Installation and Operation Instruction Manual

PV Charge Controller

For Telecommunication and Hybrid Systems

POWER Tarom

Power Tarom 2070
Power Tarom 2140
Power Tarom 4055
Power Tarom 4110

1 Security instructions and restriction of liability

1.1 Sign for security instructions

⚠ Security instructions for personal safety and instructions that refer to the functioning safety of the system are marked with this sign and are printed in bold letters.

For installation of other components that you do not find related information in the regulator's instructions, please see the corresponding manual of the manufacturers.

1.2 How to use this manual

This manual describes the functions and installation of a solar charge controller in a PV-system with a battery as storage.

For installation of other components e. g. solar modules and battery, please see the corresponding manual of the manufacturers.

Tip: Before you start your work read the instructions for **Installation** (chapter 6; page 12).). Make sure that all preparatory measures are taken.

Only start to install your controller when you are sure that you have understood technically this manual. Please make sure that all works are done in sequence which is described in this manual.

These instructions must be handed out to all persons that work with this system. These instructions are part of the system controller and must be handed over in case the controller is sold. Only proceed in the order stated in this manual!

This manual has to be made accessible for third persons for all works done at the PV-system.

This manual is part of the system controller and has to be passed over when it is sold.

Before you start the work:

- Read this chapter: **Installation** (chapter 6; page 12)
- Make sure that all **Precautions** (chapter 6.1; page 12) are taken.
- Only start to install your controller when you are sure that you have understood all technical instructions.
- Only proceed in the order started in this manual!

1.3 General safety instructions

For your own safety please note the following for installation:

Avoid sparkings!

Solar modules produce current when light is falling in. Even at a small light infall the full voltage is applied. Therefore work carefully and pay attention to the corresponding safety precautions.

During installation and electric wiring within the photovoltaic system´s direct current circuit the system voltage may double (within a 48 V system up to 96 V !).

⚠ **Therefore: Do not touch blank wire ends!**

Only use well insulated tools!

Do not use technical equipment that is defective or broken!

The constructive safety precautions of the charge controller can be negatively be affected when it is operated in a way not specified by the manufacturer.

A restriction of the ventilation can lead to an overheating of the controller and thus to a failure. Do not cover ventilating slots and cooling rips.

The controller must not be installed and used in moist areas (e. g. bathrooms) or in rooms in which flammable gas mixtures (by gas bottles, paint, solvents etc.) are likely to occur!

Do not store any of the above and similar things in rooms where the solar charge controller is installed!

The pre-set signs and marks must not be changed, removed or made illegible.

All operations must be conducted in accordance with the national electricity regulations and local rules!

For installation in foreign countries please see your corresponding institutions for information on regulations and safety measures.

⚠ **Keep children away from electronics!**

1.4 Restriction of liability

The producer cannot survey the observation of this manual as well as the conditions and methods for installation, operation, use and maintenance of the system controller.

Improper installation can lead to material damage and thus can endanger persons.

Therefore we do not take any liability and responsibility for losses, damages and costs which are due to an improper installation, operation, use and maintenance or any other consequences.

Furthermore we do not take any liability for infringements of patent rights, or rights of third persons, which result from the use of this system controller.

The manufacturer reserves the right to make alterations without prior notice concerning the product itself, technical data or the installation and instruction manual.

Other components which are not defined by manufactures and are connected to this controller, the users have to take the consequences.

2 Application range

The system controller can be used in PV energy supplies with battery storage within the field of business and commerce as well as in small-sized firms and telecommunication devices.

It can not be used outdoors where it would not be protected against rain or sun.

Without further measures see **Options** (chapter 2.2, page 4) the controller must be installed in the same room as the battery due to the following reasons:

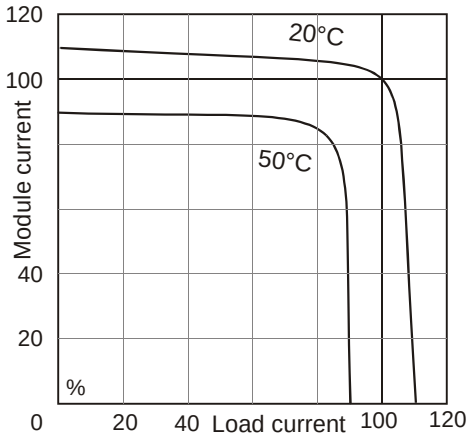
- an integrated temperature sensor registers the ambient temperature which is almost identical with the battery temperature.
- In order to keep the voltage drop between controller and battery to a minimum please use only short battery cables.

The controller should only be used for regulating solar modules. However, the battery can also be charged by other sources with appropriate battery charge functions.

2.1 Power range

The controller can be used in a wide range of performance and temperature. It automatically registers the maximum permissible temperature and disconnect the loads in the case it is exceeded. Now the complete radiating surface of the heat sink could be used for the power loss produced during charging. It is necessary to stay within the „safe operating area“ (SOAR) for dimensioning the system in order to avoid undesired switch-off of the loads in the case the temperature is exceeded.

Select dimensioning in a way that the ambient temperature line is not exceeded in the case of maximal charge and discharge currents. With an ambient temperature of 20 °C and correct installation the controller can process both module and load nominal currents (see labels). These nominal currents correspond to 100 % in the diagram.

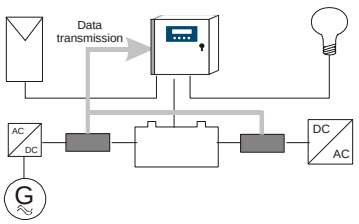


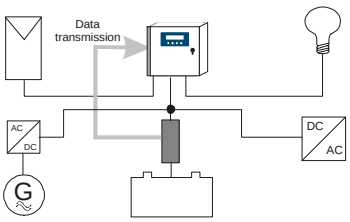
2.2 Options

The controller can be operated with the following additional devices which you can purchase at authorised dealers. The options of description and instructions are pointed out by following listed possibilities and examples of use:

⇒ Full-load shunts can be installed in the conductors of additional generators and loads. This enables the controller to calculate the state of charge (SOC) even when further sources like wind or diesel generators charge the battery or bigger loads like inverters are connected directly to the battery. The shunts register the current and put them into the controller digitally.

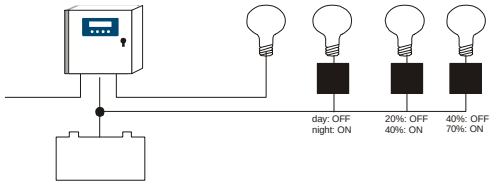
- The pair-shunt solution enables differentiated measuring and so indication of charging and discharging currents. This is the reason why all load currents have to be conducted across a shunt, except for those already flowing through the controller.
- A single shunt can be put into the battery cable that balances the charging and discharging currents. This battery current is then displayed. With this variant it is also possible to calculate the SOC. For this variant only one single shunt is necessary. An external temperature sensor must be used if the controller is applied in another room or control box. If it´s installed in a box please see that it is sufficiently cooled.



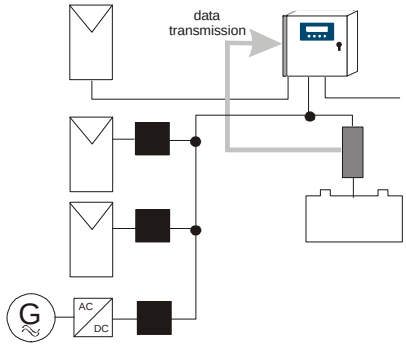


⇒ The controller transmit system parameters via power line. These parameters can be evaluated at each point of the grid with additional receivers. By this there are the following extension possibilities:

- decentralised load disconnection with different priorities. The receivers are then individually programmed in accordance with the load status at which the corresponding load is switch on or off. So the light in a room can be switched off when reaching the deep discharge level except emergency lights (not total darkness!) when a certain low load level is reached. The emergency light consume almost no energy so that it can be kept for a long period of time. With this device also second batteries can be charged when the main battery has been fully charged. It is in this way that you are managing the energy yourself. Switch-on and switch-off level is programmed on the battery's state of charge.



- Operating lights during night-time, e. g. entrance lights. With the help of the module the controller registers the density of light so that no additional light sensor is needed.
- With the receiver additional solar generators for charging the battery can also be used without parallel operation of charge controllers. As soon as the charge current of the first solar generator which is connected direct to the controller is limited to a minimum the second generator will be disconnected from the battery by the receiver. This is how the first generator supplies maximum charge current which is necessary to keep up the final load voltage and so the battery can be charged according to the IU line by simply switching on or off further generators.



- Additional operation of load sources, e. g. diesel generators, grid charge devices. These devices are put into operation at a low state of charge and switch-off after re-charging the battery. For most back up generators, the receiver serves not as a power switch but only as a punch emitter to start the generator.
- When the final end of charge voltage is reached the controller must limit the charge current. Here a big stake of the solar energy is no longer used for charging the battery. This is how operating excess loads can be programmed into the receiver. As soon as there is excess current the excess energy is forwarded to superfluous loads such as heating spirals or electrolyser outfits for the exploitation of hydrogen.

⇒ An external data logger can be connected to the controller. It stores essential system parameters that can be forwarded to a PC via interface. Data frequency and number of parameters can be chosen freely to determine the storing period. In addition there are two analogue entrances in the data logger. These entrances can register parameters could not be measured by the charge controller itself like (wind speed, module temperature, solarimeter etc.). The software that is necessary comes with the logger.

⇒ For special applications you can order Power-Taroms without a load output. In this case the allowed max. module currents are increased. See "power range", chaper 2.1 with load current = 0%.

3 Functioning

The system controller monitors the load status of the battery, regulates the load process as well as switch-on and switch-off of loads in order to make full use of the battery and to extend its life.

On delivery the system is equipped with liquid electrolyte for lead accumulators and can be converted for accumulators with fixed electrolyte like gel batteries. The system controller can be used for all kind of solar modules.

3.1 General description

An intelligent charge controller has been developed whose regulating, controlling and indicating functions are fulfilled by a microprocessor. The components only consist of low loss MOS-FET-transistors that have a long operating life and guarantee high performance due to this low loss, thus leading to a low degree of the device's own warming up.

All configurations according to customers´ specifications are conducted without going into the electronics. Due to a minimum of sensor and data cables the device is load-friendly and clear of strays.

The overcharge protection is realised by a pulse width modulation parallel controller which is equipped with switch element and not – as usual – with a reverse diode in order to prevent current flowing back from the accumulator. In accordance with the IU line the charging process is conducted according to the temperature. Moreover, the accumulator determines a temporary limitation on the excess final load voltage. Voltage drops and internal resistance of the accu are compensated without the sensor cables.

In order to protect the battery from being totally discharged the loads are automatically disconnected form the accu. Here the processor determine the rest capacity at which no more consumption is possible. Furthermore the loads are switched off in the case of excess current and temperature for the protection of the charge controller, in the case of excess voltage for the protection of the loads and in the case of low voltage for the protection of the accumulator.

The integrated temperature compensated equalisation charge maintains the accu from time to time via electrolyte circulation (controlled gassing) and increases its life by preventing harmful acid layers. This increase in the final load voltage is time-geared after having reached a certain level of voltage. After this time the controller returns to normal charging. In addition equalisation charging enables a faster full charging during bad weather periods e. g. in winter as only part of the energy is need for gassing whereas the remaining energy can be used for a fast charging. This function is

activated by either undershooting of a determined SOC or exceeding a substantial period of time after the last compensating charge. Equalisation charging can also be activated manually.

An LCD display indicates all important information on the current operating status. The first line informs on the most important rough parameters and the second line displays fine parameters or system information. This displays are changing their information every three seconds.

The controller has a reverse battery protection and is secured against no-load operation and short circuit. The load exit is protected against overcharge. However, it is very likely that the controller is damaged if components are not connected to the corresponding clamps (e.g. wrong polarity of battery is connected to module clamps).

3.2 Detailed description

3.2.1 SOC calculation

With the help of a new algorithm the controller is capable to „learn“ the characteristic parameters of the accumulator. After having learnt this in a few days the operating status (SOC „state of charge“) is indicated. This state is the basis for most controlling and monitoring functions. If system components are directly connected to the battery the state of charge can only be determined with the help of optional SOLARIX shunts. The state of charge always refers to the current capacity which the battery already has in accordance to its age. So a SOC of 50 % does not mean that half of the battery's nominal capacity can be used but that only half of the battery's current capacity.

The state of charge is not dependant on the battery voltage but on the amount of energy taken out. Traditional controllers most of the time determine a final load voltage that hardly never corresponds to the discharge depth. During discharge nominal acid density is being reduced and sulphates are placed on the battery plates. If discharge is too deep this growth leads to harmful sulphatation that reduces the battery's capacity considerably, thus making the battery useless for energy storage. The traditional measuring procedures (Ah balancing, acid density measuring) are time-consuming and cost intensive and were seldom integrated in charge controllers.

If generators or loads are directly connected to the battery without SOLARIX shunts the SOC determination is wrong. Certain voltage values cannot be fallen below in order to protect the battery from an all-too deep discharge despite wrong values.

3.2.2 Overcharge protection

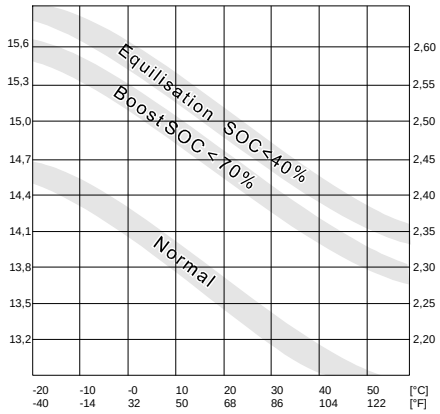
The overcharge protection prevents uncontrolled gassing within the battery cells. The gas development is depending on the acid temperature and cell voltage. So the controller monitors the ambient temperatures and adapts the battery's voltage. The overcharge protection and so the voltage limitation is independent on the battery's state of charge since the decomposition of electrolyte is exclusively depending on the voltage and the temperature. This means that charging is already limited although the battery is not completely charged.

Overcharging the battery leads to uncontrolled gassing. Here the electrolyte is decomposed into oxygen and hydrogen. The consequences are harmful oxidation processes and mechanical damages since the gas blisters rip out active masse form the lead plates.

What is even worse is the uncontrolled gassing in closed batteries e. g. sealed or fluid batteries where the gas pressure can even destroy the battery case. Frequent overcharging damages the battery storage basin. The charging process and the overcharge protection are thus regulated by a new hybrid actuator with pulse width modulation in order to secure a smooth battery charging. The float voltage in particular should not be chosen too high. If you want to program this value individually please take note of the battery manufacturers´ recommendations.

3.2.3 Temperature compensation of final charge voltage

With the battery temperature increasing the acid/lead battery's optimal final load voltage is falling. A constant final charge voltage leads to uncontrolled gassing in the case of higher battery temperatures. The temperature compensation decreases the final charge voltage at higher temperatures and increases them at lower ones. The temperature compensation with the sensor integrated in the solar charge controller influences all three overcharge thresholds.



The integrated sensor is maintenance and installation friendly and can be fully used under the following circumstances:

- controller and battery must be in the same room
- the precise temperature is not granted although the controller's own warming-up is compensated by substantial calculations. However, the room temperature only corresponds to the battery pole temperature within a bigger window.

However, an external sensor can be installed.

3.2.4 Voltage determination

Due to a special measuring method accumulator sensor wires are no longer needed. The drop in voltage on the accu wire is compensated after the first full charge process. This is why no further sensor is needed, the installation is more simple and the reliability of the system is increased due to the fact that sensors cannot break. However, measurements may not be as precise as with sensor wires. We would like to mention that – for a temperature coefficient factor of approx. 25mV per 1°C (changing of the final charge voltage with the ambient temperature within the 12V system) – a tolerance of 100mV corresponds to a temperature deviation of 4°C. There are no negative influences on the batteries with such low deviations.

3.2.5 Energy determination

The energy determination is calibrated on the lower energy range so within the maximum currents there are deviations. We would like to mention that you have purchased a comfortable controller with many indicator functions and not a measuring device.

3.2.6 Boost charging (lead/sealed) and equalisation charging (only lead)

For the next charging cycle the system controller increases the final charge voltage for a certain period of time after a fixed charge status has been fallen below. The so-called countdown is only activated when the desired final voltage has been reached. This is the reason why it is important to pay attention to the fact that the solar generator can give out sufficient charge energy with the corresponding final voltages.

⚠ If the final voltage is to high in comparison with the generator voltage (minus conductor losses) it might well be the case that the countdown is never counted and your battery is charged with no control.

You can manually activate a time limited boost charging.

Using equalisation charging is only possible and can only then be programmed if a battery has been configurated with liquid electrolytes. It is activated when the battery falls below a certain charge status.

3.2.7 Monthly mixture of acids

Slightly cyclizated batteries have the function that the final charge voltage is increased for a limited time every month. Here either boost or compensatory charging is activated depending on the electrolyte configuration. This function prevents harmful acid layering which occurs especially after a long maintaining of a certain charge status.

3.2.8 Display

A double-line display informs on important system parameters via status indicator. The first line indicates status of charge, battery voltage, charging and final charging current (with rough decomposition).
The second line informs on the system parameters and current status with permanently changing detailed values and descriptions.
The display works correctly within a temperature range specified by the manufacturer. When this temperature range is left disturbances may occur which is regenerated itself when the operating temperature range is again reached. The storing temperature range, however, must not be exceeded.

3.2.9 Central overdischarge protection

By Overdischarging leads to sulphatation and as result a loss of your our battery's capacity. The overdischarge protection disconnects the loads and re-connects them after sufficient re-charging. The loads can also be manually switched on/off. This is how the controller takes over the function of a main switch.
Falling under a certain voltage leads to a load switch-off regardless of whatever values or manual adjustments have been programmed.

3.2.10 Control keyboard

With the tact switches underneath the screen set values can be configurated. Freely programmable values can only be changed within a preset window. These values are selected in a way that not even extreme adjustments do not lead to severe damage to the lead batteries.
However, the operating elements are with no child-proof lock (code). We would recommend – in your own interest – to make the controller as well as the battery room inaccessible for children.

3.2.11 System voltage

The controller adjusts itself automatically to 12 or 24 V. For this it is necessary that the battery is connected first.

There are two variants for the system voltages of 12/24V or 48V. The controller only adjusts itself for system voltages below 30 V. For 48 V systems you will need another model with more voltage-stable components. Please have a look at the marks on the case for information if your controller fits the desired system voltage..

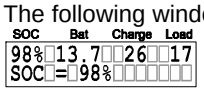
4 Indication of status

4.1 LC-Display

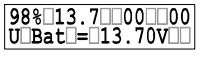
The two-line display indicates all current values in short form and without units due to a lack of space. This is why you will find the meaning above each value as a little helper:

State of charge	battery voltage	charging currents	discharge currents
SOC	**Bat**	**Charge**	**Load**

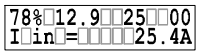
The second line permanently changes its information. All values and system information are indicated alpha-numerically. The following windows can only be indicated during operation, with the descriptions only referring to the second line.



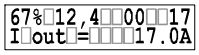
SOC means state of charge and indicates how much capacity the battery still has. The SOC is never 100% as due to technical reasons it is easier to realise a two-digit number.



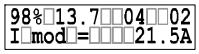
Since the voltage drop between controller and battery can be compensated without sensor wires it is the battery's pole voltage and not the controller's terminal voltage that is indicated.



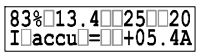
I_in is the sum of the charging currents running through the accu. It is composed of the solar generator current running through the controller and the charging current of further charging components that are directly connected to the battery via an optional external SOLARIX shunt. If no shunts are used I_in indicates only the solar charging current.



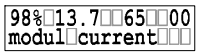
I_out is the sum of discharge currents flowing into the battery. It is composed of the load current running through the controller and the discharge current of loads that are above the controller's nominal performance and that are directly connected to the battery via an external SOLARIX shunt.



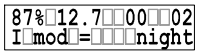
I_mod is the charging current placed by the solar generator. It is less than the short circuit current which is not available in any case. When the final charge voltage is reached (see example) the module current I_mod is substantially higher than the charge current (I_in). „I_in" will then be reduced by the controller in order to protect the battery from being overcharged.



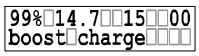
I_accu is the balance of all charging and discharging currents. As long as the charging current is higher than the discharging current the value is positive, in the opposite case it is negative.



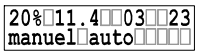
Wrong status such as „over-temperature", „load current", „low voltage" and „high voltage" are warning signs (see **Malfunctions and errors**; chapter 9, page16). The controller automatically takes steps in order to protect itself, the battery or the load. After having eliminated the error the controller gets back to normal function.



Night can be identified by solar generator. The state condition „night" is showed instead of current. Another operation recognises whether a solar generator has been connected (I_mod = no modul). This function is displayed and is additionally sent to the external data logger. This signal can be used as theft recognition under the following precondition: The solar generator must completely be disconnected, this operation does not recognise the disconnection of single strings.



Regulating status such as normal charge, boost charge and equal charge indicate which final charge current is activated. After the limited period of time normal charge is re-connected. Deep protection is also indicated even when manually been de-activated.



System configurations such as the selection of the electrolyte „liquid electrolyte" for liquid batteries or „fixed electrolyte" for sealed batteries as well as manually load disconnection „manuel auto, „manuel load off" or „mauel load on" are indicated.

4.2 Alarm contact

All PowerTaroms are equipped with a signal contact.. See illustration in chapter 6.4 to locate the terminals. The signal relais switches if a system fault occurs: under/over voltage, SOC < 30%, overtemperature, no module connected, no charging during the last 24 hours. If one or more of this events occurs the terminal contacts #5 and #6 close and #5 and #4 opens. The error conditions resets automatically if the reason has stopped.

Error Conditions

System voltage	12V	24V	48V
System voltage	12V	24V	48V
Undervoltage	10.5V	21V	42V
Overvoltage	15V	30V	60V

For all voltages: Overtemperature: > 85°C, overcurrent; >110% max. current, no charging since 24 hours, SOC < 30%

5 Operating the system controller

5.1 Pre-set configurations

With the pre-set configurations the controller can be applied in most of the application needs without further programming.

On delivery the controller is equipped with pre-set basic configurations that enable immediate use of the solar system after installation. This pre-set configuration match most PV systems´ demands. We recommend only specialists and authorised dealers to change this configuration.
However, the controller can at any time be reset to pre-set configurations within the **menu CONF** (chapter 5.5, page 10). It is indispensable to register the battery type within the **menu CONF**. Since this is even necessary when no programming is desired or found too complicated you will find a detailed **Example of configuration** (chapter 5.7, page 11). All other parameters should only be changed if you have sufficient information on the battery in use.

With this controller the user of a photovoltaic solar system has the possibility to design his own and individual solar system. This is granted by various configuration alternatives for parameters and functions.

In the following you will find information on how to change readings, parameters and functions. Menu windows clarify possibilities on what to select and give an overview on the menu-driven use of the system controller.

5.2 Main menu

Set values and functions can be adjusted with the four control keys. By pressing one of them a window appears – **MANU** (manual adjustments during operation), **LOGG** (inquiry of internal data logger), **CONF** (configuration of system components) and **PROG** (programming set values). With the key below the corresponding abbreviation you can enter the corresponding menu.
Otherwise the keys always have the same function in a certain menu:

⇒ With the arrow keys ▲▼ you can turn the windows, no values appear and no parameters can be changed by incident.

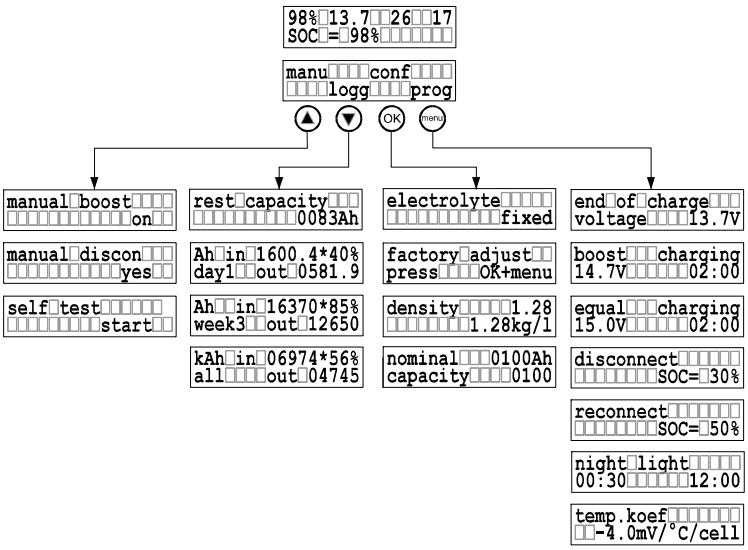
⇒ With **OK** the selected menu window is activated, the value is indicated. Pressing **OK** once again leads to a closure of the window without adjustment.

⇒ With the arrow keys ▲▼ you can change the values within a certain window. When the maximum value has been reached the parameters start at the lowest value again. By constantly pressing the key the values start to „run“ in small steps.

⇒ Confirmation by **OK**

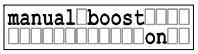
⇒ Indication of status appears automatically after 5 seconds with no selection of another menu.

⇒ If there are no adjustments for 2 minutes the indication jumps into the main menu and the adjustment in the open window is not applicable.



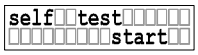
5.3 Menu MANU

Here you have the possibility to directly influence the control behaviour.



Manual rapid charging increases the final charge voltage to set values for a limited period of time. Having reached this window it can either be skipped the arrow keys ▲▼ or entered by pressing **OK**. After entering with **OK** you have the possibility to activate boost charging with the arrow keys ▲▼.
possibilities for programming: ON, OFF

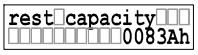
Within this window the load can manually be connected. By pressing **OK** you enter this window and you may then switch over ▲▼ from „**load on**“ to „**load off**“ or „**auto**“. However, the accumulator will still be protected from the worst by a low discharge voltage. „**load off**“ switches off all loads and may be used as main switch if you leave your solar system for a longer period of time. „**auto**“ automatically protects the battery from being discharged.
possibilities for programming: load ON, load OFF, load AUTO



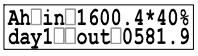
Before this menu started, it is necessary to disconnect the solar panel load. Before **Uninstalling** (chapter 6.5, page 14) please refer to the related information. After having entered this window a self test can be conducted. After entering with **OK** the self test will start.. Afterwards the controller examines its performance components: software and parts of the hardware. When the window appears **„TEST MODUL OK; TEST LOAD OK“** , the operation is under good condition. When appears **„TEST MODUL FAIL“** and/or **"TEST LOAD FAIL"**, check whether load and modules are disconnected and evtl. restart the test again. For regulators without a load output (no deep discharge protection) the message “load fail” has no further meaning.

5.4 menu LOGG

Within this menu you can call for registered values. Within the following windows values cannot be amended. Therefore only the arrow keys ▲▼ and the **MENU** key are activated.
In the regulator there is a small data logger inserted for quick view of the energy allocation. To provide a economically research of a exact value, we recommend you the optional data logger.

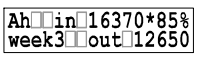


Within this window the rest of the available capacity is indicated by SOC calculation in ampere hour units when the nominal capacity is entered under the **menu CONF**(chapter 5.5, page 10)

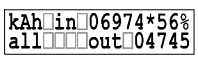


From this menu window, you can read the actual daily value. You can also choose wished period with the arrow key with **OK** to get the extended real value for the latest 7 days until weeks long ▲▼. „day“ simply stands for today and „day 1“ for the day before.

The 7th day will always be written down with the actual value. For a given period, There should be an external data logger linked with this system as an additional options **Options** (chapter 2.2, page 4). The daily value (in ampere hours, Ah) is always show with the available value of battery energy and then the percentage after. The used energy is showed on the second line.



Analogously is the weekly value with function „week“ (in ampere hours, AH) which shows the accumulated value from the latest 7 days.



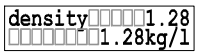
This window adds all values of energy since the day of installation. You can reset all these values carrying out a new installation. Please take care about the sequence described in **Installation and operation** (chapter 6.4, page 13) and **Uninstalling** (chapter 6.5, page 14)

5.5 menu CONF

Within this menu you can configurate your system components. Here you can review all program amendments and activate pre-set configurations. Within this menu the type of accumulator has to registered. Please find detailed information on programming the type of battery in **Example of configuration** (chapter 5.7, page 11)

Within this window you can register the accu´s nominal capacity. Press OK for enter and press arrow keys ▲▼ for amending the nominal capacity.

Within this menu the battery type can be adjusted. After having entered this menu by pressing **OK** you may switch over ▲▼ from **fixed** to **liquid** or vice versa. **fixed** deactivates the window for programming the acid resistance as well as compensatory charging **equal charging** since gassing must be prevented in case sealed batteries are used.



Within this window the acid density can be configurated. After having entered this menu by pressing **OK** the acid density can be amended within a given value by the arrow keys ▲▼. By pressing the arrow keys ▲▼ select your desired value and press **OK**. For the use of sealed batteries this window is not accessible since the acid density cannot be configurated.
possibilities for programming: 1.2 .. 1.3 kg/l.

In order to reset the configurations to the original status you can use this reset window. Press **OK** for enter. The indication "press ok+menu" ask you to press the two right keys **OK** and **MENU** simultaneously. In case that you do not wish the reset into the operating state, you can leave this opportunity by pressing any key. If you press **ok+menu** however, all changed values will be reset and the execution will be confirmed by "**done**".

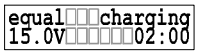
Advice: We recommend this reset in case you are using a second-hand controller or you intend to change the battery.

5.6 Menu PROG

Within this menu values that do not damage the battery yet can be changed within given windows. However, certain skills are needed as far as battery behaviour is concerned. If you are insecure please refer to your authorised dealer and leave the pre-sets configurations as they are.
In order to adjust the values press **OK** for enter. You will find a detailed Example of configuration (chapter 5.7, page11) describing how to proceed.

The final end of charge voltage serves for keeping up the charge and should not be too high since permanent gassing damages the battery. Maximum values are stated on the battery data sheet.
possibilities for programming: 13,0V...14,5V.

Increasing the final charge voltage over a limited period of time is not harmful for all lead battery types. Maximum values are stated on the battery data sheet. Within this window both the voltage and the period of time can be programmed. After having entered the window by pressing **OK** the first line shows the expression „**Boost___voltage**“ and you may alter the voltage – now appearing in the second line - by pressing the arrow keys ▲▼. By pressing **OK** the window „**Boost___time**“ appears and you may adjust the time period. All this is confirmed by **OK**.
Possibilities for programming: 13,5V...15,0V in the period from 00:30 to 05:00.

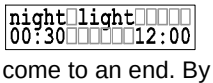


Like adjusting the boost voltage the equalisation charging can be programmed. Press **OK** for enter, amend by pressing the arrow keys ▲▼, confirm the adjustable time period by pressing **OK**. After programming confirm with **OK**. The equalisation charging can only be adjusted for batteries with liquid electrolyte since voltages that are too high are harmful for sealed batteries. The maximum voltage value is stated on the battery data sheet. This window is deactivated if you have decided for „Fixed“ within the menu CONF (selection of electrolyte) or if you have not decided at all. Pre-set configurations presume sealed batteries. You will find a detailed description in chapter 5.7.1, page 11; **Pre-set configuration by the manufacturer**
Possibilities for programming: 14.0V...15.5V in the period from 00:30 to 05:00.

⚠ For compensatory charging high final charging voltages can be programmed that may damage some loads. Please select this voltage very carefully and compare the desired value to the battery and load manufacturers´ data sheets.

The discharge threshold can be individually programmed. When you have reached the window by pressing the arrow keys ▲▼, you may open it by pressing **OK**. Afterwards you may alter the disconnection threshold by pressing the arrow keys ▲▼ within given values. However, the difference between disconnection and reconnection threshold must be 20%. If you wish disconnect at high state of charge you have to adjust at first the reconnection threshold to 20 % above the disconnection threshold.
Possibilities for programming: SOC 20..70%

The reset window is reached by pressing the arrow keys ▲▼. Enter the window by pressing **OK** and alter the values within the given window. The reconnection level can only be reduced to 20% above disconnection threshold.
Possibilities for programming: SOC 40..90%



The charge controller evaluates the density of light with the help of the solar generator. Depending on the generator alignment it may well be that despite successful night recognition twilight has not yet come to an end. By the programmable time adjustment „night delay“ the night light switch-on may be activated to a later

time. When you have entered the window by pressing **OK** the first line appears with the expression **„night___delay“** and you may change the time of delay by pressing the arrow keys ▲▼. After confirmation by pressing **OK** the window **„night___timer“** appears and you may enter the period of time for light after dawn. By pressing **OK** all this is confirmed and programmed.
This configuration has no influence on the charge controller. However, loads can especially for darkness be connected with the SOLARIX receivers. Here the receivers have to be programmed to nightlight and the controller sends a signal which activates the loads.
Possibilities for programming: 00:00 .. 12:00 timer and delay 00:00 .. 03:00

temp.koef
-4.0mV/°C/cell

The gassing in the battery is proportionate to the voltage and the temperature. The higher both are the higher is the gas development. So in dependence on the temperature the voltage value has to be changed. The configurated final charge values (end of charge, boost, equal) refer to the room temperature and are amended by the programmable coefficient in accordance with the ambient temperature.
Possibilities for programming: -2 .. –8 mV

5.7 Example of configuration

5.7.1 Pre-set configuration by the manufacturer

After a power failure by e. g. defective safety fuses usually no parameter values or functions have to be programmed again since these values are stored in the controller´s EEProm. Please note that these configurations are even stored when you install the controller into a new system.

Tip: Used controllers had to **Reset to pre-set configuration** (chapter 5.7.3; page 11) before putting into operation in a new system

For pre-set configurations please see **Performance data** (chapter 7, page15). This configuration can be reset to at any time. However, configurations already programmed will be lost.

Tip: Adjust the battery type after reset

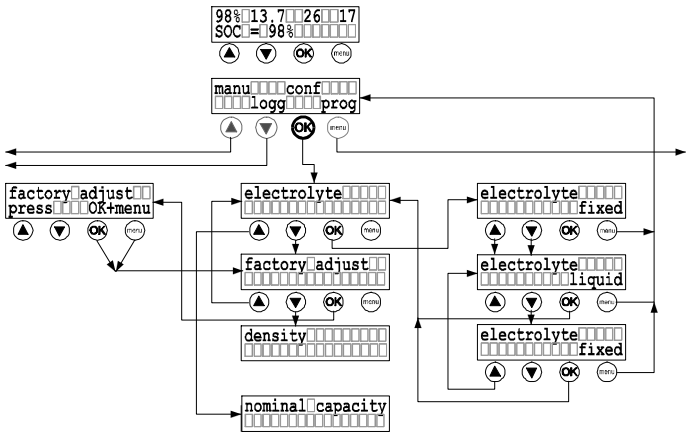
On delivery the controller is pre-set for closed batteries with fixed electrolyte „**fixed**“ (sealed batteries). This configuration is also applicable for other lead batteries. However, adjusting to other battery types (e.g. open batteries with liquid electrolytes „**liquid**“) leads to an optimal monitoring and maintenance function. Only with the configuration „**liquid**“ have you the possibility to program the acid **density** and the compensatory charging „**equal charging**“. Within the configuration **fixed** these windows are not activated.

5.7.2 Battery type

By pressing either one of the keys you leave the online display and get to the main menu. By pressing the key below the corresponding abbreviation **MANU** (manual alterations during operation), **LOGG** (Checking the internal data logger), **CONF** (configuration of system components) and **PROG** (programming of set values) you can select the corresponding menu. In the case of this example you have to press the third key from left below the abbreviation **CONF** with the marks **OK.** This is how you get into the window for programming the electrolyte.

Tip: If you have pressed the wrong key by incident press **MENU** to get back to the main menu and start allover again.

If you press OK now you have already entered the window and you may change the expressions „**fixed**“ and „**liquid**“ by pressing the arrow keys ▲▼. After having selected a configuration (this expression must appear in the second line) press **OK** to confirm the configuration. Now you have already reached the so-called title window and are now free to either enter further windows by pressing the arrow keys ▲▼ or to get back to the main menu by pressing the menu key.



5.7.3 Reset to pre-set configuration

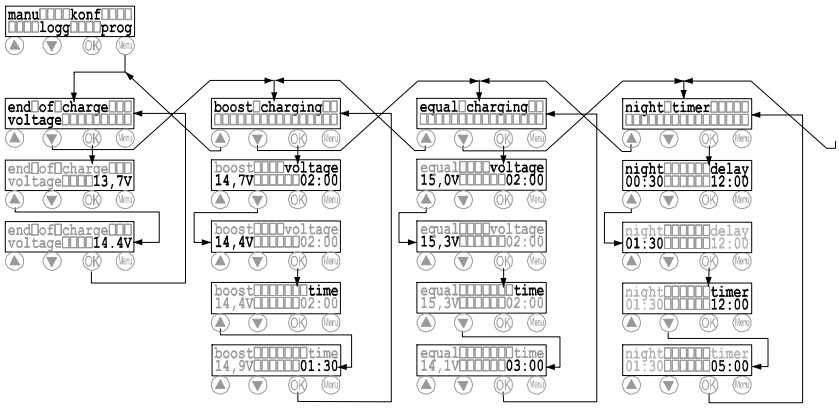
In the previous chapter it is described how to enter the window **electrolyte**. Starting from this window the subsequent window for pre-set configuration (**factory adjust**) is opened. If you use the arrow key ▼, however, you get to **factory adjust** via the windows **nominal capacity** and repeated pressing of the arrow key ▲ via **density**. By pressing **OK** you can open the window. The instruction to press the menu key plus the OK key appears immediately.

5.8 Example of programming

This example shows how pre-set configurations can be altered within the menu **PROG**. Changes are displayed in black letters.

With the example **equal charging** you will again find a description on how to program. First of all press any key. The window with the four menus appears, please press the key below the corresponding title (**MANU, LOGG, CONF, PROG**). In this example press the very right key that has the function menu in all other menu windows.

After having pressed this key the window **end of charge** appears. Since only the **equal** values is to changed we move to the window **equal charging** by pressing the second key from left ▼ via the window end of charge. By pressing the **OK** key the first line indicates the expression **equal voltage** and you may change the voltage value (here 15V) to 15,3 by pressing the arrow keys. By pressing OK this value is programmed and at the same time the expression **equal time** appears in the first line. Now you can adjust the time that the increased final charge voltage should take by pressing the arrow keys ▲▼ (here: from 02:00 to 03:00). Press **OK** for confirmation and the original window for boost configuration appears.



Tip: If you want to make sure that you have programmed correctly, exclusively press OK and move through all Boost submenus.

Tip: If you have programmed a wrong value you will reach the window with the undesired value by pressing the OK key several times. When you have entered the window change the value by pressing the arrow keys.

6 Installation

6.1 Precautions

Do not install PV components in rooms where easily flammable gas mixtures may occur!

Within the battery's immediate surrounding explosive electrolytic gas may develop. So please see that the battery room is adequately aerated and avoid spark development.

⚠ **The following instructions for batteries must be adhere to!!**

⇒ DIN VDE 0510 part 2, 8. Precautions against risks occurring by electrolyte (hydrogen sulphide) and 9. Location

⇒ National Electric Code with article no. 590

6.2 Location of installation

The controller must be connected to the solar generator, the battery and the loads. The line loss and drops in voltage should be kept to a minimum, so the controller must be installed in a way that the shortest cable possible and the most direct access can be used. This is – in any case – the decisive factor for the battery's as well as for the solar generator's location. The cable lengths to the loads can only be influenced to a minimum extent since distribution inside the house is necessary.

The ideal location for the battery is the same well-aerated battery room (safety distance min. 30 cm). Since both charging and discharging currents are running via the battery connection a spatial proximity and short strong cables to the battery are recommended. This is the connecting point where the losses have worst impair on the efficiency.

The solar generator should be installed in a way that – in the most unfavourable case – the voltage drop is not too high so that the battery could not be charged completely again. Within the limited period of time for compensatory charging the battery is charged on a high voltage level. However, if the generator's drop in voltage is too high this voltage can not be reached. The generator's MPP voltage is 16.5V minus 1.0V drop in voltage on the generator main pipe minus 3,0V drop in voltage on the controller, the safety fuses. The overall battery voltage is 15.2V. This voltage is indispensable when the battery is installed in rooms with less than 17°C temperature.

Large loads such as inverters should also be installed near the battery. Distribution within the house net is not used around the clock so that the losses do not occur permanently.

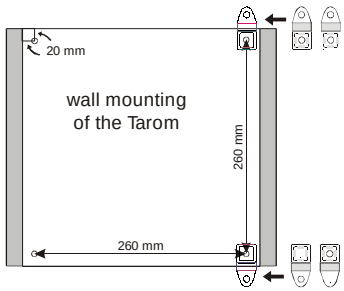
The controller must not be installed in locations with easily flammable liquids or gases. Installation is only permitted in areas where the controller's protective system (see technical data) is sufficient. The max. permissible. Furthermore, the controller must not be installed and operated in moist rooms e. g. bathrooms or in rooms with easily flammable gas mixtures such as gas bottles, paint, varnish, solvents etc.

The system controller must be protected from direct exposion to weather. Sun and warming-up by nearby devices must be avoided.

The battery and the controller must be out of children's and unauthorised persons´ reach. So it is not necessary to take any precautions on the controller in order to prevent unauthorised use.

The basis on which controller is to be installed should not be easily flammable. During operation the backside of the controller (cooling body) heats up by the loss performance and so the location for installation should persist a temperature of 85°C.

6.2.1 Installation on walls



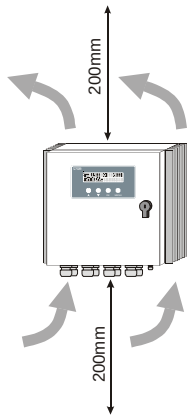
The regulator has to be mounted on fire proofed basement. Furthermore no inflammable material is allowed under the place regulator is mounted.

The controller is to be installed on vertical walls. This is the only way that the controller can be cooled by surging air (chimney effect) and work correctly.

The system controller is screwed to the wall with the 4 supported wall hinge. See illustration.

6.2.2 Mounting the system controller

The controller must be installed with cable openings down.



Make sure that the cooling body is aerated when mounting. When the controller is in operation, producing loss performance that warms up the device air is surging on the cooling body and extracts the heat. This chimney effect is necessary for perfect operation. Do not shut up the controller since this would make aerating impossible. Adhere to a safety distance of min. 200 mm.

After screwing the controller to the wall start wiring.

6.3 Preparations

6.3.1 Assembly

Principally before installation set all cables, feeder boxes and safety fuses:

- cut into sections
- isolate on both sides and press on end sleeves for strands
- prepare feeder boxes

6.3.2 Preparation of wiring

Please make sure that the wire diameter is in accordance with the controller's performance. The following table states the minimum cross sections that are necessary referring to constant currents that may occur during a period of time of approx. 30 min. Distance from regulator to generator collection box (approx. 10m); to battery (approx. 2m); load distribution box (approx. 5m).

current	diameter	AWG	Isolation
20A	10mm²	8	85°C
50A	25mm²	4	85°C
70A	35mm²	2	85°C
140A	70mm²	2/0	85°C

Before wiring please check if the batteries are the right ones and if they are connected to the circuit the right way (check system voltage!). Also make sure that the solar generator's maximum solar current does not exceed the connecting value of the controller.

6.3.3 Cabling

Solar modules create currents in the case of light incidence. Even in the case of slight light incidence full voltage is given.

- Solar modules must in no case be set free of voltage by short circuit! Spark development!
- Only use well-isolated tools!
- Never touch blank cable ends!
- Isolate each blank cable end if not connected immediately!
- Work only on dry underground! Components (solar module, cables etc.) must not be wet or moist for installation!
- Pay attention to the right polarisation during cabling!

The battery stores a substantial quantity of energy that may be set free during a short circuit and that may evoke fire if not secured adequately. So it is indispensable to install a safety fuse directly on the battery pole. This fuse secures the cables between controller and battery.

For isolated systems it is not necessary, not common or even not permitted by national laws to ground-connect the components (e. g. DIN 57100 part 410). For further instructions please see **Safety measures** (chapter 6.6, page14)

6.4 Installation and operation

It is absolutely necessary to adhere to all our **General safety instructions** (chapter 1.3, page 3). To guarantee a faultless working of the controller it is necessary to follow the chronological sequence described in the following chapters.

6.4.1 Connection the battery to the controller

- switch both fuses in the controller to OFF (0)
- Lay accumulator connecting cable (A+, A-) between system controller and battery storage parallel.
- Pay attention to the right polarity!
- Connect battery connecting cable A+ to the battery's positive pole
- Connect battery connecting cable A- to the battery's negative pole
- Switch the fuse / <u>both</u> fuses to the ON (1) position, the controller should start to work
- Note: The controller starts a self test during initialisation. For Taroms with no load capabilities it can be that the controller displays "load failed" at the beginning. This has no influence on proper operation.

6.4.2 Connecting the solar generators to the controller

- Connect both module groups with M+ and M- to the controller's terminal screws. Pay attention to the right polarity!
- Connect solely solar generators as energy source (no net devices, diesel or wind generators).

6.4.3 Connecting the loads

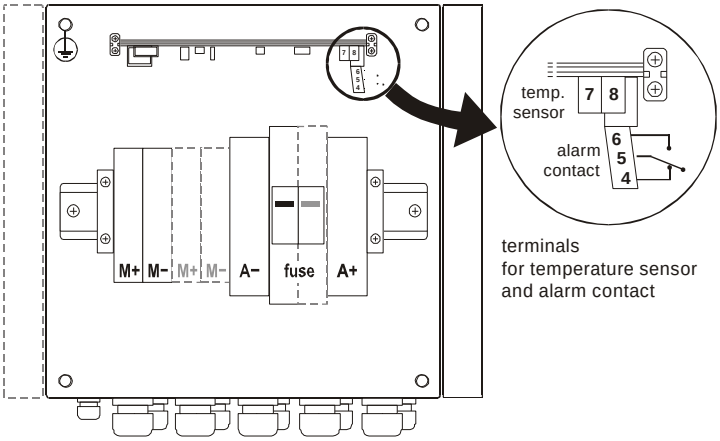
- Protect each load circuit by a safety fuse
- Disconnect all loads before cabling the load cables in order to avoid spark development.
- Connect load cables to the controller's terminal screws. Pay attention to the right polarity!

6.4.4 Connecting the temperature sensor

- Fix the temperature sensor to a battery pole.
- Connect the sensor with the terminals 7 and 8 of the printed circuit board. See illustration.

6.4.5 Connecting the alarm contacts

- The signal relais switches if a system fault occurs: undervoltage, SOC < 30%, overvoltage, overtemperature.
- If one or more of this events occurs the terminal contacts #5 and #6 close and #5 and #4 opens.
- The error conditions resets automatically if the reason has stopped. See chapter 4.2 too.



terminals
for temperature sensor
and alarm contact

Connect loads that must not be disconnected by the controller (e.g. emergency light, radio link) directly to the battery! Increased risk of discharge no longer controlled by the system controller! Secure these loads by installation of safety fuses.

Finally secure all cables within the controller's immediate surrounding by strain relieves. All other components must also be strain-relieved.

6.5 Uninstalling

Uninstall the regulator in the opposite way like installing. Firstly all consumers must be switched off by hand and then disconnected from the controller. Secondly the modules must be disconnect. To avoid any sparking the modules had to be disconnected at night or covered. Now the fuse can be removed.

In order to avoid short cuts you have to remove the junctions from the battery poles before you disconnect the cables from the controller. Before reinstalling the controller it should be reset to the factory adjustment.

6.6 Safety measures

All safety measures for the solar charge controller's protection cannot prevent any impact caused by wrong installation outside the controller. This is the reason why we urgently recommend the installation of a safety device on the battery pole in order to prevent short circuits between battery and controller.

6.6.1 Electronic short circuit safety

An electronic short circuit safety device prevents both destruction of the controller and the safety device's release in the case of short circuits on the solar generator and consumer components exits. The display indicates this error as „load current". After elimination of this fault the controller automatically switches to normal operation after about 30 seconds.

6.6.2 Hardware safety

The controller has been protected by fuses far beyond nominal currents. So the controller's nominal current must not be taken from the safety fuses values. The power range (page 4) must be taken from the SOAR diagram.

The safety fuses are on parallel switch. In order to prevent fuses from releasing in the case of high currents over a short period of time a high value has been selected. Before the fuses release the electronic safety fuse will prevent the extensive current flow.

The safety fuses are only for the controller's protection from being polarised. Due to polarisation both fuses will cut off the power. The cut off is done faster by using two paralled fuses instead of one bigger fuse. Moreover the system's safety is considerably increased by the fact that even in the case of an electronic breakdown there is no danger at all to continue operation.

6.6.3 Flammability

The controller is solely made of non-flammable and self-dissolving material. Even in unpredictable error situations there is no risk of fire if there is no flammable material within the ambient surrounding and if the controller has been installed on a fire-proof underground.

6.6.4 Overvoltage protection

Due to cost and space it has not been possible to integrate a high-voltage protection in a controller of this size. High-voltage protection must be installed within the framework of the system's installation and must be adjusted to local

circumstances. However, measures have been taken to compensate atmospheric overvoltage. In most applications this protection is sufficient. Nevertheless, for very expensive consumers you should consider additional protection.

6.6.5 Simple and double errors

The controller is protected from simple errors (e.g. load short circuit, battery polarisation, module polarisation etc.) by appropriate measures, mainly electronically or by fuses.

However, there are some double errors that may lead to the destruction of the controller or components (consumer components, modules), such as:

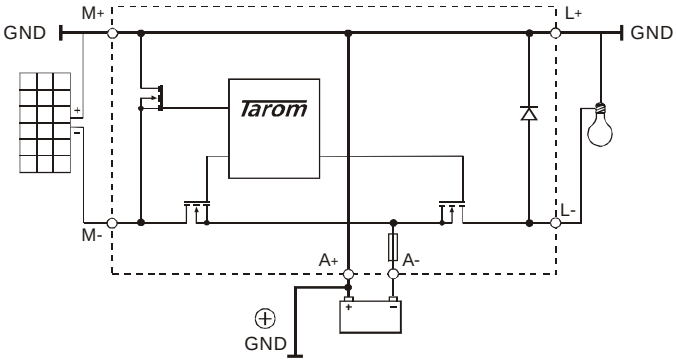
- Polarised battery on the solar entrances
- One battery wire on the module entrance, the other on the load exit
- A wrong source (current net with 230V) on the solar entrance

6.7 Grounding

By grounding the negative poles the servo components that are necessary for the regulation and the safety fuse are bridged. In this way internal protection components are also deactivated and the controller is destroyed.

6.7.1 Positive grounding

Following passages describe only the technical possibilities of a grounding. Aim is to maintain the controller's functions. National regulations of the operational area are to be adhered to by the electrician to do the installing. Loss of the safety low voltage status arising from grounding has to be compensated by corresponding insulation methods of active parts (protection against direct contact).

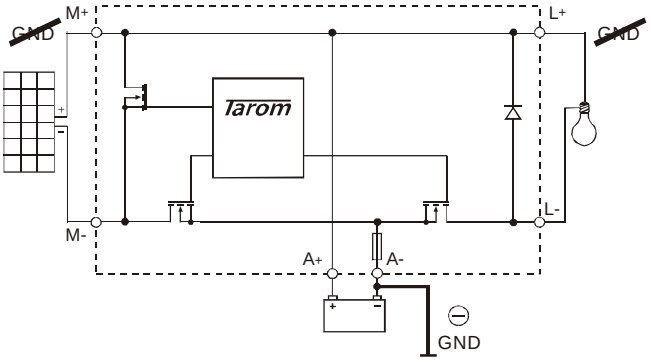


When a grounding at the plus-side is chosen, it can also be taken as common mass for all system components. All plus connections are internally connected anyway.

6.7.2 Negative grounding

Only one minus connection of the components module, accu or load can be grounded.

When your solar system determines a minus mass (e. g. accu minus) only this component can be connected with this mass. A connection with further minus poles (module or load) bridges control elements and the fuse. This can lead to a malfunction and destruction of the controller.



In systems with determined load-minus-mass (e. g. grounding of aerials), all further components have to be connected floatingly.

7 Maintenance

The controller depends on its cooling area to match its technical data. Therefore the heat sink must be kept clean.

As far as the cables are concerned they must be checked on corrosion. Due to corrosion the transfer resistance increases and the contacts could become so hot that defects arise.

8 Technical data

8.1 Performance data

Type of controller	2070	2140	4055	4110
System voltage	12/24V	12/24V	48V	48V
Max charge at 20°C	70A	140A	55A	110A
Max discharge at 20°C	70A	70A	55A	55A
Max. current for 5s	200A	200A	200A	200A
Operating temperature	-10°C...50°C			
storage temperature	-10°C...80°C			
Terminals	50/70mm²			
Weight	9 kg	10 kg	9 kg	10 kg
Dimensions	360x330x190mm			
Type of protection	IP65			

8.2 Controlling data

The following data are the factory adjustment at 25°C for a 12 V system

end of charge voltage	factory adjustment 13.7V programmable between 13.0 .. 14.5V

Quick charging boost charging activating	Factory adjustment 14.7 for 2 hours Programmable between 13.5 .. 15.0 V from 00:30 .. 05:00 hours In case of falling below SOC < 70% (fixed value)
Compensatory charging equal charging activating	Factory adjustment 15.0 V for 2 hours Programmable between 14.0 .. 15.5 V from 00:30 .. 05:00 hours In case of falling below SOC < 40% (fixed value)
Deep discharge protection	Factory adjustment SOC <30% Programmable 20 .. 70 %
Load reconnection	Factory adjustment SOC > 50% Programmable 40 .. 90%
Charging process	IU-line with PWM at 20 Hz
low voltage high voltage	< 10,5 V > 15.2 V (min +0.2 V equal charge)
high temperature	75°C inside, reset occurs automatically at 65°C
Voltage tolerance	+/- 50mV

9 Malfunctions and errors

The controller is designed for many years of constant use. Nevertheless, there may be faults. It is very often, however, that the causes for these faults and errors do not occur by the controller itself, but in the peripheral system components. The following description should be used as a helpful guidance to find the sources of malfunctions and to put the device into operation as soon as possible so that unnecessary costs can be avoided. Certainly not all errors are listed below. You will find the most common errors and faults covering the biggest part of all those possible. Send in the controller only when you are sure that none of the below-described errors has occurred.

The system controller is protected against damage by various measures. Nevertheless apply utmost care to the proper operation of the controller. Parts of the malfunctions are indicated with the help of the LCD display. However, only errors are indicated for which the system has been properly installed. If there are other malfunctions as the ones described below please check first of all if the controller has been connected to the accumulator, the module and the loads correctly in the right polarity. Afterwards check the circuit breakers. In case of malfunction the controller switches off the load.

Error message	**Meaning**	**Remedy**
CB is off	Wrong polarity at the accumulator or module	• Switch the circuit breaker on
No LC-display	There is no current feed current temperature is too high or too low	• Check the system voltage • Check the working temperature • disconnect everything and connect it again in the right order
Module current	The module current exceeds the max. currents allowed. Although this will not cause a defect, the heat sink will become very hot and could cause injury. The load is disconnected in order to avoid further losses and self-heating. After the current has decreased the load will be reconnected automatically	• The solar generator exceeds the nominal currents. The system must be splitted into smaller generator units.
load current	The load current is too high and the output is disconnected. Either the whole consumption exceeds the max. discharge currents or the max. pulse currents were exceeded by using powerful consumers A short circuit has been caused. After the problem has been solved the controller reconnects the load after 30 seconds.	• Switch off some consumers by hand • Clear the short cut
Over temperature	The temperature inside has been exceeded. In order to reduce the loss of power the consumer are disconnected automatically. If the controller has cooled down this measure will be revised.	• Check the ventilation • Protect the controller from direct sun
high voltage	In particular the recharge process through back up generators causes voltages, which are harmful for some consumers. Therefore these are disconnected.	• Disconnect external chargers • Check batterycables and the fuse
low voltage	To protect the battery all consumers influenced by the controller will be disconnected. They will be reconnected automatically after they have reached the load reconnecting level.	• Connect all consumers through the controller to avoid strong discharge
missing modul	No module is connected (theft control)	• Check contacts and junctions
EEProm Error	The EEProm of the controller cannot be read or described any longer. Remedy: interrupt the controller's supply of voltage and reconnect it again. If the error cannot be cleared, please see your authorised dealer	• Disconnect the charge controller and reconnect it in the order described. If the indication remains, the controller must return to the dealer for repair.
selve test failure	The self-test could not have been carried out correctly, since the solar generator or the load had not been disconnected. On of the power components or any other does not function	• Disconnect all modules and loads • If the self-test still failed, the controller should be sent to the producer.

10 Warranty

The manufacturer will remove all construction and material faults that occur during the warranty time and that do not impair the proper functioning of the device. The usual tear and wear is not a fault. After conclusion of the sales contract guarantee is not granted for any mistakes that have been caused by improper use of the end user or third parties, particularly by improper installation and operation, faulty or careless use, extremely heavy use, inappropriate operating material,

inadequate construction, unsuitable construction ground or similar things. Guarantee is only granted when the mistake has - immediately after notice - been reprehended to your dealer who, in turn, informs the manufacturer about the reprehension. In this case a copy of the receipt must be enclosed.

For a fast settlement a detailed error description is necessary. Any guarantee obligations expire after 12 months after date of purchase, except that the manufacturer agrees by written confirmation to prologue the expiration period.

The authorised dealer's guarantee on the basis of the purchase contract with the end user is not applicable for this guarantee obligation. Guarantee is effected by either rectification or replacement This does not include the costs involved in exchanging, dispatching or re-installing. If rectification or replacement is not possible or are not effected within a certain period of time (despite written respite by the customer) the manufacturer comes up for all losses in value caused by the malfunction or – if this is not sufficient in the interest of the end user - accepts the buyer's right of conversion. 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.