

60A SOLAR CHARGE REGULATOR FOR LEAD BATTERIES

WR60



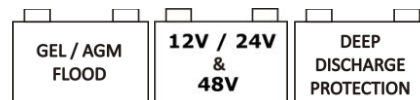
WR60 is a charge regulator from PV modules for the charge of both sealed and flooded lead acid batteries. It protects the battery from overloads or deep discharges so to make it work always in the best conditions and to maximize its useful life. WR60 has got a simple and reliable PWM charge circuit. It is planned to be used in large PV plants for industrial and residential applications and it can manage battery banks at 12V, 24V and 48V.

WR60 has got an output (LOAD) that can be used to power supply a small load to the battery voltage (Max 10A) according to 18 different automatic management programs: load always ON, load ON only during the day, load ON only during the night or load ON from twilight for a number of hours from 1 to 16. The loads that are power supplied through LOAD output are automatically deactivated if the battery voltage falls below a voltage threshold called “ low battery”; this guarantees the battery protection from deep discharges.

A wide display shows the working status of the regulator either through simple and intuitive icons or through the visualization of the following values: charge current, battery voltage, energy produced by PV module, load current and energy consumed by the load.



- PWM charge
- Max charge current: 60A
- Integrated blocking diode
- For Pb sealed, GEL and flooded lead acid batteries
- Charge voltage compensated in temperature
- Battery voltage: 12V / 24V and 48V
- Configurable parameters by two buttons and LCD
- 18 programs for load management
- Low battery protection
- Over temperature protection
- Protection for battery polarity inversion
- Overload protection on output
- IP20 metal box
- Terminal for 35mm² wire housing



General description

WR60 is a charge regulator from PV modules for Pb electrochemical batteries either sealed (SEAL) or flooded lead acid (FLOOD). Fig. 1 shows a diagram of WR60.

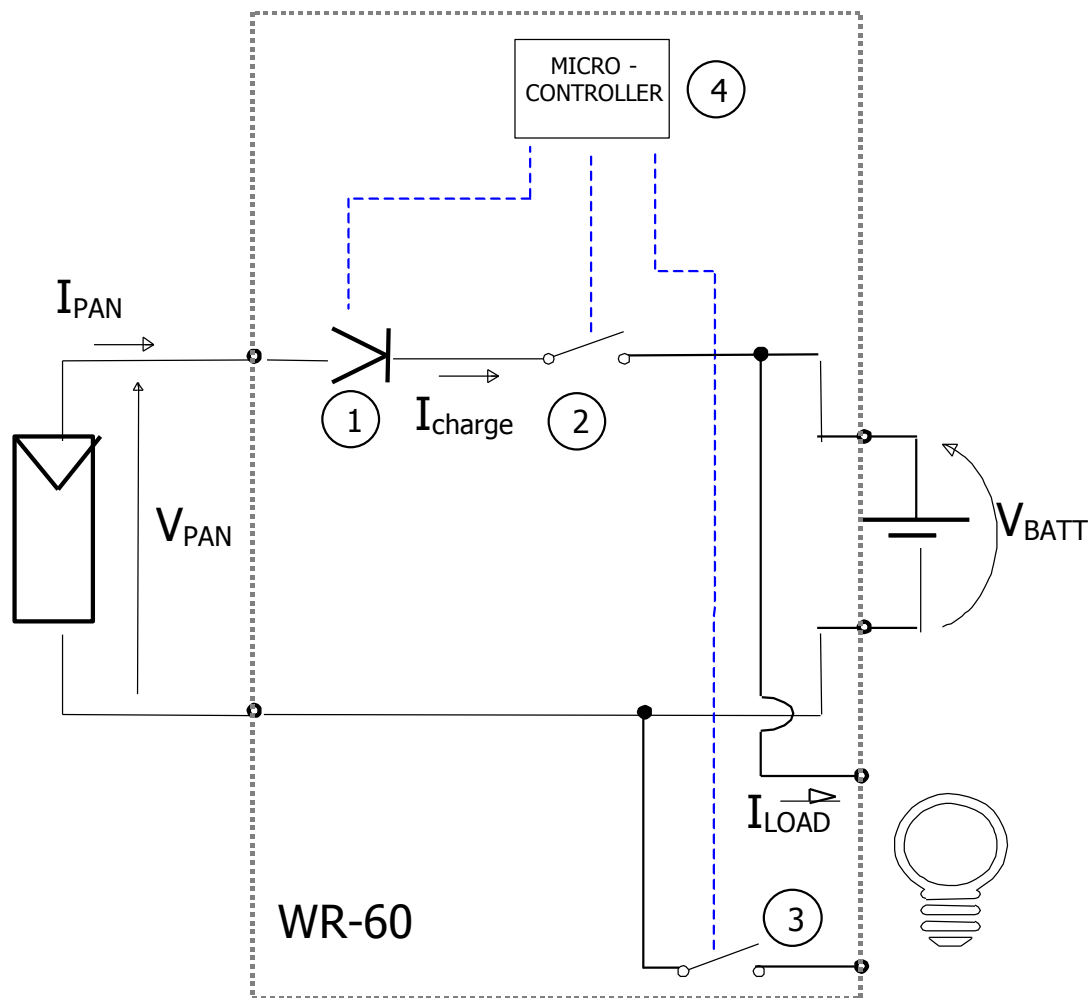


Fig. 1 Block diagram

- 1- Series diode: it is needed to avoid that the not-lighted PV module (during night) can absorb current from the battery.
- 2- The charge circuit can be thought as a switch that connects in parallel the PV module to the battery when the battery has got a lesser voltage than the maximum charging voltage (V_{ch}), while it disconnects the PV module from the battery when the battery voltage is $>$ or $=$ to the maximum charging voltage (V_{ch}). The charge circuit is made of semiconductor components that are more reliable and durable than electromechanical components. This kind of charging circuit is known as PWM series.
- 3- The load is power supplied with the same battery voltage (the positive terminal of LOAD output is in common with the positive of battery) and is controlled through a semiconductor switch.
- 4- Microprocessor: it controls the whole circuit; it measures current and voltages of PV module, battery and load and shows them on the display.

For a more precise detection of the correct voltage and battery temperature, WR60 measures these quantities through a sensor placed close to battery terminals (the sensor is included in the product). It is important to connect this sensor so to guarantee the compensation in temperature of the system's end-charge voltage (V_{ch}) and for a measure of the battery voltage that is independent from the voltage drop on cables. If you do not connect this sensor the system works equally, but the battery voltage is measured on the internal terminals of WR60, while the compensation of V_{ch} in function of temperature is not performed and prudently V_{ch} is set to the minimum value as if the system detects a temperature of 60°C . The LED L1 (fig. 3) is turned on only when the temperature sensor and battery voltage are properly connected; therefore, if L1 is not ON, check the connections of the probe.

WR60 has got an automatic detection of battery voltage that allows the automatic recognition of the battery nominal voltage and it sets the proper charging parameters as shown in tab. 5.

During the activation WR60 measures the battery voltage (V_{batt}) on internal terminals and, according to this measure, it recognizes the battery nominal voltage according to the levels that are shown in Table 1.

battery voltage measured at startup	
$10.0V < V_{batt} < 16.0V$	Battery at 12V
$20.0V < V_{batt} < 32.0V$	Battery at 24V
$40.0V < V_{batt} < 64.0V$	Battery at 48V

Table 1 recognition thresholds for battery nominal voltage

If the battery voltage does not fall into one of the abovementioned bands, WR60 reports E03 error (see Table 4), it does not charge and it does not power supply any loads connected to the system. If there is such an error, check the voltage of the battery bank.

Choice of PV module and strings

The choice of PV modules to use in the photovoltaic system is closely linked to the battery voltage. Please follow strictly to what is indicated in the Table below in choosing the PV modules string configuration to use in the system.

Battery nominal voltage	Features of PV modules
12V battery	Strings with 36 cells - Mono-crystalline / poly-crystalline silicon typical V_{oc} @25 21.0V Max I_{sc} 60°
24V battery	Strings with 72 cells - Mono-crystalline / poly-crystalline silicon typical V_{oc} @25 42.0V Max I_{sc} 60°
48V battery	Strings with 144 cells - Mono-crystalline / poly-crystalline silicon typical V_{oc} @25 84.0V Max I_{sc} 60°

Table 2

When you connect more than 2 PV modules in parallel, it is compulsory to use the parallel diodes as shown in fig. 2:

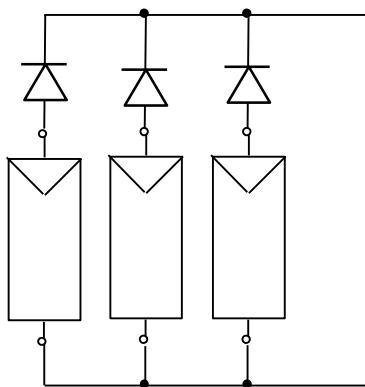


fig. 2. Connect 3 or more strings in parallel using appropriate parallel diodes

If you have to use the parallel diodes as in fig. 2, we recommend to buy Western Co. product code JB5.

Wiring scheme

- 1) Install WR60 in a dry and adequately ventilated place, fixed on a non-flammable surface and positioned so to leave an unobstructed space of at least 10cm near the device so to have a cooling for natural air convection. Remove the front cover to access to electrical connections (see fig. 5 later in this manual).
- 2) Connect following this order: load, sensor for temperature measure and battery voltage (included), PV module and finally the battery as shown in the diagram - fig. 3. When connecting the battery, the regulator turns on and begins to operate. You must choose the cable sections so that in any part of the cable the maximum allowed voltage drop is $<$ of 1.5% of the system nominal voltage. In table 3 there is the maximum length of the cable that guarantees a voltage drop $<$ 3.0% of nominal V_{batt} in relation to mm^2 section.
- 3) You can connect to WR60 Pb batteries with 12V, 24V or 48V nominal voltage. During activation WR60 measures the battery voltage, recognizes the nominal voltage of the battery bank and it sets automatically

the correct levels of charging voltage (see description at page 2). Please configure the kind of battery in use to adjust the correct charging voltage (V_{ch}). Please set SEAL configuration if you use sealed VRLA or GEL batteries, and set FLOOD configuration if you use flooded lead acid batteries. To make this setting follow the instructions in the 'System Configuration' section, later in this manual.

- 5) Set the load management program for your application. Note: do not connect loads that absorb a current > 10A to LOAD output, otherwise the system goes into over-current protection (E02) and the load is not power supplied.
- 6) Mount the given cable-clamp so that the weight of the cables is not passed on to the electrical terminals, but on the same cable-clamp; then please mount the front door to protect electrical connections.

12V battery nominal voltage

		Wire section					
		6 mm ²	10 mm ²	16 mm ²	25 mm ²	32 mm ²	
Current	10.0A	6,3	10,5	16,7	26,2	33,5	<i>Max distance pair of wires [m]</i>
	20.0A	3,1	5,2	8,4	13,1	16,7	
	30.0A	2,1	3,5	5,6	8,7	11,2	
	40.0A	-	2,6	4,2	6,5	8,4	
	50.0A	-	-	3,3	5,2	6,7	
	60.0A	-	-	2,8	4,4	5,6	

24V battery nominal voltage

		Wire section					
		6 mm ²	10 mm ²	16 mm ²	25 mm ²	32 mm ²	
Current	10.0A	12,6	20,9	33,5	52,3	67,0	<i>Max distance pair of wires [m]</i>
	20.0A	6,3	10,5	16,7	26,2	33,5	
	30.0A	4,2	7,0	11,2	17,4	22,3	
	40.0A	-	5,2	8,4	13,1	16,7	
	50.0A	-	-	6,7	10,5	13,4	
	60.0A	-	-	5,6	8,7	11,2	

48V battery nominal voltage

		Wire section					
		6 mm ²	10 mm ²	16 mm ²	25 mm ²	32 mm ²	
Current	10.0A	25,1	41,9	67,0	104,7	134,0	<i>Max distance pair of wires [m]</i>
	20.0A	12,6	20,9	33,5	52,3	67,0	
	30.0A	8,4	14,0	22,3	34,9	44,7	
	40.0A	-	10,5	16,7	26,2	33,5	
	50.0A	-	-	13,4	20,9	26,8	
	60.0A	-	-	11,2	17,4	22,3	

Table 3 maximum cable distance for two wires battery cables which guarantees the maximum voltage drop of 3% of battery nominal voltage system at rated charging current

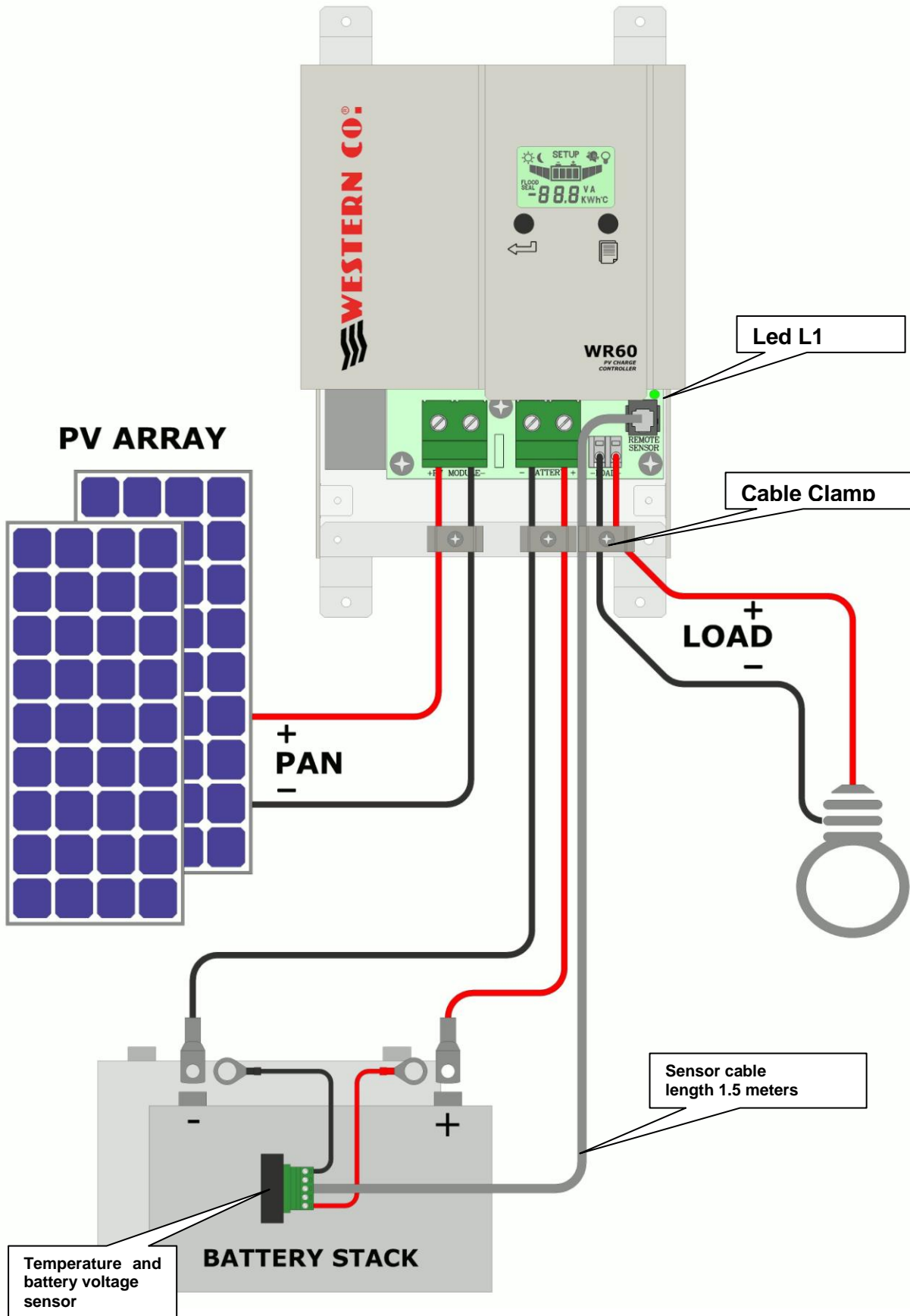


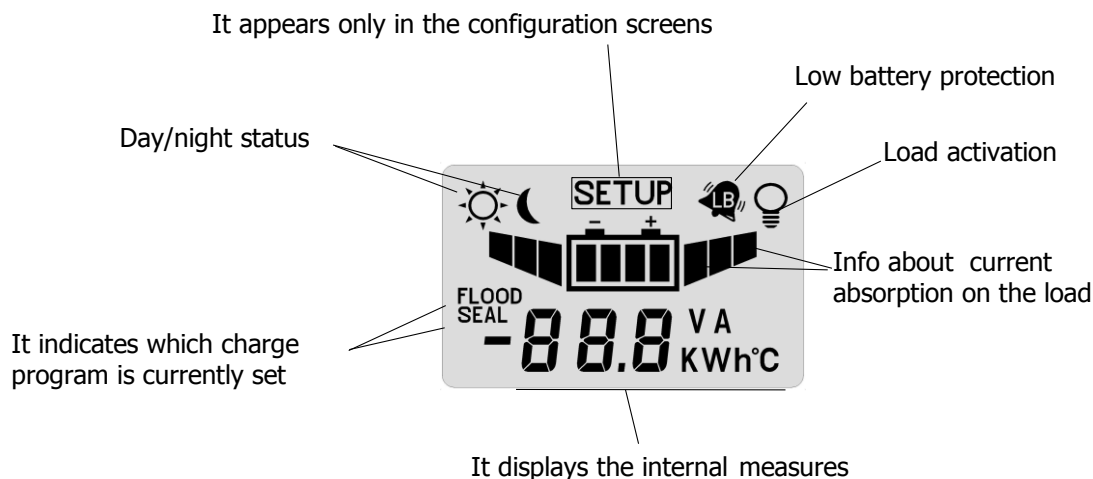
Fig. 3 Wiring scheme









Testing of the system

Once made the connections as shown in fig. 3, it is necessary to test the system.

- 1- Verify that L1 LED indicator is ON, to indicate the proper connection of the voltage and temperature battery sensor.
- 2- With the PV module exposed to sunrays, verify that WR60 charges the battery going to read the charging current I_{PAN} and I_{BAT} (see section 'Visualizations' later in this manual).
- 3- Check the correct LOAD activation. If the load is ON only during night it is possible to simulate the night temporarily disconnecting one of the wires of the PV module. With the load ON, verify the current absorbed by it reading in the proper LCD page.

Visualizations



	<p>Main page. It shows the battery voltage (V_{BAT}), the charging program currently selected (SEAL or FLOOD), the day/night status detected by the PV module. The load icon, if ON, indicates that the load is power supplied.</p>
<p>push-button</p>	
	<p>It shows the current of the PV module (I_{PAN}). Remember that the current delivered by the PV module depends on its state of sun irradiation and on the battery state of charge. In condition of charged battery ($V_{batt} > 14,4V @ 12V$, $V_{batt} > 28,8V @ 24V$, $V_{batt} > 57,6V @ 48V$) even with a good sun irradiation of the PV module we have low charge currents since the regulator limits such a current to avoid a battery overcharge.</p>
<p>push-button</p>	
	<p>It shows the power in watt actually delivered y the PV module.</p>
<p>push-button</p>	
	<p>It displays the counter of energy that is delivered from the PV module in kWh. It is possible to reset such measure by pushing at the same time the push-buttons   for 2 seconds.</p>
<p>push-button</p>	
	<p>It displays the current actually delivered to the load; even if in this screen there is the load icon ON, this does not mean that the load is not effectively power supplied. In fact the load is controlled according to the program of load management which is actually set.</p>
<p>push-button</p>	
	<p>It shows the power actually delivered to the load in watt.</p>
<p>push-button</p>	

	It displays the counter of energy in KWh consumed by the load. It is possible to reset such measure by pushing at the same time the push-buttons for 2 seconds.
	It shows the battery temperature currently measured by the temperature sensor connected to WR60.
	When you press this button you go back to the main page.

System configuration

You can access to the configuration pages of WR60 by pressing at the same time the push-buttons for at least 2 seconds.

Configuration page of charge program

 	It sets the charge voltage for the battery. We advise to set the SEAL program for PB sealed / GEL batteries, while we advise to set the FLOOD program for the charge of flooded lead acid batteries The charge voltages related to each are indicated in fig. 4 and have to be chosen according to the manufacturer's battery.
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change of page

Configuration page of Low Battery voltage

	It sets the intervention voltage of Low battery protection (load disconnection in case of discharged battery). By pressing the push-button you modify the setting from 10.8V to 12.2V for 12V systems, from 21.6V to 24.4V for 24V systems and from 43,2V to 48,8V for 48V systems .
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change of page

Configuration page of the threshold for day detection

	WR60 detects that it is day when the PV module voltage (V_{PAN}) is $>$ than V_{DAY} threshold. It detects that it is night when V_{PAN} is $<$ than V_{NIGHT} threshold. In this screen it is possible to modify (by pressing) V_{DAY} threshold, while the threshold $V_{NIGHT} = V_{DAY} - 0.8V$
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change of page

Configuration page of load management program

Load always ON during day or during night.	Load ON only during day.	Load ON only during night.	Load ON during night for 1 hour.					Load ON during night for 16 hours.			

change of page

Page for visualization of software version

	It displays the software version of WR60.
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When pressing the right push-button, you go back to the configuration page of the charge program

Once you have modified the settings of WR60 these become operative only after having left the configuration pages by pressing at the same time the push-buttons for at least 2 seconds.

Error codes

When in WR60 an internal protection occurs, it is displayed the error code (see table below):

	<p>The flashing <i>low battery</i> symbol indicates that there is the low battery protection; therefore the load has been disconnected to preserve battery life. This protection intervenes when the battery voltage falls below V_{LB} threshold which can be set by the user. WR60 leaves this protection when the battery will be charged by the PV module at V_{OUT-LB} voltage (see Table 5 - electrical features).</p>
	<p>It occurs when the internal temperature of WR60 exceeds 80°C and it deactivates the charge. This protection automatically leaves when the internal temperature falls below the threshold of 50°C. (note: the internal temperature of the regulator is not displayed in the LCD). If there is often this protection we recommend to place the regulator in a cooler location.</p>
	<p>It occurred the overload protection. The charge current has exceeded the maximum allowed limit for WR60 (Iload in “electrical features” table) and the regulator disconnected the load to prevent internal breaks. If there is this message please check if the current absorbed by the load is < than the allowable limit. After 1 minute WR60 tries again to power supply the load and it leaves this status if the cause that generated the overload has been eliminated.</p>
	<p>Battery error. During activation the controller has detected an anomalous battery voltage and, therefore, it has not been able to detect the battery nominal voltage. This error could be caused by excessively discharged batteries; therefore when there is this error you need to replace batteries.</p>

Table 4 - Error codes

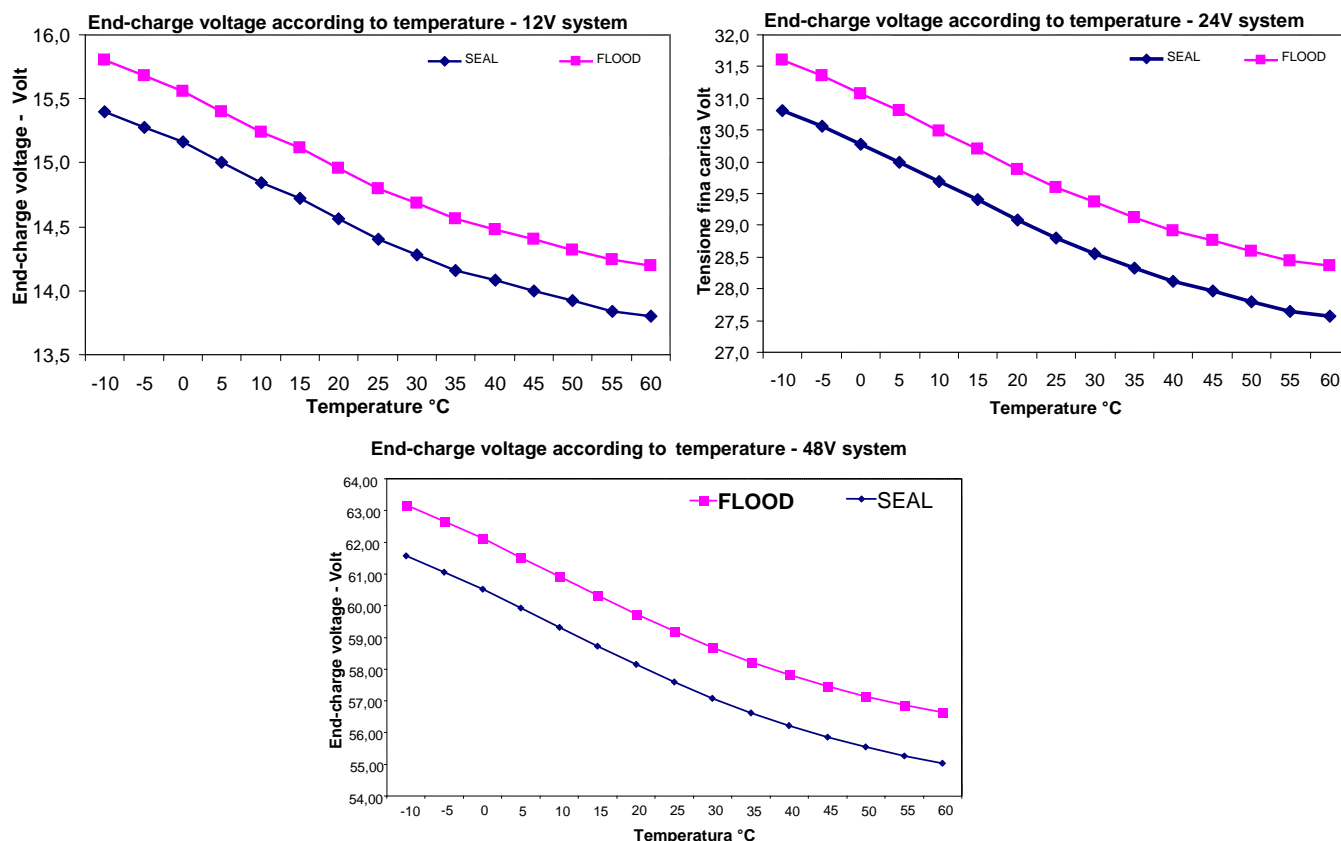


Fig. 4 Compensation curve of V_{ch} charge voltage according to battery temperature

ELECTRICAL FEATURES

		12V battery nominal voltage			24V battery nominal voltage			48V battery nominal voltage		
		Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.
Battery voltage	Vbatt	-	12.0V	-	-	24.0V	-	-	48.0V	-
PV Open circuit voltage	Vpan	-	-	22V	-	-	44V	-	-	88V
Panel current	Ipan	-	-	60.0A	-	-	60.0A	-	-	60.0A
Max panel power	Pmax	-	-	800W	-	-	1,6KW	-	-	3,2KW
Load output voltage	Vload	-	Battery voltage	-	-	Battery voltage	-	-	Battery voltage	-
Load current	Iload	-	-	10.0A	-	-	10.0A	-	-	10.0A
Charge voltage at 25°C – SEAL program (default)	Vch	-	14.4V	-	-	28.8V	-	-	57.6V	-
Charge voltage at 25°C - FLOOD program	Vch	-	14.8V	-	-	29.6V	-	-	59.2V	-
Vch charge voltage compensation function of battery temperature (Tbatt)	Vtadj	-	-24mV/°C	-	-	-48mV/°C	-	-	-96mV/°C	-
Low battery voltage (it can be set)	Vlb	11.0V	11.4V (default)	12.0V	22.0V	22.8V	24.0V	44.0V	45.6V (default)	48.0V
Low battery resume voltage at 25°C – SEAL program	Vout_lb	-	13.9V	-	-	28.3V	-	-	57.1V	-
Low battery resume voltage at 25°C – FLOOD program	Vout_lb	-	14.3V	-	-	29.1V	-	-	58.7V	-
Voltage for day detection (it can be set)	Vday	2.5V	10.0V (default)	10.0V	5.0V	20.0V	20.0V	10.0V	40.0V (default)	40.0V
Voltage for night detection: Vnight = Vday –1.0V	Vnight	1.5V	9.0V	9.0V	4.0V	19.0V	19.0V	9.0V	39.0V	39.0V
Self-consumption	Isleep		12.7mA (Vbat 14,0V)						17,7mA (Vbat 28,0V)	
Operating Temperature	Tamb	-10°C	-	+40°C	-10°C	-	+40°C	-10°C	-	40°C
Dissipated power	Pdiss	-	-	20W	-	-	20 W	-	-	20 W
Terminals' section		-	-	35 mm ²	-	-	35 mm ²	-	-	35 mm ²
IP protection degree			IP20						IP20	
Weight		-	800 g	-	-	800	-	-	800g	-

Tab. 5 electrical features

Dimensions

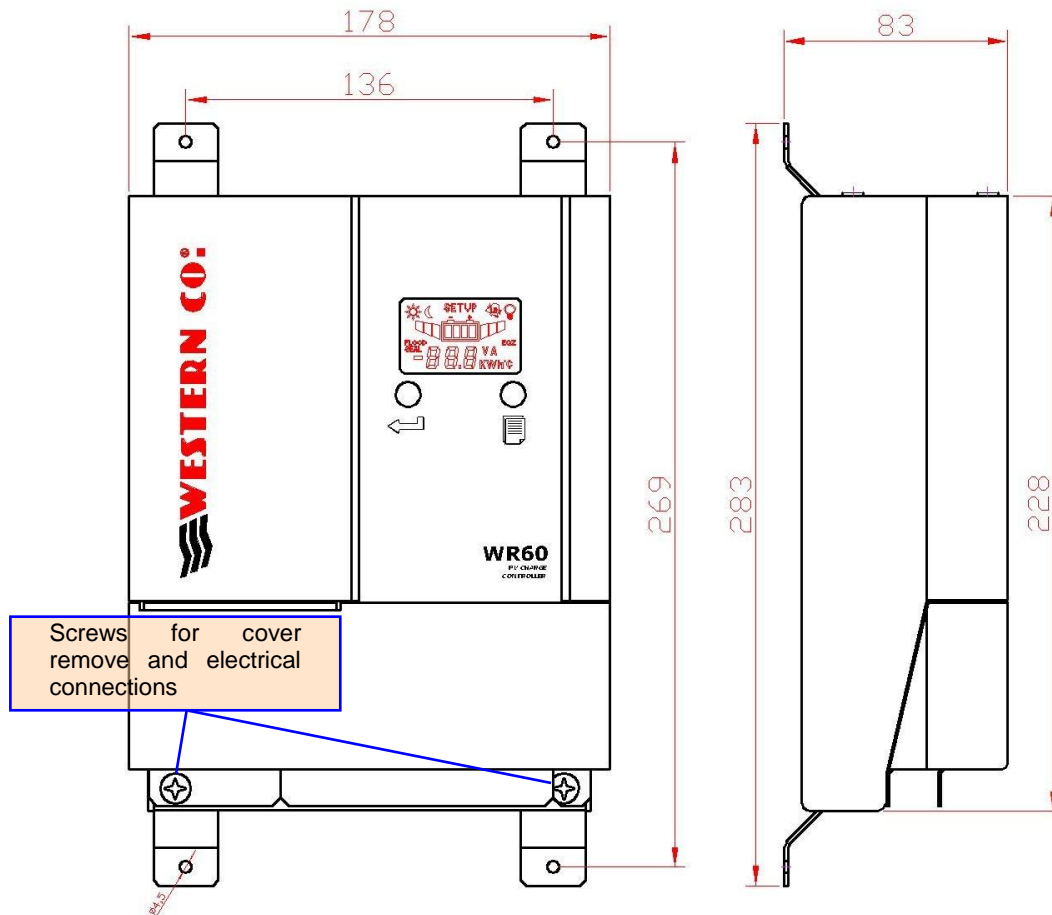


Fig. 5 Dimensions

Warranty

Western Co. Srl guarantees the good quality and manufacturing of its products obliging itself, during the warranty period of 2 (two) years, to repair or replace at its sole discretion, for free, those parts that are defective owing to poor quality material or workmanship defect.

The defective product must be returned to Western Co Srl by a delegated company for assistance, at the expense of the customer, along with a copy of the sales invoice, both for repairing and guaranteed replacement. The costs of re-installation of the material will be borne by the customer.

Western Co srl will pay the transport expenses for the shipment of the repaired/replaced product.

Warranty does not cover Products that, according to our discretion:

- are defective owing to natural wear,
- have failures caused by malpractice or negligence of the customer, by incorrect installation, by tampering or interventions that are different from the instructions supplied by us.

Warranty is void if damage is also caused by:

- transport and/or bad storage of the product.
- force major or catastrophic events (frost for temperatures < -20°C, fire, flooding, lightning, vandalism, and so on).

All the above guarantees are the sole and exclusive agreement which supersedes any proposal or agreement whether written or oral and any other communication made between the producer and the purchaser with respect to the above. **For any dispute the jurisdiction is Ascoli Piceno (Italy).**

Disposal of waste

Western Co., as a producer of electrical device herein described and in accordance with Law No. 151 25/07/05, informs the buyer that this product, once divested, must be delivered to an authorized recycling centre or, in case of purchase of equivalent equipment, it may be returned at no cost to the distributor of the new equipment. Penalties for those who get rid of an electronic waste will be used by individual municipalities.



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