

# Operating instructions

## Solar Charge Controller PR 2020 IP65

Version 2.0

# Contents

<b>1.</b>	<b>Safety instructions and liability disclaimer</b> .....	<b>3</b>
1.1.	The safety instructions are marked as follows.....	3
1.2.	General Safety Instructions.....	3
<b>1.3.</b>	<b>Scope of Application</b> .....	<b>4</b>
1.4.	Liability Disclaimer.....	5
<b>2.</b>	<b>Installation</b> .....	<b>6</b>
2.1.	Installation Site.....	6
2.2.	Connecting the Regulator.....	7
2.3.	Grounding.....	7
<b>3.</b>	<b>Protective functions of the controller</b> .....	<b>8</b>
<b>4.</b>	<b>Operating the system regulator</b> .....	<b>9</b>
4.1.	Display and Operation Elements.....	9
4.2.	Display Window.....	9
4.2.1.	SOC Window.....	10
4.2.2.	Voltage window.....	10
4.2.3.	Module current.....	10
4.2.4.	Charging current.....	10
4.2.5.	Load current.....	10
4.2.6.	Ah – Battery charging meter.....	10
4.2.7.	Ah – Battery discharging meter.....	10
4.2.8.	Warning deep discharge protection.....	11
4.2.9.	Load disconnection.....	11
<b>5.</b>	<b>Function Overview</b> .....	<b>11</b>
5.1.	SOC Calculation.....	11
5.2.	PWM Charge Control.....	11
5.3.	Deep Discharging Protection.....	12
<b>6.</b>	<b>Regulator Settings</b> .....	<b>12</b>
6.1.	Calling up and Modifying the Settings.....	12
6.2.	SOC Setting / Voltage Control.....	12
6.3.	Gel / Liquid Battery Type Setting.....	12
6.4.	Night Light Function Setting.....	13
6.5.	Morning Light Function Setting.....	13
6.6.	Default Setting (Presetting) Activation.....	13
6.7.	Auto-test.....	14
6.8.	Serial Number Query.....	14
<b>7.</b>	<b>Options</b> .....	<b>14</b>
7.1.	External temperature sensor.....	14
7.2.	Alarm contact.....	14
<b>8.</b>	<b>Error Messages</b> .....	<b>15</b>
<b>9.</b>	<b>Legal Guarantee</b> .....	<b>17</b>
<b>10.</b>	<b>Technical Data</b> .....	<b>18</b>
<b>Appendix</b> .....		<b>21</b>
External temperature sensor for the PR 2020-IP.....		21
Signal contact.....		22

Subject to change without prior notice!

# 1. Safety instructions and liability disclaimer

## 1.1. The safety instructions are marked as follows



In this manual, safety instructions for personal protection are marked with this symbol.

The relevant operational safety notes of the system and regulator are marked in bold.

## 1.2. General Safety Instructions



Observe the following while installing the regulator and handling the battery:

**Danger of explosion due to improper handling of batteries! Corrosive hazard by leaking battery acid!**



**Keep children away from batteries and acid! Smoking, fire and naked lights are prohibited when handling batteries. Prevent sparking and wear eye protection gear during installation. Observe and follow the handling instructions in the user manual and on the battery.**



**Solar modules generate power from light incidence. Even by low light incidence solar modules carry the full voltage. Therefore, work cautiously and avoid sparking during all work. Observe the corresponding safety precautions.**

**During installation and electrical installation, the photovoltaic system's DC circuit may carry twice its system voltage value (in the 12 V system up to 24 V, 24 V system up to 48 V).**

**Use only well-isolated tools!**

**Do not use any technical measuring equipment that you know is damaged or defective!**



**When installing the power line ensure that no fire safety measures are damaged. The regulator may not be installed and operated in moist rooms (e.g. rest rooms), or rooms, in which easily flammable gasoline mixtures may be present, such as by gas bottles, paint, lacquer, solvents etc. Do not store any of the mentioned mixtures in the room, in which the solar regulator is installed!**

**If the regulator is operated in a manner not specified by the manufacturer, the regulator's constructive protective measures can deteriorate.**

**The factory signs and marking may not be modified, removed or made unrecognizable. All work must be performed in conformity with the national electrical specifications and related local regulations!**

**When installing the regulator in foreign countries, information concerning regulations and protective measures must be obtained from the relevant institutions / authorities.**

**Do not begin the installation until you are sure that you have technically understood the manual and perform the work only in the order provided in this manual!**

**The manual must be available during all work performed on the system, third parties included.**

This manual is a component of the system regulator and must be included with the regulator when given to a third person.

The Controller is equipped with a low power surge protection. The installer had to care for a efficient lightning protection.

### 1.3. Scope of Application

This manual describes the function and installation of a regulator for photovoltaic (PV) systems for charging 12 V or 24 V lead batteries for recreational, residential, business, commercial areas and small businesses and telecommunication.

The charge regulator is only suitable for regulating photovoltaic solar modules. Never connect another charging source to the charge regulator. This can destroy the regulator and / or source. Consult your specialized dealer or installer if other charging sources should be used and observe the "5.1. SOC Calculation" item in this manual.

The regulator is only suitable for the following chargeable 12 V or 24 V battery types:

- Lead storage batteries with liquid electrolytes
- Sealed lead storage batteries; AGM, GEL

The respective battery type must be set on the regulator, see "6.3. Battery Type Gel / Li".

Observe the manufacturer's instructions before connecting the battery.



**Important! The regulator is not suited for nickel cadmium, nickel metal hydride, lithium ions or other rechargeable or non-rechargeable batteries. Such batteries may not be connected to the regulator. Observe the respective battery's safety instructions.**

The corresponding manufacture's installation manual must be observed when installing the remaining components, e.g. solar module, battery or consumer.



**The regulator may only be used for the particular solar applications provided. Also, observe that the permitted, model-specific, nominal currents and voltages are not exceeded. No liability shall be assumed for any non-compliant usage. Carefully handle the product.**

## 1.4. Liability Disclaimer

The manufacturer cannot monitor the compliance to this manual as well as the conditions and methods during the installation, operation, usage and maintenance of the system regulator. Improper installation can cause damages and endanger people.

Therefore, we assume no responsibility and liability for losses, damages or costs that result due to incorrect installation, improper operation, usage and maintenance or in any manner associated therewith.

Similarly, we assume no responsibility for patent right or other right infringements of third parties caused by usage of this system regulator.

The manufacturer reserves the right, without prior notification, to make modifications concerning the product, technical data or installation and operating manual.

### **Caution:**

**Opening the regulator, manipulation and repair attempts as well as improper operation voids the guarantee.**

## 2. Installation

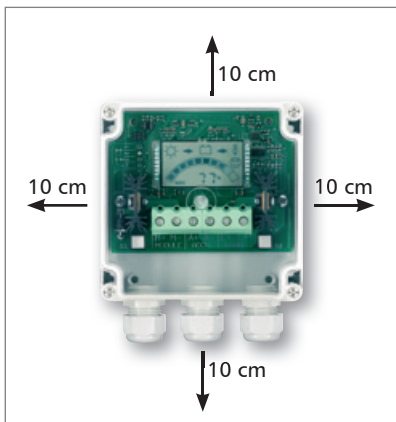
### 2.1. Installation Site

Only install the regulator near the battery on a suitable surface. This surface should be solid, stable, even, dry and nonflammable. The battery cable should be as short as possible and have a suitable cable diameter size to minimize loss, e.g. 4 mm<sup>2</sup> at 20 A and 2 m length.

If the solar battery will be operated under a large temperature range (winter/summer) the external temperature sensor should be used. A temperature compensated final charge voltage will extend the batteries lifetime and uses the optimum charge capacity (see appendix).

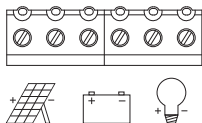
Do not install the controller to direct sunlight.

To ensure the air convection on each side keep a distance of 10 cm to the regulator. The temperature at the installation site may never fall below or exceed the maximal permitted ambient temperature.



The integrated LC display should be protected against UV rays (e.g. sunlight). Chronic exposure to UV rays can permanently discolor the LCD.

## 2.2. Connecting the Regulator



Connect the individual components to the symbols provided.

Observe the following connection sequence during commissioning:

1. Connect the battery to the charge regulator - plus and minus
2. Connect the photovoltaic module to the charge regulator - plus and minus
3. Connect the consumer to the charge regulator - plus and minus

The reverse order applies when deinstalling!

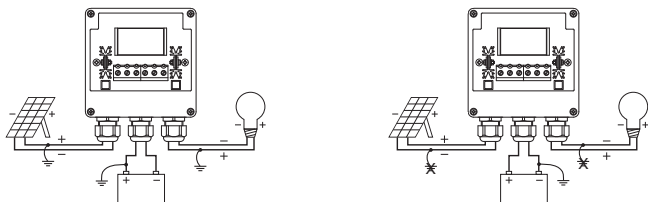
**Please observe that the automatic adjustment to 12 V / 24 V systems does not function properly, if this sequence order is not followed. An improper sequence order can damage the battery!**

## 2.3. Grounding

Grounding the regulator is not technically required when installing a stand-alone solar system.

Observe, however, the corresponding applicable national regulations. Common ground connection is possible for all positive connections; however, only a single connection is possible for a negative ground.

Observe that there is no common connection, e.g. across a ground connection, the minus module connections, battery minus and load minus. Non-observance can damage the regulator!



### 3. Protective functions of the controller

The regulator is equipped with various devices to protect its electronics, battery and load. If the regulator's maximal permitted data are exceeded, the regulator can break down despite the protective functions. Never improperly connect more than one component to the regulator! Error messages (Point 7. Error messages) display any protective devices triggered. The protective function is automatically reset after remedying the error.

- **Protection against reverse polarity of solar modules**  
The solar module's power may not exceed the regulator's nominal power!
- **Protection against reverse polarity of the connected consumer at the load output**  
Protects the regulator, not the consumer.
- **Protection against reverse polarity of connected battery**  
Charging and discharging the battery is prevented.
- **Short-circuiting at the module input**
- **Short-circuiting at the load output**
- **Protection against over charging**  
Regulator disconnects the connection to the battery and turns off the consumer.
- **Open circuit-proof during operation without battery or consumer**  
Load output is protected from high module open circuit voltage directly flowing to load side.
- **Reverse current protection at night**  
Prevents reverse current in the solar module at night.  
An additional reverse current diode is not necessary!
- **Overvoltage and undervoltage protection**  
Immediately turns off the load output during insufficient or excessive battery voltage.
- **Excess temperature protection**  
If the temperature inside the regulator is too high, the regulator's load output is turned off to reduce power loss.
- **Overload protection at load output**  
If the permitted load current is exceeded, the load output is turned off.
- **Low power surge protection**  
A TVS-Diode at the module input protects against overvoltage >47,8 V. The component limits the diverted energy to 5 kW<sub>peak</sub>.
- **Deep discharging protection / low voltage disconnect**  
Prevents excessive deep discharging or overloading the battery.
- **Meets the European CE standards**



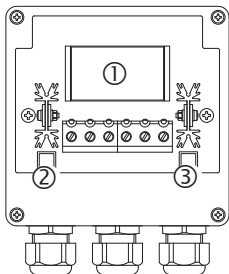
**Note:** Failures not protected by the regulator could disable essential functions and effect the over charge and deep discharge protection. As consequence uncontrolled gassing or sulphation could damage the battery.



## 4. Operating the system regulator

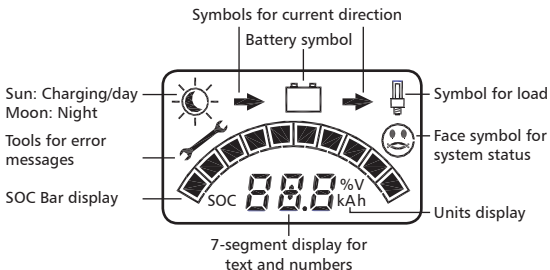
The display shows a variety of system data by symbols and digits. Both buttons control all settings and display windows.

### 4.1. Display and Operation Elements



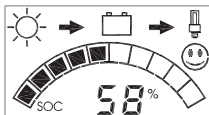
- ① Display window for system information and messages
- ② Button for switching display windows or calling up the settings
- ③ Manual load switch, or confirmation button in program mode

### 4.2. Display Window



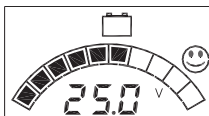
The display modes change automatically. The changing can be stopped and released with the left key. The bar display shows the actual battery level (SOC = state of charge) of the battery in each window. If the regulator is set to voltage control, the SOC bar display does not appear and the battery voltage value replaces the SOC percentage value!

**Please observe that the accuracy of the regulator's display is not comparable to that of a measuring device!**



#### 4.2.1. SOC Window

Displays the charge level, day / night level and consumer on / off. Instead of the SOC value, the battery voltage is displayed during voltage control.



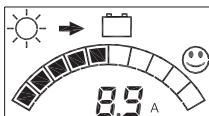
#### 4.2.2. Voltage window

Displays the battery voltage measured by the regulator.



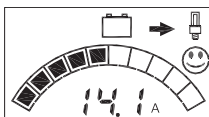
#### 4.2.3. Module current

Displays the actual produced solar module's current output.



#### 4.2.4. Charging current

Displays the charging current flowing into battery from the solar module.



#### 4.2.5. Load current

Displays the current drawn by the load output.



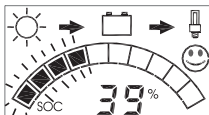
#### 4.2.6. Ah – Battery charging meter

Displays the accumulative sum of recharged Ah since the initial installation or reset. Press both buttons for 3 seconds to reset the meter to 0. Ever when the battery is disconnected the value remains. When 99.9 KAh are reached, it will switch back to 0 Ah.



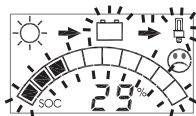
#### 4.2.7. Ah – Battery discharging meter

Displays the accumulative sum of Ah drawn by load since the initial installation or reset. Press both buttons for 3 seconds to reset the meter to 0. When 99.9 KAh are reached, it will switch back to 0 Ah.



#### 4.2.8. Warning deep discharge protection

As an early warning, the SOC bar or the voltage value flashes. The face still looks friendly!



#### 4.2.9. Load disconnection

If the deep discharging protection has been activated the SOC bar or the voltage value flashes. The face looks sad until the reconnection setpoint is reached.

## 5. Function Overview

This charging regulator has basic functions for specifying the state of charge (SOC), charging specification and deep discharge protection that are described in the following section. Additional functions that can be activated such as the settings, night light function, auto-test, presetting and serial number query are explained under the corresponding menu items in chapter 6.

### 5.1. SOC Calculation

During operation, the regulator monitors various parameters (U; I) of the battery and from that calculates the battery's charge level (SOC = state of charge). The state of charge is the energy level still available in the battery. Modifications in the system, e.g. the battery's aging process are automatically taken into consideration by the system's continuous learning process.

Using this SOC information, you always have an accurate overview on the actual battery level. Using the SOC, the regulator also controls the selection of the charging procedure and the deep discharging protection in order to ideally maintain the battery. If one of the parameters cannot be recorded because for example, a consumer or charging source is directly connected to the battery, the SOC calculation is invalid. The regulator can then be set to the more simplified voltage-guided control, see chapter 6.2.

The SOC calculation is restarted each time the regulator is reinstalled.

### 5.2. PWM Charge Control

The regulator applies a constant voltage charging to the battery. The entire available electricity provided by the charging source is used for charging the battery until the final voltage is reached. A pulse width modulator (PWM) regulates the charging current by briefly closing the module input (shunt charge controller) in the charge control area.

Depending on the actual battery level, various charging procedures, float charging, boost charging and equalization charging are automatically performed. In doing so, the settings for the battery and control type are factored in. The final charging voltage is temperature compensated. Every 30 days a test is automatically performed to determine if an equalization charging must be carried out.

### 5.3. Deep Discharging Protection

The regulator protects the connected battery against an excessive discharging. If the battery falls below a specified charge level (during SOC control) or battery voltage (during the voltage-controlled function), the load output is disconnected and the discharge of the battery is prevented. The display shows the early warning and disconnection during deep discharging. The setpoints of the deep discharging protection are predefined and cannot be reset.

## 6. Regulator Settings

The battery type, control type and night light function can be set in the regulator. Points for the auto-test and the serial number query are also located within the menu. The settings remain when the battery is disconnected.

### 6.1. Calling up and Modifying the Settings

Press the left button for at least 3 seconds to open the first setting window (control type). Press the left button again to call up the various windows.

Press the right button to modify settings. The display begins to flash. Now, with the left button select the settings options. The setting must be saved with the right button. The display then stops flashing.

The normal window reappears after a 30 second waiting period or pressing the left button for 3 seconds. This applies to all windows.

### 6.2. SOC Setting / Voltage Control

The SOC control is the factory setting. This way, the charging procedure and the deep discharging protection are controlled by the calculated SOC value for ideal battery usage. If external loads are connected directly to the battery you can change to voltage



control. The bar gauge can then be enabled or disabled. See chapter 10 for voltage thresholds.

### 6.3. Gel / Liquid Battery Type Setting



The standard setting is "Li". The setting of the battery type influences the cutoff voltage of the controller. If you use a Gel or AGM battery, you have to change the battery type to GEL.

**Caution!** An incorrect battery type setting can damage the battery!

## 6.4. Night Light Function Setting

This setting provides three options in the following order:

- OFF: The function is deactivated (default).
- Operating time-choice of 1 to 8 hours.
- ON: The consumer output remains on for the entire night.



This function controls the load output only when it is dark (at night). During daylight the consumer output remains off. The connected solar module records information on the light intensity.

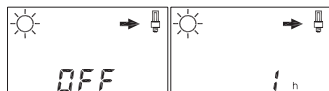
The load is activated once the solar module detects that it is dark.

Once it becomes light, the regulator deactivates the consumer output regardless which illumination duration has been selected. Due to different properties of various modules, the twilight threshold cannot be specified accurately. An activation delay cannot be set when twilight sets in.

## 6.5. Morning Light Function Setting

Analog to night light this function can switch on the load in the morning prior to sun rise. The morning light menu is indicated by the sun symbol instead of the moon.

- OFF: no morning light (factory default)
- 1..12 h: morning light duration prior to sun rise



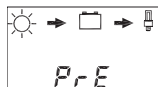
The load output will be activated the programmed hours before sun rise. "Sunrise" is assumed 24 h after the last sun rise detection.

Example: morning light programmed to 3 h, last sunrise was at 6:30 h. Then the light will go on at 3:30 h the next day and go off at daylight.

## 6.6. Default Setting (Presetting) Activation

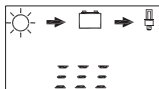
Calling up the default settings (PRE) deletes the previous settings and resets the charge controller to the factory settings.

The default setting is: SOC Control / Gel Storage Battery / Night Light OFF



## 6.7. Auto-test

The auto-test can determine whether the charge controller is fully operational.



- Disconnect solar module and load from the regulator, connect only the battery.
- Press the right button. The display begins to flash.
- Start the auto-test with the left button.
- If there is no error, this window is displayed shortly (1 sec.). Afterwards, all LCD segments fade in and out for 1 second. Then the auto-test window reappears in the display.
- If there is a defect or the module and load is still connected you will see an error code:
  - digit = "1" : module input defected
  - digit = "1" : load output defected
  - digit = "1" : battery fuse defected
- In the flashing auto-test window, press the left button again to repeat the test or the right button to end the test.

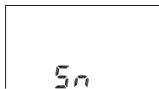


## 6.8. Serial Number Query

Each regulator has a serial number that can be queried using this window. Press the right button and the SN display begins to flash. Now, press the left button to display the number. The digits are displayed successively: - - - 1 2 3 4 5 6 7 8 - - - .

Press the right button to stop or continue the display.

Note the order of the digits for the complete serial number.



## 7. Options

### 7.1. External temperature sensor

If the solar battery will be operated under a large temperature range (winter/summer) the optional external temperature sensor should be used. A temperature compensated final charge voltage will extend the batteries lifetime and uses the optimum charge capacity (see appendix).

### 7.2. Alarm contact

For remote monitoring of an alarm condition the PR2020-IP is available with an alarm contact. The contact closes, if the SOC of the battery falls below 40 % or if a system error occurs.

**Notes:** The external sensor can be installed by the end user, the alarming option has to be mounted in the factory.

## 8. Error Messages


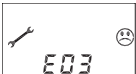
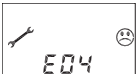







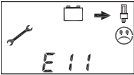
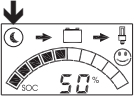

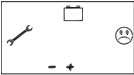
**Caution! Please do not open the regulator or attempt to replace components when troubleshooting. Improper maintenance can be hazardous to the user and the system.**

If the regulator detects errors or unauthorized operating states, it flashes error codes on the display. Error codes can generally be differentiated, whether there is a temporary malfunction, e.g. regulator overload or a more serious system error that can be remedied by appropriate external measures.

Since not all errors can be simultaneously displayed, the error with the highest error number (priority) is displayed. If several errors are present, the second error code is displayed after remedying the more significant error.

The following meaning is assigned to the different error codes:

Display	Meaning	Cause / Remedy
	Communication error with the internal memory (EEPROM).	Disconnect consumer, solar module and battery. Reinstall the device. If the error reoccurs, please contact your specialized dealer.
	Communication error on the external bus (6-pole edge connector).	Check the 6-pole plug-in connection on the edge connector, power supply and function of the external extension. If the error reoccurs, please contact your specialized dealer.
	Short-circuit at the external temperature sensor.	Check the contact of the 2-pole edge connector, remove short-circuit. Check sensor.
	Excessive temperature regulator turned off the consumer due to internal over heating.	Let regulator cool. Check the cause for overheating (installation site, other heat sources). Possible reduce charge or load current. Ensure the regulator has proper ventilation.
	Battery voltage too low. Voltage < 10.5 V or < 21.0 V	Check installation. Check battery voltage, possibly recharge battery manually. Consumer connected directly to the battery can deep-discharge the battery.
	Battery voltage too high. Voltage > 15.5 V or > 31 V.	Check installation. Check battery voltage, possibly check additional charge sources.

Display	Meaning	Cause / Remedy
	Load current too high. The regulator's permitted consumer current has been exceeded, the load output has therefore been disconnected.	Reduce the load current using the consumer output. Perhaps current spikes are occurring through the consumer. Try reconnecting the load.
	Module current too high. The regulator's permitted input current has been exceeded.	Reduce the load current or module power.
	Short-circuiting at the load output.	Remove short-circuit, disconnect consumer and try to reconnect.
	<ul style="list-style-type: none"> <li>no module connected <i>or</i></li> <li>short circuit in the module (moon symbol appears during the day).</li> </ul>	Check module connections.
	No battery connected or connection interrupted.	Supply only by solar module. Connect battery to regulator and check battery fuse.
	Storage battery connected with reverse polarity.	Disconnect battery and connect to regulator with correct polarity.



## 9. Legal Guarantee

In accordance with German statutory regulations, there is a 2-year legal guarantee on this product for the customer.

The seller will remove all manufacturing and material faults that occur in the product during the legal guarantee period and affect the correct functioning of the product. Natural wear and tear does not constitute a malfunction. Legal guarantee does not apply if the fault can be attributed to third parties, unprofessional installation or commissioning, incorrect or negligent handling, improper transport, excessive loading, use of improper equipment, faulty construction work, unsuitable construction location or improper operation or use. Legal guarantee claims shall only be accepted if notification of the fault is provided immediately after it is discovered. Legal guarantee claims are to be directed to the seller.

The seller must be informed before legal guarantee claims are processed. For processing a legal guarantee claim an exact fault description and the invoice / delivery note must be provided.

The seller can choose to fulfil the legal guarantee either by repair or replacement. If the product can neither be repaired nor replaced, or if this does not occur within a suitable period in spite of the specification of an extension period in writing by the customer, the reduction in value caused by the fault shall be replaced, or, if this is not sufficient taking the interests of the end customer into consideration, the contract is cancelled.

Any further claims against the seller based on this legal guarantee obligation, in particular claims for damages due to lost profit, loss-of-use or indirect damages are excluded, unless liability is obligatory by German law.

## 10. Technical Data

The technical data is subject to alterations by the manufacture.

Electrical Data	
Operating voltage	12 V or 24 V; automatic recognition
Voltage range 12 V	6.9 V – 17.2 V
Voltage range 24 V	17.3 V – 43.0 V
Permitted operating temperature range	-10 °C to +50 °C
Permitted storage temperature range	-20 °C to +80 °C
Power consumption mA	12,5 mA @ 12 V; 15,8 mA @ 24 V
PWM-Frequency	30 Hz
Maximum input voltage	45 V
Minimum battery voltage	6.9 V

Currents		
Max. continuous module current at 25 °C	20 A	
Max. continuous load current at 25 °C	20 A	
Excess Temperature Protection		
Disconnect load >85 °C		
Reconnect load <75 °C		
Data for final charging voltage		
Depends on set battery type	Gel – storage battery (GEL)	Liquid electrolyte (Li)
Float charge	13.9 V / 28.2 V	13.9 V / 27.8 V
Boost charge; for 2:00 h	14.4 V / 28.8 V	14.4 V / 28.8 V
Equalization charging; for 2:00 h	---	14.7 V / 29.4 V

30 day maintenance charge, if necessary	14.4 V (28.8 V) (for 2:00 h)	14.7 V (28.8 V) (for 2:00 h)
Temperature compensation	-4 mV per °K and cells (internal sensor present, optional external sensor possible)	
<b>Charge controller activation</b>		
Activation threshold of the charge type	SOC Control	Voltage control
Float charge	SOC >=70 %	>= 12.7 V resp. >= 25.4 V
Boost charge	SOC 40 % – 69 %	11.7 V – 12.4 V; resp. 23.4 V – 24.8 V
Equalization charge	SOC <40 %	< 11.7 V resp. 23.4 V
30 day maintenance charge	if within 30 days no equalization or boost charge was active.	
<b>Load disconnection</b>		
	SOC Control	Voltage control
Early warning load disconnection	SOC < 40 %	< 11.7 V / 23.4 V
Load disconnection	SOC < 30 %	< 11.1 V / 22.2 V
Load reconnection	SOC > 50 %	> 12.6 V / 25.2 V
<b>Bar gauge voltage thresholds</b>		
≥ 13,00 V	10 bars	
12,90 – 12,99 V	9 bars	
12,80 – 12,89 V	8 bars	
12,70 – 12,79 V	7 bars	
12,50 – 12,69 V	6 bars	
12,00 – 12,49 V	5 bars	
11,70 – 11,99 V	4 bars	
11,10 – 11,69 V	3 bars	
11,00 – 11,09 V	2 bars	
< 11,0 V	1 bars	

Mechanical Data	
Protection type	IP 65
Installation	wall installation
Weight	350 g
Housing	recyclable, plastic housing
Dimensions L x B x H	187 x 44 x 96 mm
Fastening hole clearance	vertical 60 mm; horizontal 177 mm
Terminals	10 mm <sup>2</sup> / AWG: 6
Strain relief	3 x M2.5 x 1,5 mm
Diameter of cable	9 – 17 mm

## Appendix

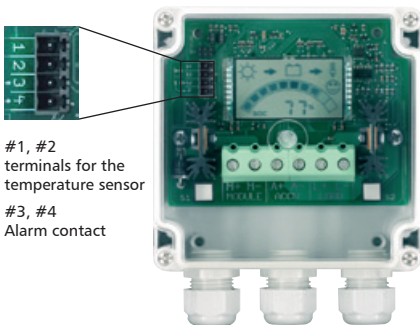
### External temperature sensor for the PR 2020-IP

In order to fully charge a lead battery, the end-of-charge voltage must be adjusted in accordance with the temperature. The external temperature sensor TSRIIP8 is needed, if the range of the battery temperature is outside the standard range of 10 ... 25 °C. The external sensor can record the actual temperature of the battery. The temperature compensation is used to adjust the end-of-charge voltage using the factor  $-4 \text{ mV/K/Cell}$ .

If the connection of the sensor to the regulator is interrupted, the regulator will automatically use the standard charge voltage. If the cable short circuits, the regulator displays the fault E04.

Please use only this kind of temperature sensor (33 k $\Omega$ ). Using an incorrect sensor could damage the device and/or the battery!

The sensor should be plugged into the terminals #1 and #2 in the upper left corner. The socket is provided with the sensor, the contacts have no polarity. For the connection you can use each cable with a diameter of 0.5 mm<sup>2</sup> or more.



#1, #2  
terminals for the  
temperature sensor  
#3, #4  
Alarm contact

## Signal contact

Optional available for the PR2020-IP is the alarm contact output. An alarm is raised if one or more of the following conditions is true. It reopens automatically if the alarm condition is cleared. The contact can handle max. 50 V, 100 mA.

The alarm contact (dry contact) output is at pin #3 and #4. (see illustration) A plug with screw terminals is included. The polarity is ignored.

Alarm conditions	Alarm ON	Load disconnected
temp. sensor short circuit [E04]	yes	no
overtemperature inside [E05]	yes	yes
battery < 11,7 V or SOC <40 %	yes	no
battery < 10,5 V or SOC < 30 % [E07]	yes	yes
battery >15,5 V [E08]	yes	yes
load current >25 A [E09]	yes	yes
load output short circuited [E11]	yes	yes

No error is signalled when :

- The battery is not present or with wrong polarity connected
- The module current is too high (>20 A)





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