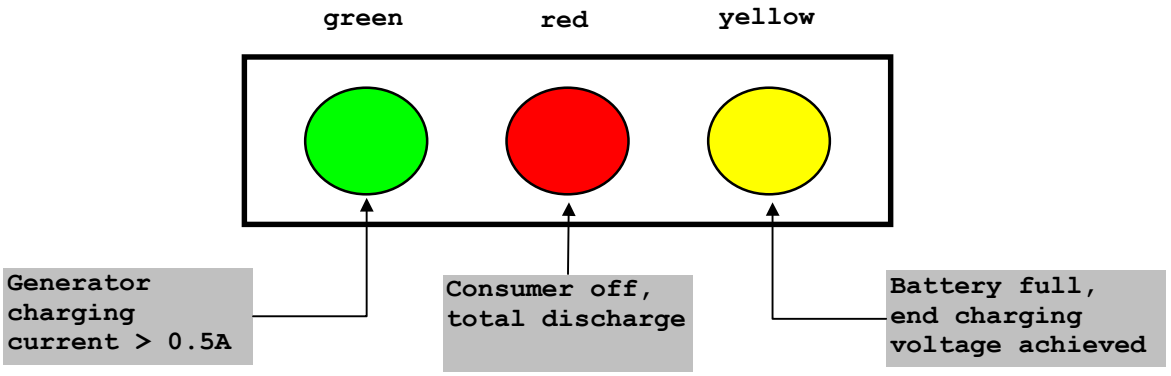
In this way the MPP can be adjusted manually, while watching the charge current. Maximum charge current is maximum powerpoint.

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 14.5V at 20°C. Is the temperature sensor waived, the sensor entrance has to be replaced by a fixed resistor of 1.9kOhm. This resembles to a battery temperature of 20°C. The effect on the end charging voltage is -4mV/°C/battery cell. At an battery temperature of 45°C, the controller disconnects the consumer-and charging current in order to protect the battery.



B.7 LEDs on controll pcb



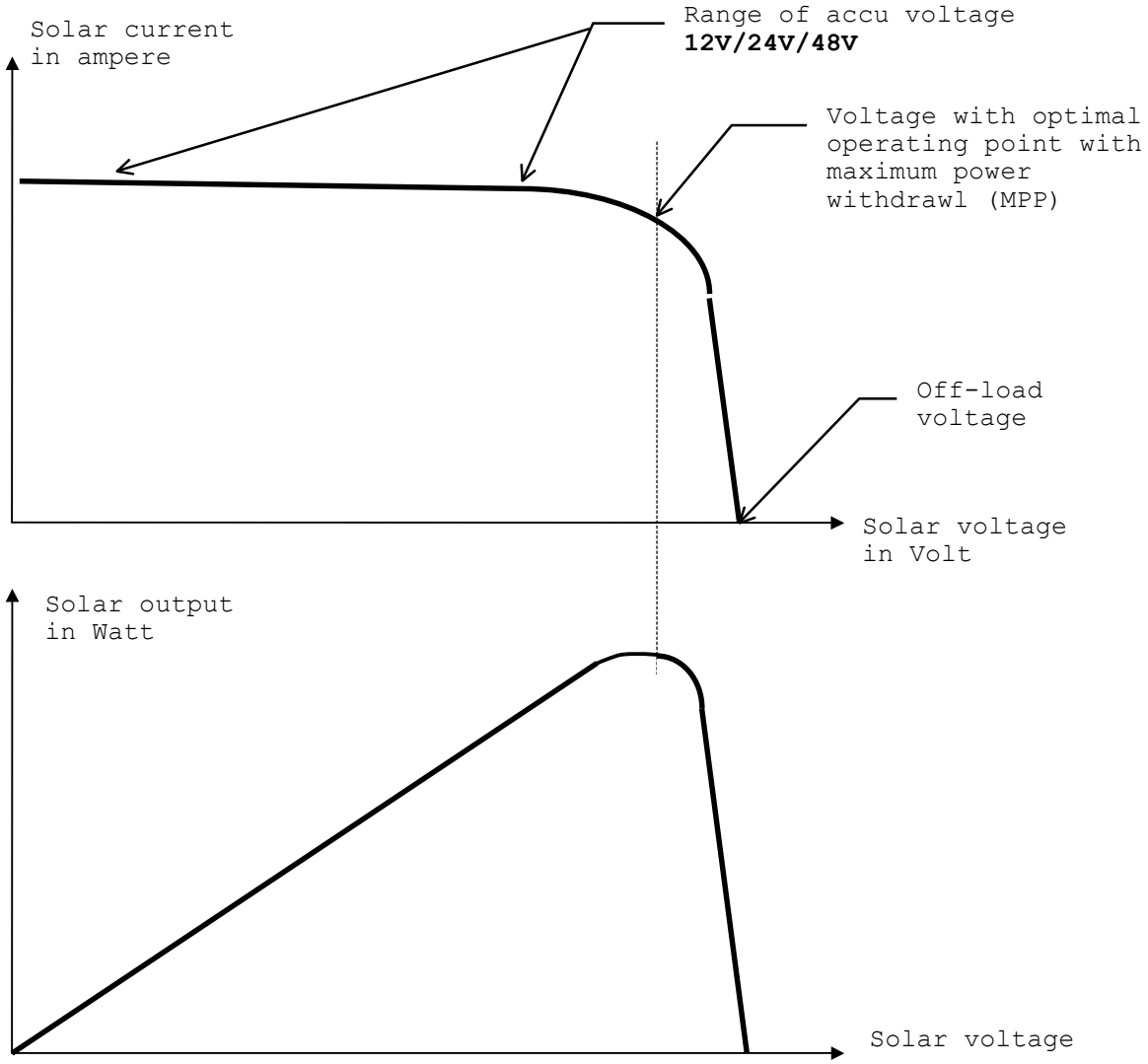
Continuously yellow:	end charging voltage achieved
Blinking yellow discontinously:	dumpload on, while battery is full.
Blinking yellow:	manual equalization on, autom. equalization
Continuously red:	load throw-off (consumer output)
Continously green.:	Charge current higher than 0.25A, Current via Tracker.
Impulses green:	Every 8s for about 0.5 - 1s, Tracker is active.
1s blinking green, while Reset pressed:	Operating point=solar voltage goes up with 0.5V/sec.

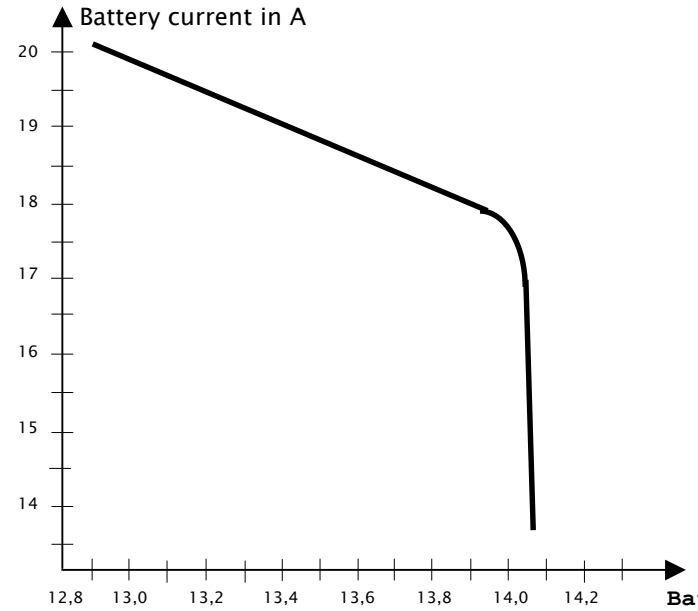
B.8 Saftey installations

- ⇨ A fks fuse at the +accu exit protects the device from significant mechanical damage at excessive currents at the consumer output. The fuse disconnects the accu from the consumer and wind generator.
- ⇨ A fks fuse at the +generator entry disconnects the charge controller from the wind generator at excessive currents.
- ⇨ The accu output is protected from inverse-polarity. A transistor separates the accu from the chargecontroller, in case of inverse-polarity. **Inverse polarity protection is not functioning in case, when electrical power is generated by a connected wind turbine!!!**
- ⇨ Overheat switchoff is achieved within the electronic unit, as soon as the inside temperature of the box reaches 70°C.
- ⇨ In connection with the use of a KTY10-5 accu temperatur sensor, the controller is switched off at 45°C accu temperature.
- ⇨ At start up, the green and yellow LED is blinking for a few seconds. If this blinking does not stop, the battery setting is not properly done. Please check the dil switches.
- ⇨ A lightning protection is placed at the solar input, right after the fuse (Varistor+Capacitor).
- ⇨ Earth connection has to be done to the enclosure inside. There is no galvanic connection to the electronic circuit.

B9 MPP Tracking

Solar modules up to an off-load voltage of 150V may be connected. The accu voltage can be 12V/24V/48V. The MPP-tracking 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 solarvoltage is switched to the battery voltage.





The characteristic curve shows, that the battery charging current increases with reducing battery voltage. This is an additional advantage of the MPPT controller, which always charges the maximum generator current independently of the charging condition of the battery.

B.9 Potential-free Contact

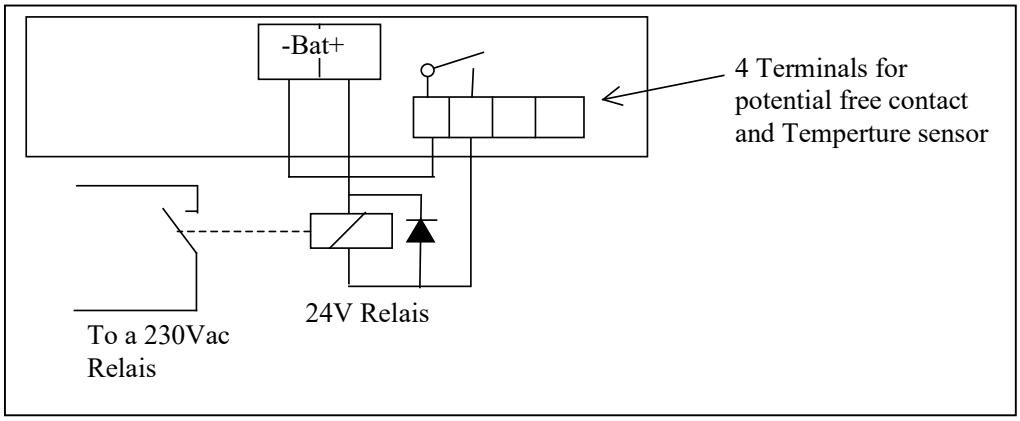
A potential-free contact is closed, as soon as the battery voltage goes below:

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

Please refer to section D. Connection diagram.

This contact (reed relais) is available via to terminals on the power pcb, leftside of the temperature sensor terminals. The maximum allowed voltage on the relais contacts is 100Vdc, maximum current is 0.5A.

How to switch a 230V relais with the potential-free contact:
This could be important for controlling a diesel generator.



B.10 Efficiency

The diagrams below, show efficiencies of to 2 different battery voltages 28V/56V and generator-DC-voltages of 33V to 99V. The higher the battery voltage is, the better the efficiency is. However, they also show that with a higher difference in generator-dc-voltage to battery voltage, the efficiency decreases slightly. The optimal efficiency would be at 56V battery voltage and at 66V generator-DC-voltage (see diagram 2).

Diagram 1: Efficiency at 28V battery voltage and 33V to 82V generator-dc-voltage

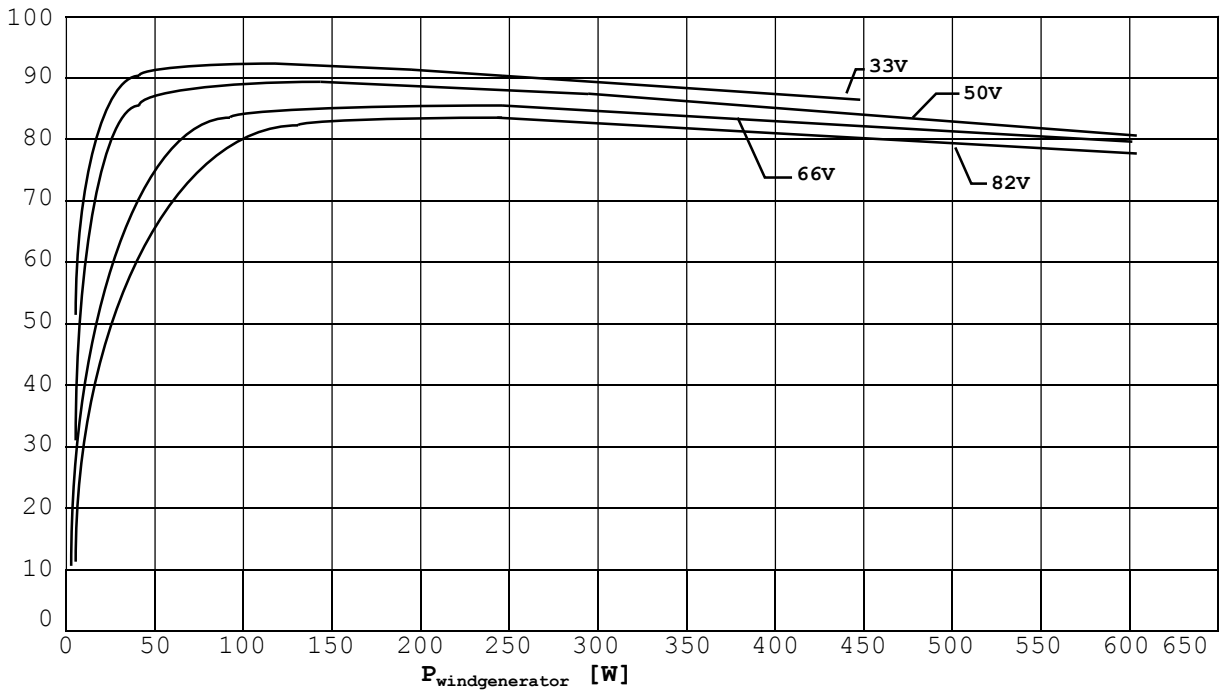
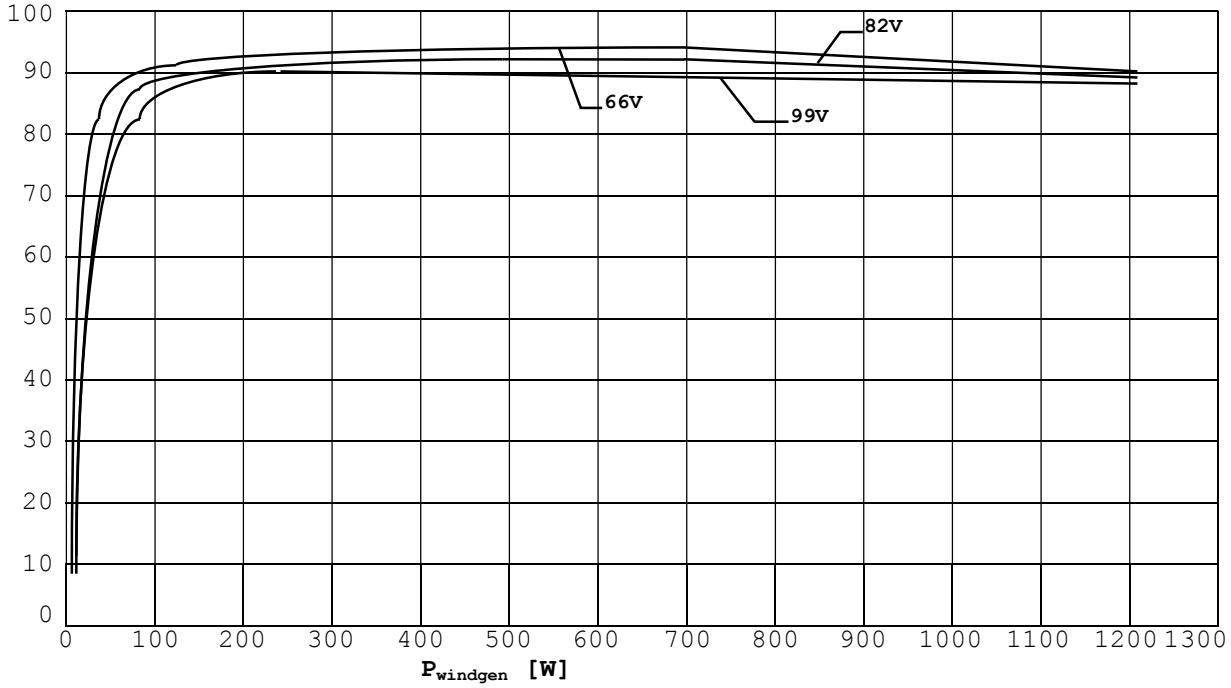


Diagram 2: Efficiency at 56V battery voltage and 66V to 99V generator-dc-voltage



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**		755W	1510W	2266W	3021W	3776W
Max. charge current, Ia		12.5A	25A	37.5A	50A	62.5A
Max. Solar voltage ,**Usol**		200V				
Max. batt. voltage. At 20°C, **Ua**		58.0V				
Float voltage, **Ufl**		54.0V				
Max. consumer current, **Iv**		12.5A	25A	37.5A	50A	62.5A
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 of charge end voltage and on deep discharge voltage	-96mV/°C				
Current consumption on battery side, **Io**		7mA	10mA	13mA	16mA	19mA
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 aktive 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	300x500x210	300x500x210
Weight		2,5kg	11kg	12.5kg	17kg	17.5kg
Operating temperature		-20°C to +60°C				
Relative humidity		90%				
Protection		IP65	IP65	IP54	IP54	IP54
Certification		**CE**	**CE**	**CE**	**CE**	**CE**
Terminals and cable glands		Lizz 10sqmm, one wire 16sqmm			Lizz 25sqmm, one wire 35sqmm	
		3xPG16 2xPG7				

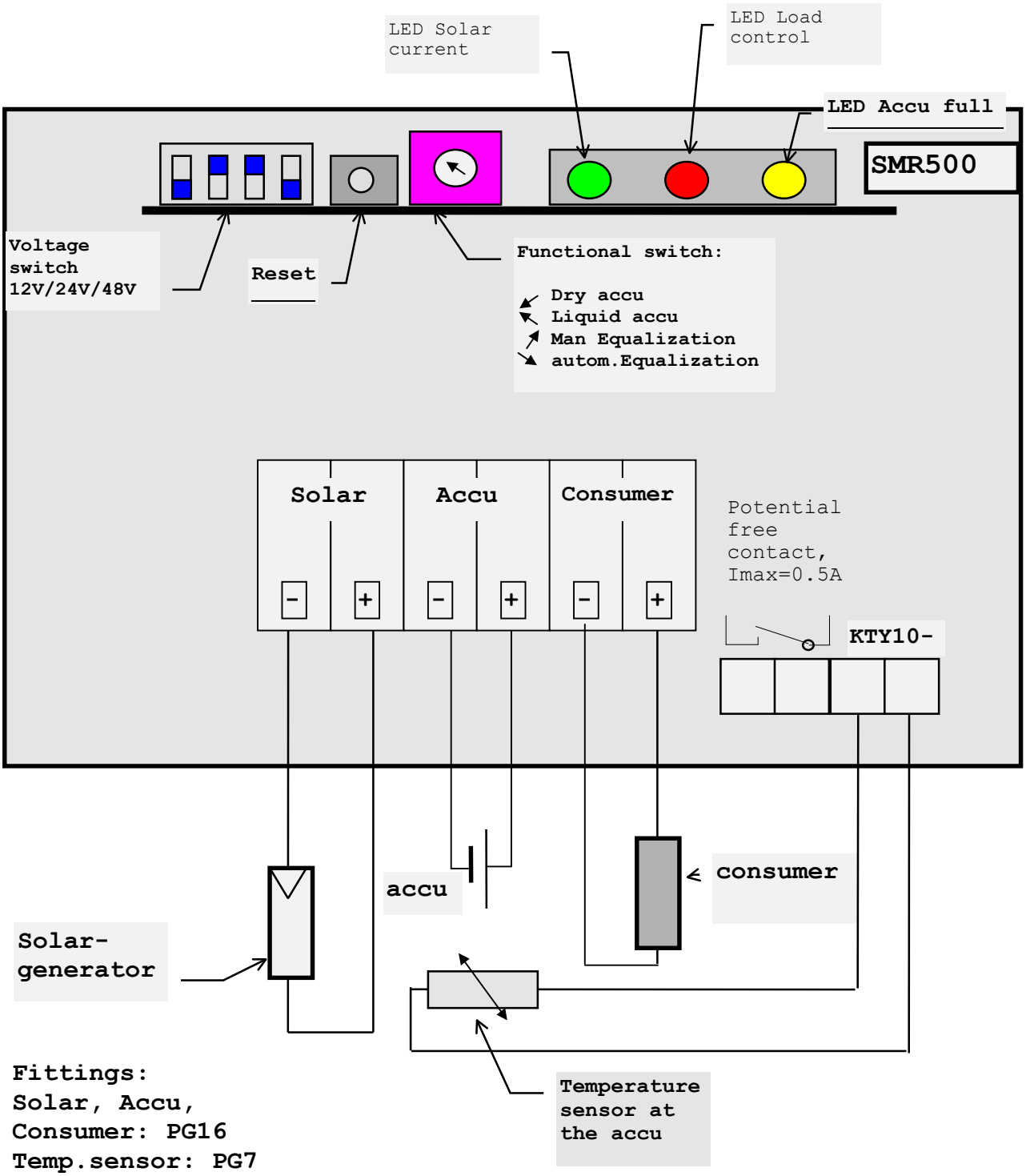
C.2 24V Configuration

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		604W	1208W	1813W	2417W	3021W
Max. charge current, Ia		20A	40A	60A	80A	100A
Max. Solar voltage ,Usol		200V				
Max. batt. voltage. At 20°C, Ua		29.0V				
Float voltage, Ufl		27.0V				
Max. consumer current, Iv		12.5A	25A	37.5A	50A	62.5A
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				
Temperatur e 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		7mA	10mA	13mA	16mA	19mA
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 aktive 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	300x500x210	300x500x210
Weight		2.5kg	11kg	12.5kg	17kg	17.5kg
Operating temperature		-20°C bis +60°C				
Relative humidity		90%				
Protection		IP65	IP65	IP54	IP54	IP54
Certification		CE	CE	CE	CE	CE
Terminals and cable glands		Lizz 10sqmm, one wire 16sqmm			Lizz 25sqmm, one wire 35sqmm	
		3xPG16 2xPG7				

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**		312W	624W	935W	1247W	1559W
Max. charge current, Ia		20A	40A	60A	80A	100A
Max. Solar voltage ,**Usol**		200V				
Max. batt. voltage. At 20°C, **Ua**		14.5V				
Float voltage, **Ufl**		13.5V				
Max. consumer current, **Iv**		12.5A	25A	37.5A	50A	62.5A
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**		7mA	10mA	13mA	16mA	19mA
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 aktive 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	300x500x210	300x500x210
Weight		2,5kg	11kg	12.5kg	17kg	17.5kg
Operating temperature		-20°C to +60°C				
Relative humidity		90%				
Protection		IP65	IP65	IP54	IP54	IP54
Certification		**CE**	**CE**	**CE**	**CE**	**CE**
Terminals and cable glands		Lizz 10sqmm, one wire 16sqmm			Lizz 25sqmm, one wire 35sqmm	
		3xPG16 2xPG7				

D. Connection diagram



E. Installation 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, accu, and consumer are found inside the box. Please see also **Fehler! Verweisquelle konnte nicht gefunden werden.**.

1. Connect the accu cable (however without having connected the accu).
   The minus cable to the fastener –accu, the plus cable to +accu
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 accu to the accu cable.
   Normally, the LED display shows "accu empty" (red). The accu 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 indicates tracking by shortly blinking.

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.

F. Warranty

The manufacturer will remove all contstruction and material faults that occur during the warranty time of two years and that do not impair the proper functioning of the device. Guarantee is effected by either rectification or replacement. This does not include the costs involved in exchanging, dispatching or re-installing. Any further claims against the manufacturer arising from this obligation, particularly compensation claims due to losses in sales, reimbursement payments as well as indirect damages are excluded if not forced by law.

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