

## User Description: MPPT Wind Power Charge Controller

### windMax500, windMax1000, windMax1500, windMax2000, windMax2500

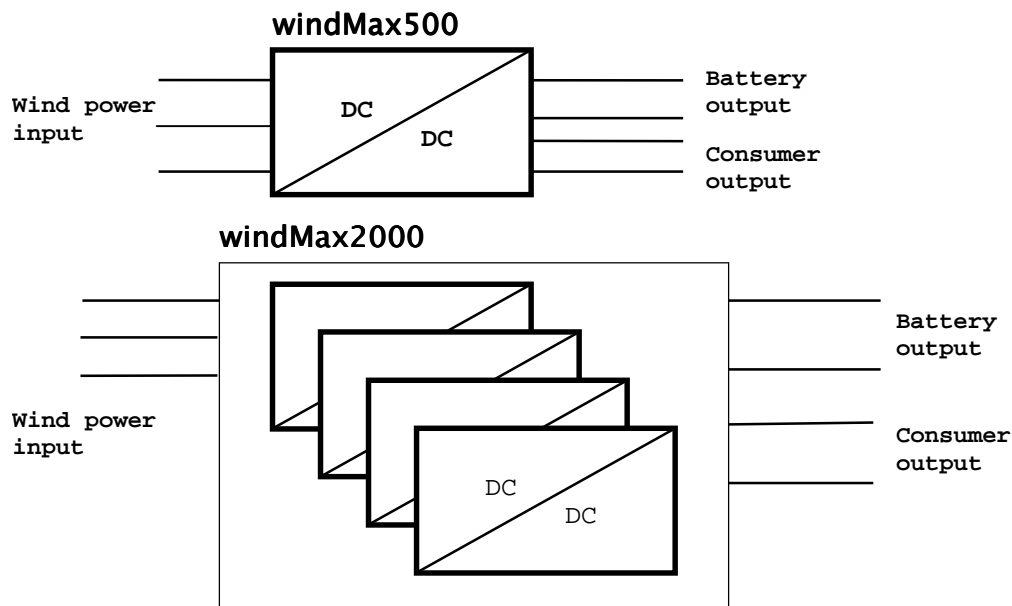
Version: WMR-MS\_110202\_EN

#### A. Function

The MPP (Maximum Power Point) – wind power charge controller show a very high degree of efficiency and higher charge currents (up to 200%) as compared to standard charge controllers.

The modular concept consists of 12V or 24V/20A units which are switched parallel at the input as well as at the output so that a double wire cable is sufficient at the battery input as well as at the output

The *windMax500* consists of only one module; however the *windMax2000* consists of 4 modules. Each controller has a 3-phase rectifier at the input for a three-phase current supply.



- ⇒ The micro controller system consists of step-down-converters being regulated to maintain the nominal voltage of the wind power generator in connection with the wind speed (power tracking) and to transform the total input to the battery level. This results in an increase of the charging current.
- ⇒ At the achievement of a maximum generator voltage of 160V dc, a load resistor can be connected at the output (RL+, RL-).
- ⇒ On the basis of power tracking an ideal power withdrawal is always guaranteed. This is shown for example through the increased charge current at a decreasing battery voltage.
- ⇒ At a lower wind speed (generator current smaller than 2% of the maximum charge current) the power tracker switches off and the controller works similarly like an ordinary controller.

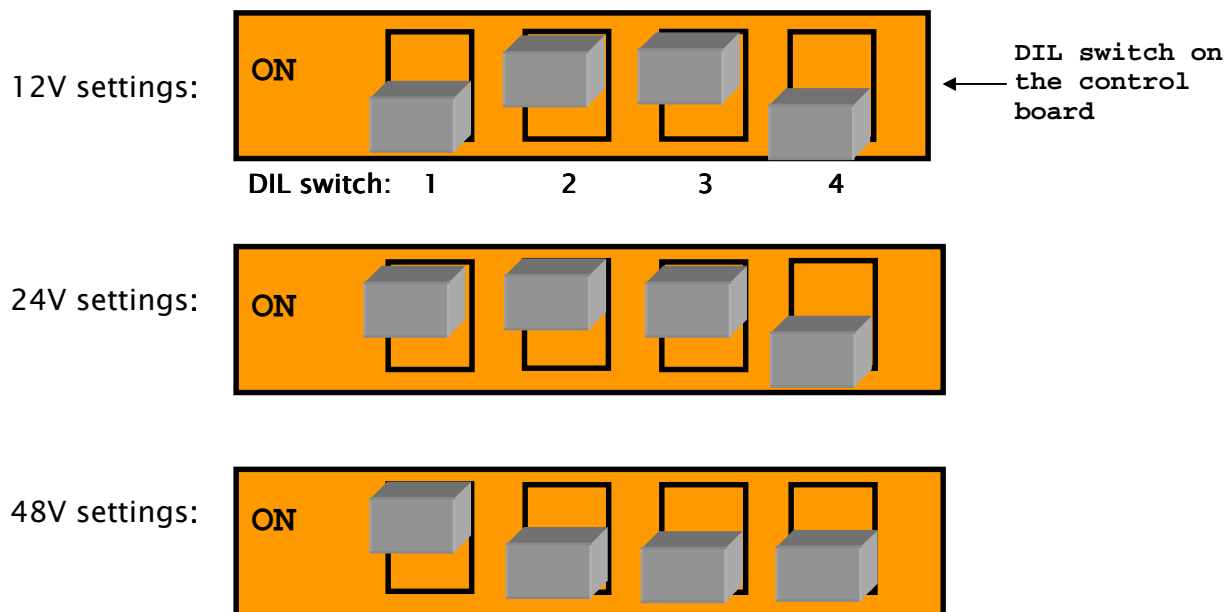
- ⇒ To protect the battery from overcharge, at achieving the charge end voltage, the maintenance charge controlling sets in. The maintenance charge controlling moves the generator voltage towards off-load voltage until the charging current is off. With a temperature sensor, the end charging voltage can be changed. The higher the temperature is, the lower the end charging voltage will be.
- ⇒ To protect the battery from total discharge, a MOSFET throws off the load at the **minus output**.
- ⇒ The fine lightning protection consists of a varistor at the generator input
- ⇒ The device has a transistor inverse-polarity protection.

## B. Operation

A 12V, 24V or a 48V lead battery emulator can be used. For this only the DIL switch of the controller has to be switched.

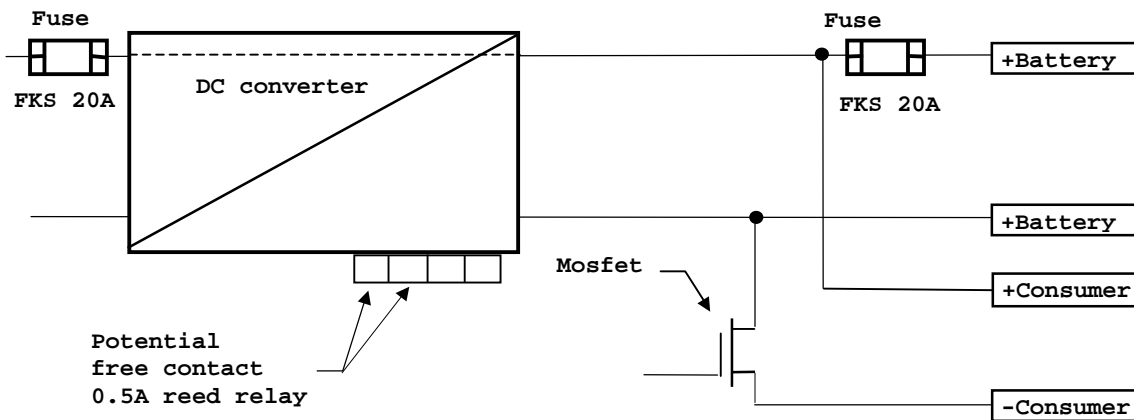
### B.1 12V/24V/48V Change Over Switch

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



## 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 battery voltage will be smaller than 10.8V/21.6V (at 20° C) for about 60 secs, the MOSFET disconnects the consumer from the battery (load control)

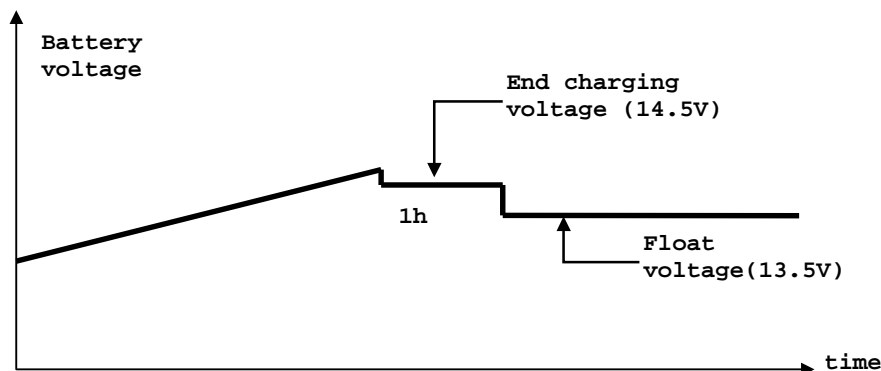
This is indicated through the red LED in the middle

Only if the battery voltage has reached 12.5V/25V, or through pressing the "reset" button, the load will be reconnected.

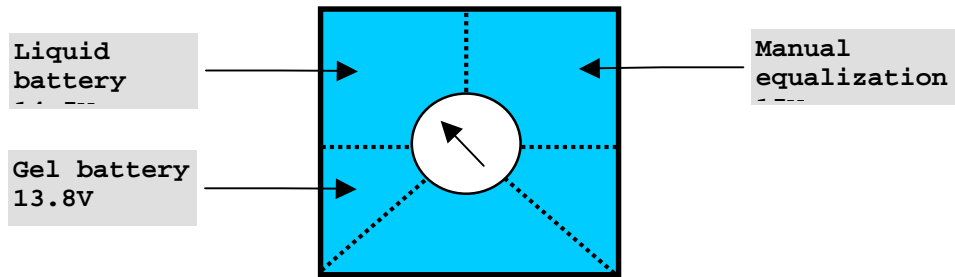
The load control is temperature-controlled. That means, the battery temperature as reported by the battery temperature sensor determines the interrupting voltage of the load control as well as the reconnection voltage. The effect is -4mV/battery cell. (See section B.6 Temperature sensor KTY10-5)

## 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 end charging voltage exceeds 14.5V/28.2V, the micro controller switches to end charge voltage controlling, the yellow LED flashes. After 1 hour, the end charging voltage will be limited to 13.5V/27.0V. Only if the voltage drops below 13.6V/27.2V the controlling will be deactivated. This charging characteristic always guarantees a maximum charging current until the end charging voltage is reached.



## B.4 Funktionsschalter



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.

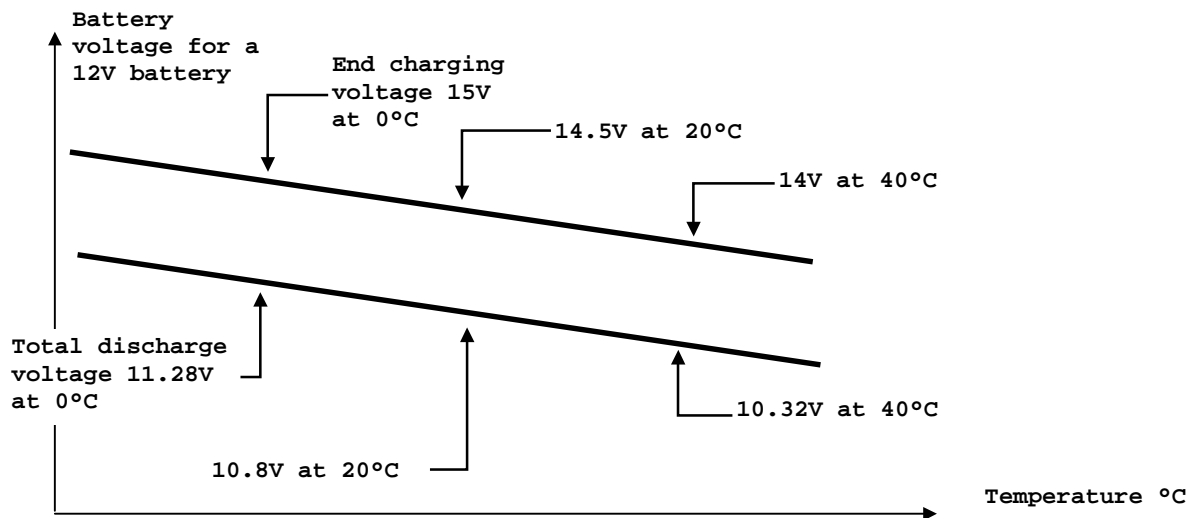
## B.5 Reset

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

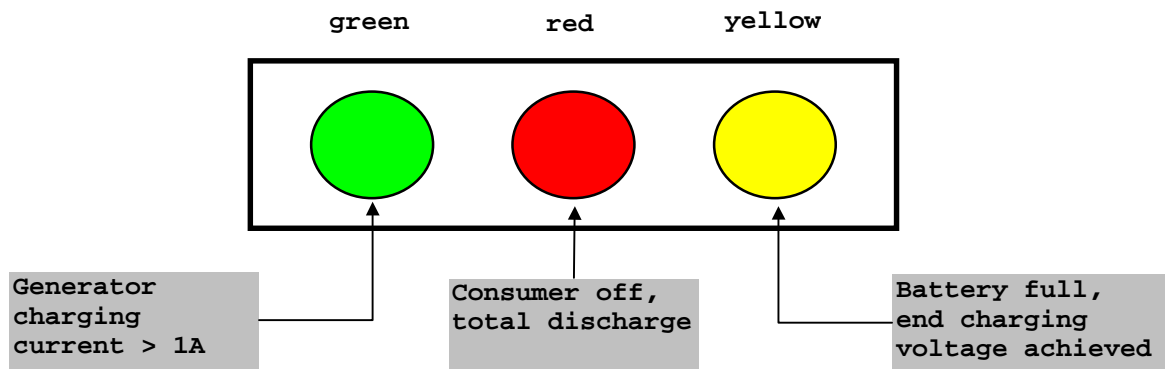
- ⇒ Reset of the total discharge protection at a voltage below 12.5V/25V.
- ⇒ Reset of the MPP-controlling to the 14,5 voltage level. After pressing for a longer time, the operating point increases up to the off-load voltage.
- ⇒ Reset of the end charging voltage control (the yellow LED display is off)
- ⇒ Fast blinking of the green LED display indicates that the "reset" button has been 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 14.5V at 20°C. If the temperature sensor is 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 effect on the end charging voltage is  $-4\text{mV}/^\circ\text{C}/\text{battery cell}$ . At an battery temperature of 45°C, the controller disconnects the consumer- and charging current in order to protect the battery.



### B.7 LED Anzeigen



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

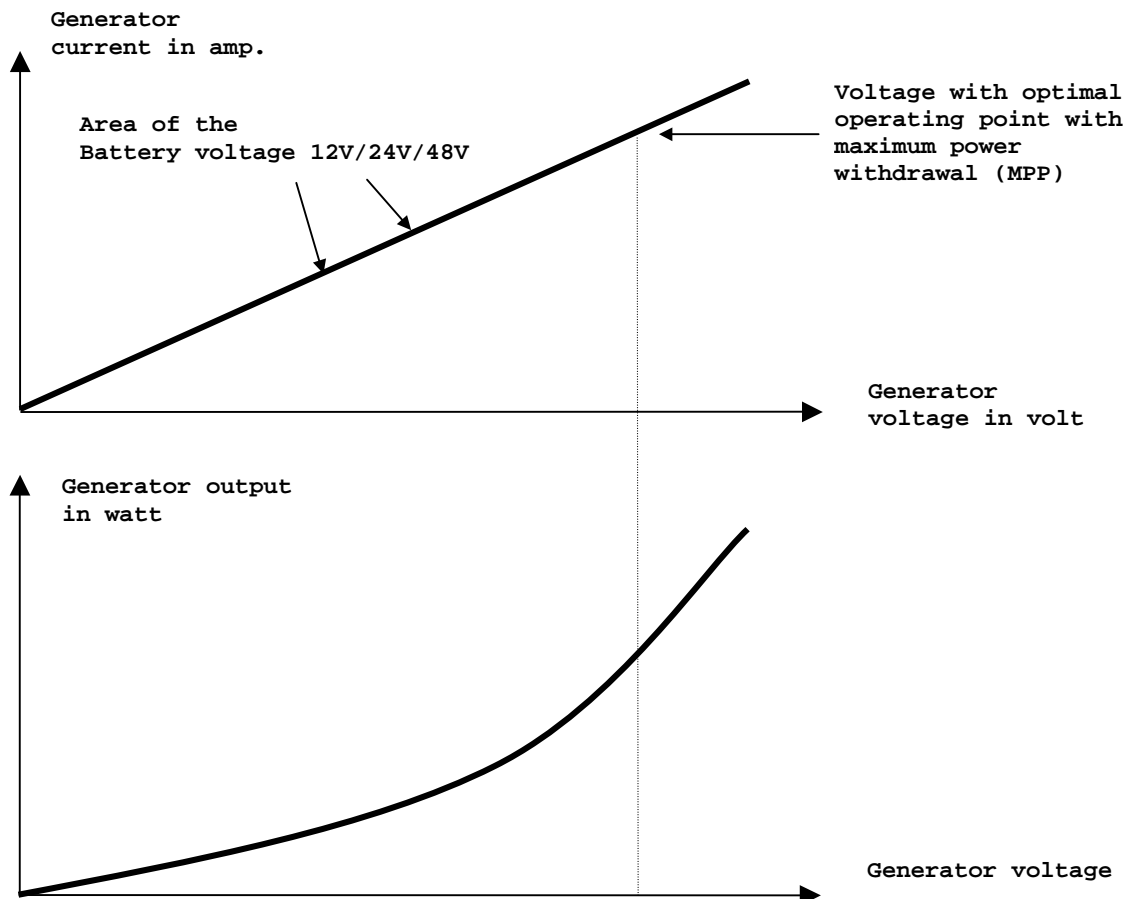
## B.8 Safety devices

- ⇒ A fuse at the +accu exit protects the device from significant mechanical damage at excessive currents. The fuse disconnects the accu from the consumer and wind generator.
- ⇒ A 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.
- ⇒ 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 accu temperatur sensor, the controller is switched off at 45°C accu temperature.

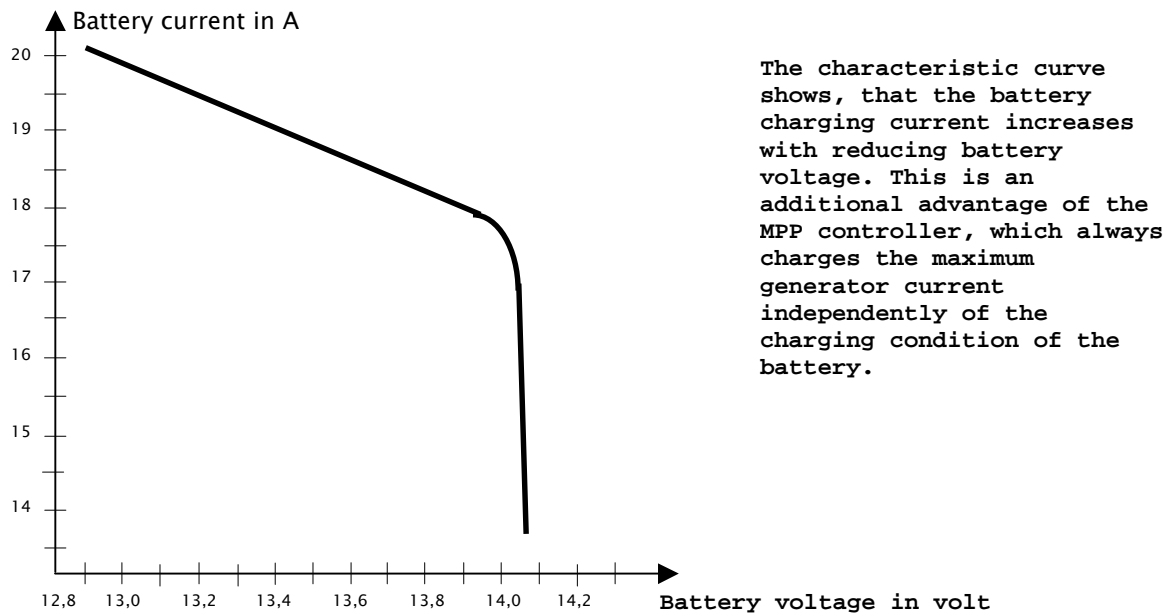
## B.9 MPP Controlling

A wind power generator can be connected up to a voltage of 170V. The battery voltage can be 12V/24V/48. The MPP controlling works in intervals of 0.5 sec for about 0.2-05sec. It automatically searches for the ideal operating point between 15V and 170V generator voltage.

Below 2% of the maximum allowed charging current of the device, the controlling switches to the battery level.



The curves of a windpower generator above show, that the power increases nonlinear with rising voltage. The MPPT-charger transforms the electrical power from the point of highest voltage down to the battery level.



### **B.10 Potential-free Contact**

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

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

This contact is available via two terminals on the power PCB, on the left of the temperature sensor terminals. Please refer to section D. Connection diagram

### B.11 Dump Load Resistor

The dump load resistor is connected at the output of the 3 phase converters. The dimensions should be such that the converter loads the wind generator sufficiently at high wind speeds in order to avoid an increase of the generator voltage. With a rectified generator voltage of  $U_{\text{gendc}}=160\text{V}$ , the dump load resistor will be connected. At  $U_{\text{gendc}}=125\text{V}$ , the dump load resistor will be disconnected.

**Recommended dimensions:**

Value of resistance:

$$R_{\text{load}}=160\text{V}\times 160\text{V}/P_{\text{nom}}$$

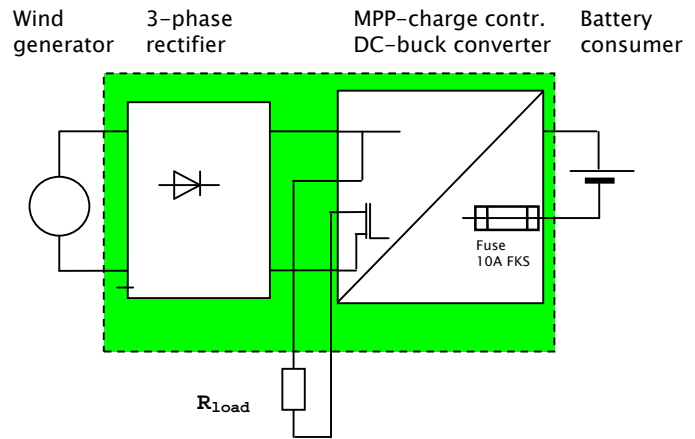
Output at resistor:

$$P_{\text{load}}=170\text{V}\times 170\text{V}/R_{\text{load}}$$

Example:  $P_{\text{nom}}=620\text{W}$

$$R_{\text{load}}=160\times 160/620=41.30\text{Ohm} \Rightarrow 39\text{Ohm}$$

$$P_{\text{load}}=165\times 165/39=698\text{W}$$



### B.12 Efficiency

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



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

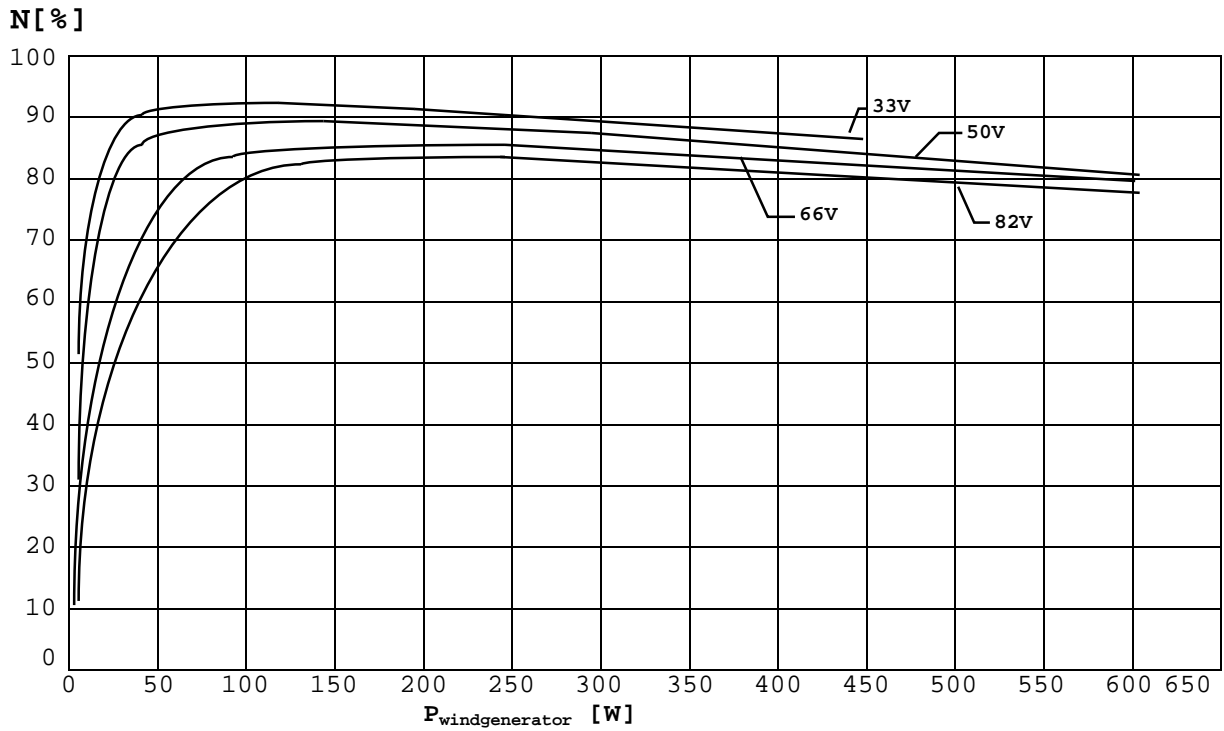
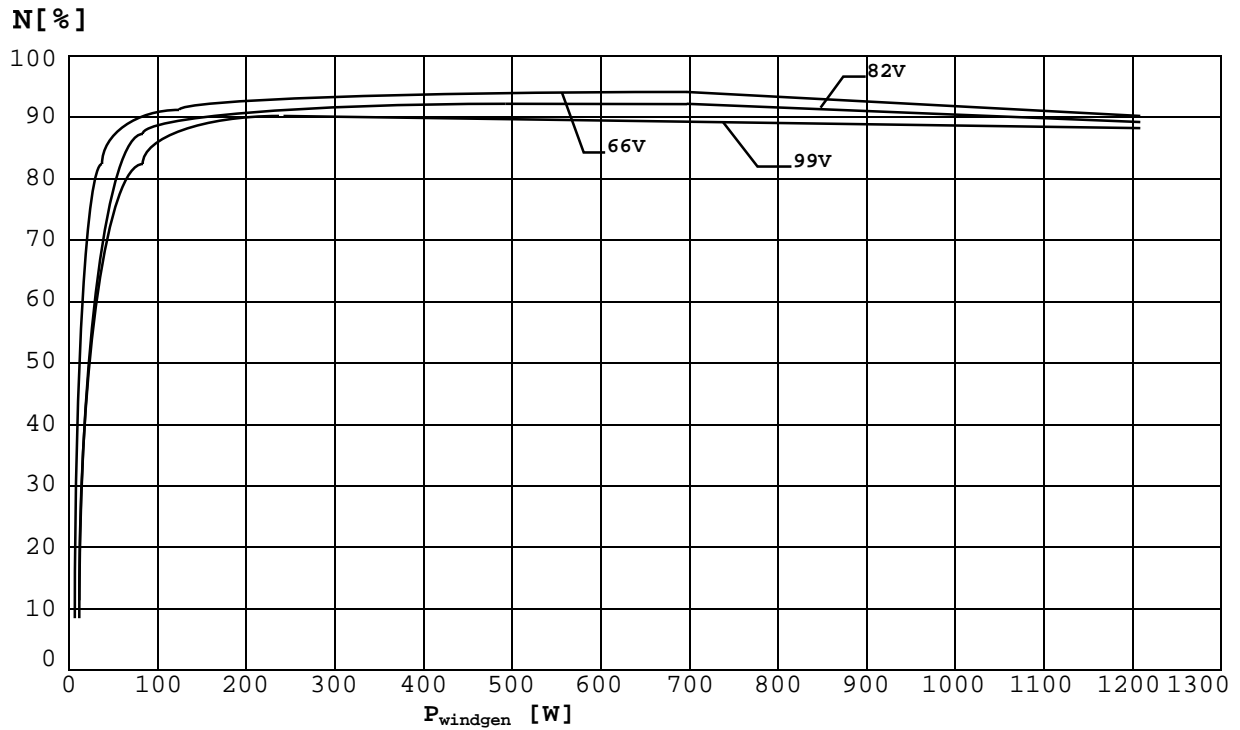


Diagram 2: Efficiency factor trends at 56V battery voltage and 66V to 99V generator-dc-voltage



## C. Technical Data

### C.1 48V Configuration

Typ	WindMax 500	WindMax 1000	WindMax 1500	WindMax 2000	WindMax 2500
Number of MPP-Modules	1	2	3	4	5
Ventilation	no	no	yes	yes	yes
Max. wind generator output	750W	1500W	2250W	2800W	3750W
Max. charging current	12.5A	25A	37.5A	50A	62.5A
Max. generator-DC-voltage	200Vdc				
AC-voltage (3phase)	140Vac				
Dump load resistor Re- / Deconnection at Udc or Uac (3phase)	150Vdc/85Vdc 106Vac/60Vac				
Max. generator AC current	8A	16A	16A	24A	24A
Max. battery voltage at 20°C	58.0V				
Max. float voltage	54.0V				
Max. Consumer current	20A	40A	60A	80A	100A
Deep discharge protection	Switch off voltage., <b>Uta</b>	43.2V at 20°C			
	Switch off delay	60 seconds			
	Switch on voltage, <b>Ute</b>	50.0V at 20°C			
	Volt.drop at Mosfet at Imax	0.24V			
Temperature sensor	Input	Connection of a 1.9kOhm resistor or temperature sensor KTY 10-5			
	Switch off temperature	45°C			
	Effect on end charging voltage and deep discharge voltage	-96mV/°C			
Self consumption	5mA	10mA	15mA	20mA	25mA
Efficiency at half load and at 80V generator voltage inclusive 3- phase recitifier	91%	91%	91%	91%	91%
Fuses	2x20A FKS	4x20A FKS	6x20A FKS	8x20A FKS	10x20A FKS
LED displays: Left, green Middle, red Right, yellow	Charging current, MPP controlling activated Load discharge Battery fully charged, flashing when equalization control activated				
Housing: material	Alu casting	Sheetsteel	Sheetsteel	Sheetsteel	Sheetsteel
Housing: measures in mm wxhxd	220x80x120	300x300x150	300x400x150	500x500x210	500x500x210
Weight ca	2kg	11kg	12.5kg	17kg	17.5kg
Protection category	IP65	IP65	IP65	IP54	IP54
Certification	<b>CE</b>	<b>CE</b>	<b>CE</b>	<b>CE</b>	<b>CE</b>
Admissible operating temperature	-20°C to +50°C				
Admissible relative humidity	90%				
Connecting terminals	Lizz 10sq.mm, single wire 16sq.mm				
Cable glands	3xPG16, 1xPG7, 1xPG9				

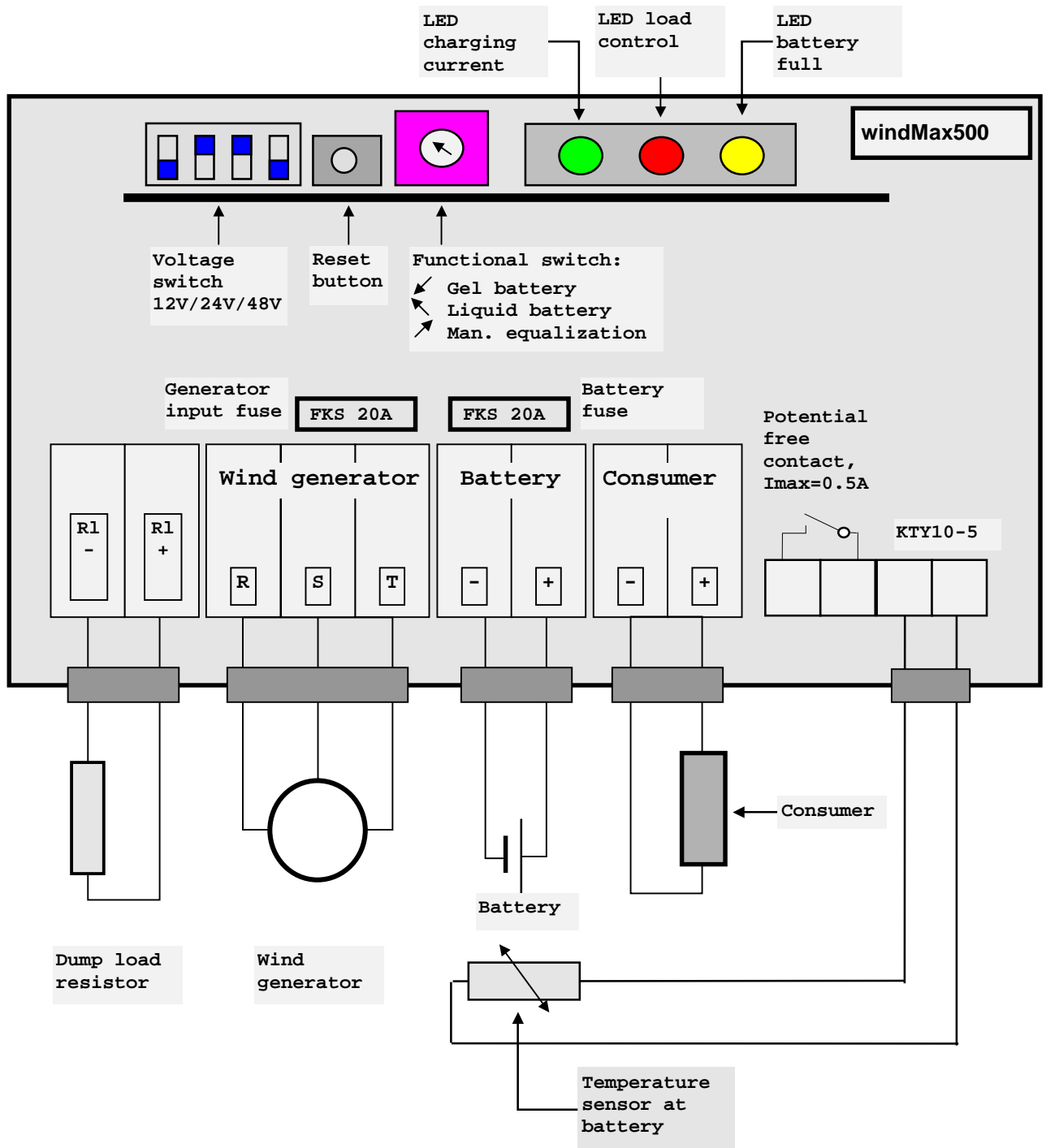
## C.2 24V Konfiguration

Typ		WindMax 500	WindMax 1000	WindMax 1500	WindMax 2000	WindMax 2500
Number of MPP-Modules		1	2	3	4	5
Ventilation		no	no	yes	yes	yes
Max. wind generator output		560W	1120W	1680W	2240W	2800W
Max. charging current		20A	40A	60A	80A	100A
Max. generator-DC-voltage		200Vdc				
AC-voltage (3phase)		140Vac				
Dump load resistor Re- / Deconnection at Udc or Uac (3phase)		150Vdc/85Vdc 106Vac/60Vac				
Max. generator AC current		8A	16A	16A	24A	24A
Max. battery voltage at 20°C		29.0V				
Max. float voltage		27.0V				
Max. Consumer current		20A	40A	60A	80A	100A
Deep discharge protection	Switch off voltage., <b>Uta</b>	21.6V at 20°C				
	Switch off delay	60 seconds				
	Switch on voltage, <b>Ute</b>	25.0V at 20°C				
	Volt.drop at Mosfet at Imax	0.24V				
Temperature sensor	Input	Connection of a 1.9kOhm resistor or temperature sensor KTY 10-5				
	Switch off temperature	45°C				
	Effect on end charging voltage and deep discharge voltage	-48mV/°C				
Self consumption		5mA	10mA	15mA	20mA	25mA
Efficiency at half load and at 80V generator voltage inclusive 3- phase recitifier		89%	89%	89%	89%	89%
Fuses		2x20A FKS	4x20A FKS	6x20A FKS	8x20A FKS	10x20A FKS
LED displays: Left, green Middle, red Right, yellow		Charging current, MPP controlling activated Load discharge Battery fully charged, flashing when equalization control activated				
Housing: material		Alu casting	Sheetsteel	Sheetsteel	Sheetsteel	Sheetsteel
Housing: measures in mm wxhxd		220x80x120	300x300x150	300x400x150	500x500x210	500x500x210
Weight ca		2kg	11kg	12.5kg	17kg	17.5kg
Protection category		IP65	IP65	IP65	IP54	IP54
Certification		<b>CE</b>	<b>CE</b>	<b>CE</b>	<b>CE</b>	<b>CE</b>
Operating temperature		-20°C to +50°C				
Admissible relative humidity		90%				
Connecting terminals		Lizz 10sq.mm, single wire 16sq.mm				
Cable glands		3xPG16, 1xPG7, 1xPG9				

### C.3 12V Konfiguration

Typ		WindMax 500	WindMax 1000	WindMax 1500	WindMax 2000	WindMax 2500
Number of MPP-Modules		1	2	3	4	5
Ventilation		no	no	yes	yes	yes
Max. wind generator output		280W	560W	840W	1120W	1400W
Max. charging current		20A	40A	60A	80A	100A
Max. generator-DC-voltage		200Vdc				
AC-voltage (3phase)		140Vac				
Dump load resistor Re- / Deconnection at Udc or Uac (3phase)		150Vdc/85Vdc 106Vac/60Vac				
Max. generator AC current		8A	16A	16A	24A	24A
Max. battery voltage at 20°C		14.5V				
Max. float voltage		13.5V				
Max. Consumer current		20A	40A	60A	80A	100A
Deep discharge protection	Switch off voltage., <b>Uta</b>	10.8V at 20°C				
	Switch off delay	60 seconds				
	Switch on voltage, <b>Ute</b>	12.5V at 20°C				
	Volt.drop at Mosfet at Imax	0.24V				
Temperature sensor	Input	Connection of a 1.9kOhm resistor or temperature sensor KTY 10-5				
	Switch off temperature	45°C				
	Effect on end charging voltage and deep discharge voltage	-24mV/°C				
Self consumption		5mA	10mA	15mA	20mA	25mA
Efficiency at half load and at 80V generator voltage inclusive 3-phase rectifier		83%	83%	83%	83%	83%
Fuses		2x20A FKS	4x20A FKS	6x20A FKS	8x20A FKS	10x20A FKS
LED displays: Left, green Middle, red Right, yellow		Charging current, MPP controlling activated Load discharge Battery fully charged, flashing when equalization control activated				
Housing: material		Alu casting	Sheetsteel	Sheetsteel	Sheetsteel	Sheetsteel
Housing: measures in mm wxhxd		220x80x120	300x300x150	300x400x150	500x500x210	500x500x210
Weight ca		2kg	11kg	12.5kg	17kg	17.5kg
Protection category		IP65	IP65	IP65	IP54	IP54
Certification		<b>CE</b>	<b>CE</b>	<b>CE</b>	<b>CE</b>	<b>CE</b>
Admissible operating temperature		-20°C to +50°C				
Admissible relative humidity		90%				
Connecting terminals		Lizz 10sq.mm, single wire 16sq.mm				
Cable glands		3xPG16, 1xPG7, 1xPG9				

## D. Connection diagram



### Fittings

Wind generator, battery, consumer: PG16

Dump load resistor: PG9-PG11

Temperature sensor: PG7

## E. Installation Guidelines

For better cooling, it is advisable to mount the housing on steel or an aluminum sheet.

For the device *windMax500*, the wind power generator can be connected via the PG fittings. The consumer and battery cables however have to be connected through the PG fittings inside at the Phoenix terminals. For that purpose, the cover of the aluminum housing needs to be taken off.

In order to connect the devices *windMax1000* to *windMax2500*, the device has to be opened with a switchboard key. The terminals for the three-phase current input of the wind power generator as well as the terminals for the battery and the consumer are located inside. (See D. Connection diagram.)

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

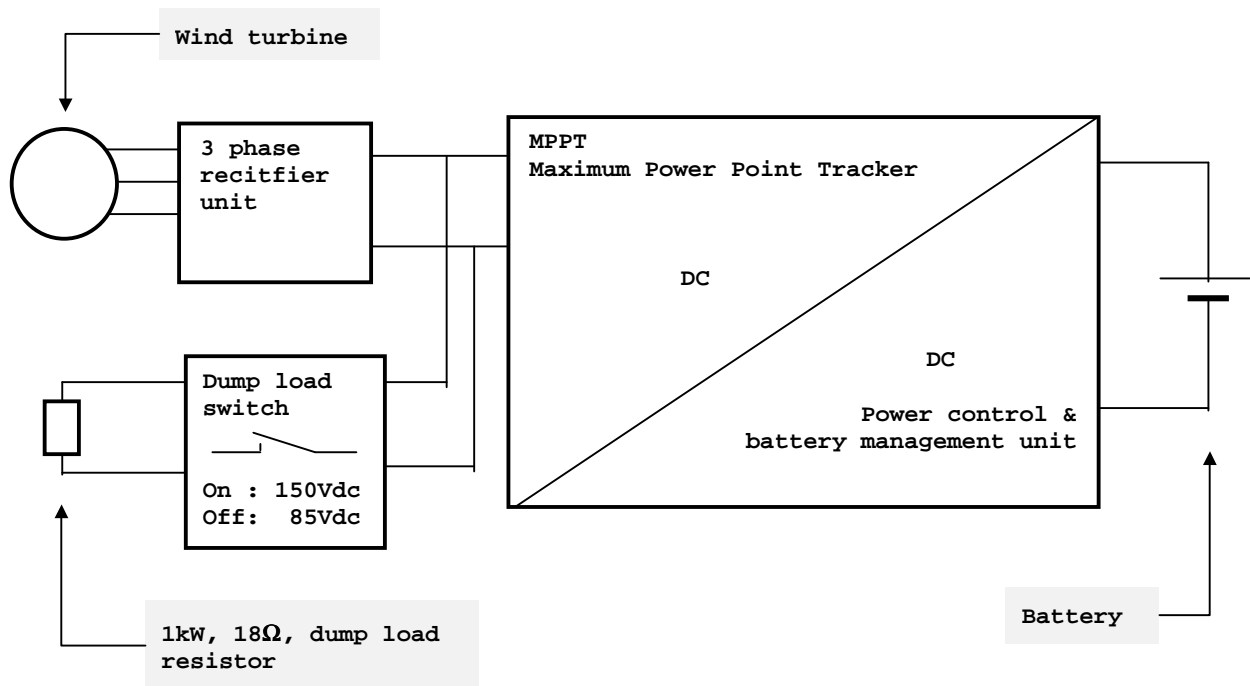
**Attention: Reverse polarity can destroy the device!**

2. Now connect the consumer. The minus cable to "-consumer", the plus cable to "+consumer".
3. Now connect the wind generator cables. Also here the wind generator should not be connected.
4. Now connect the battery to the battery cable. Normally the LED display indicates "battery empty", (red). The battery voltage is still below 12.5V/25V. Only if the wind generator starts charging current, the voltage increases above 12.5V/25V and the red LED goes off.
5. Now connect the wind power generator to the cable. The left LED (green) indicates that charging current flows. After a short period the red LED switches off and the consumer is connected.
6. Approximately every 0.5 second, the green LED switches off (or it switches on if it was off before). This indicates that the device is identifying 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.

## F. Security Concept



If battery is full and wind generator voltage rises above 106Vac the charge controller needs to be protected from overvoltage, since electrical power is not consumed from the battery. In this case the dump load switch turns on and causes the turbine to slow down its rotation and saving it from overload and mechanical stress due to excessive rotational speed of the blades.

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