



User- and Operation manual

Specially designed for hybrid systems and telecommunications

Fangpusun 2401 - 4401



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1 Safety Instructions And Waiver of Liability

1.1 Symbol of Safety Instructions



Safety instructions for personal protection and instructions that refer to the safety functions of the system are marked with this sign and are printed in bold letters.

For safe installation of other components which are not mentioned in the PV System-Manager instructions, please see the corresponding safety manual of the component manufacturer.

1.2 How To Use This Manual

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

For safe installation of other components, e.g. solar modules, electrical accessories and battery, please see the corresponding manual of the manufacturer.

Hint: Before you start your work, read the instructions for Installation (chapter 6; page 10). Make sure that all preparatory measures are taken.

Only start to install the System-Manager when you are sure that you have understood all the technical details of this manual. Please make sure that all steps are done in the sequence that 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-Manager and must be handed over in case the System-Manager is sold.

This manual has to be made accessible for any third party or parties working on the PV system.

Before you start work:

- Read the chapter **Installation** (chapter 6; page 10)
- Make sure that all **Precautions** (chapter 6.1; page 10) are taken.
- Only start to install your System-Manager 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 generating sparks!

Solar modules produce current whenever light strikes them. Even at a small light level, the full voltage can be present. Therefore, work carefully and pay attention to the corresponding safety precautions. Cover the modules with something to block the light while connecting the system.

During installation and wiring of the photovoltaic system, the system voltage may double (with the 12 V system up to 24 V, with the 24 V system up to 48 V, and within the 48 V system up to 96 V)



Therefore: Do not ever touch bare wire ends even in DC Systems! This habit can cause injury or even death!

Only use well insulated tools!

Do not use technical tools that are defective or broken!

The safety features of the System-Manager can be defeated when it is operated in a way not specified by the manufacturer.

Restriction of ventilation can lead to overheating of the System-Manager and thus failure. Do not cover any ventilating slots or cooling ribs.

The System-Manager must not be installed and used in moist damp areas (e. g. bathrooms) or in rooms in which there are flammable gas mixtures (from gas bottles, paint, solvents etc.)!

Do not allow anyone to store any of the above-mentioned hazardous items, or similar items in rooms where the System-Manager is installed!

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

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

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



Keep children away from any and all electronics! Fatal accidents can occur!

1.4 Waiver Of Liability

The manufacturer (STECA and its assigned representatives) cannot check that this manual is strictly followed, nor the conditions and methods for installation, operation, use and maintenance of the System-Manager.

Improper installation can lead to physical damage to the System-Manager and its safety features, and thus can endanger persons.

Therefore, we the manufacturer 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 resulting from such damage.

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-Manager.

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

If other components, which are not prescribed by manufacturer are connected to this System-Manager, the user has to accept the consequences.



CAUTION: Opening the System-Manager (connecting cover excluded) as well as use other than prescribed by the manufacturer, will cause the warranty to be voided.

2 Range of Applications

The System-Manager is designed for a wide range of applications from private use to professional use: private homes or leisure market (like recreational vehicles or weekend/seasonal cottages, etc.) or in locations where trade, business or commerce is done (like workshops, stores, offices etc.) or industrial applications or telecom systems.

The System-Manager can NOT be used outdoors, where it would not be protected against rain or sun.

Unless external temperature sensor the System-Manager must be installed in the same room as the battery due to the following reasons:

- an integrated temperature sensor registers the ambient temperature of the room, which is almost identical to the battery temperature.
- In order to keep the voltage drop between System-Manager and battery to a minimum, please only use the shortest possible battery cables.

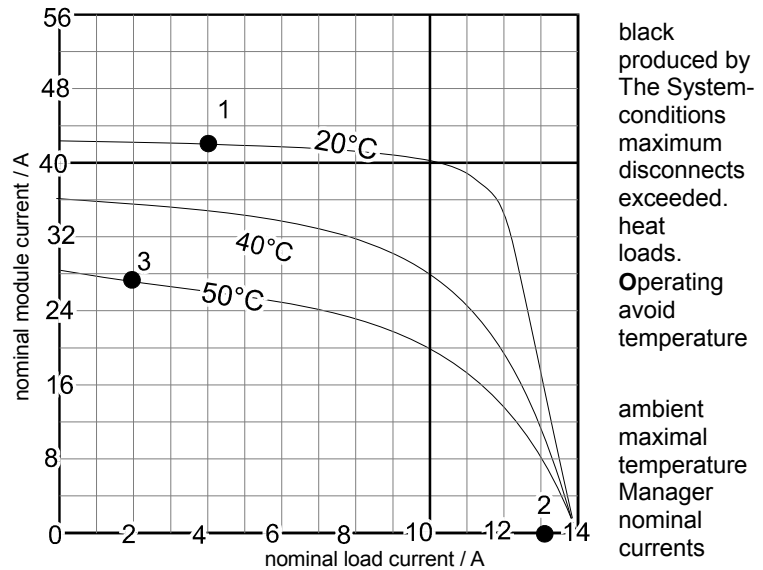
The System-Manager's PV input should only be connected to solar modules. However, the battery can also be charged in parallel by other sources with appropriate battery charge functions.

Hint: The System-Manager is able to adapt to customised applications. We will optimise your product concerning your special requirements. With these modifications the System-Manager will withstand strong ambient conditions like advanced temperature range, mechanical and climatic ambient conditions or advanced interference resistance.

2.1 Performance

The System-Manager uses a heat sink (the aluminium back plate) to dissipate heat the electronics during high amperage charging. Manager can be used in a wide range of and temperatures. It automatically detects the permissible temperature of the heat sink and the loads in the case that temperature is Therefore, the heat sink can be shared for the produced during charging and powering the However, it is necessary to stay within the “Safe ARea“ (SOAR) for sizing the system in order to undesired switch-off of the loads in the case the is exceeded.

You must size the PV system in a way that the temperature line is not exceeded in the case of charge and discharge currents. With an ambient of 20 °C and correct installation, the System-can handle both 100% module and 100% load currents (see graph at right). These nominal correspond to 100 % in the diagram



black produced by The System-conditions maximum disconnects heat loads. Operating avoid temperature ambient maximal temperature Manager nominal currents

Hint: If you install the System-Manager into an electrical box or cabinet enclosure, please assume the maximum temperatures inside this box. These are higher than the ambient temperatures, since the System-Manager and other devices may well increase the temperature.

3 Functioning

The System-Manager monitors the charge status of the battery, regulates the charge process as well as it switches the loads on -off in order to make full use of the battery and to extend its life.

On delivery, the system is set for use with lead accumulators (batteries) with liquid electrolyte and can be set for accumulators with fixed electrolyte like gel batteries. The System-Manager can be used for all types of solar modules.

3.1 Description

3.1.1 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 System-Manager monitors the ambient temperatures and adjusts the battery's maximum allowed charge voltage. The overcharge protection and 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 even though 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 may knock out active lead material from the lead plates.

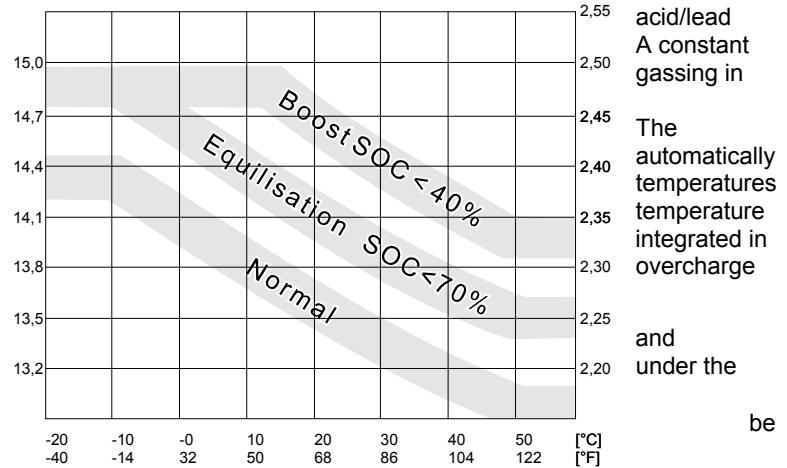
What is even worse is that the uncontrolled gassing in closed batteries e. g. sealed or fluid batteries where the gas pressure can even burst or crack the battery case. Frequent overcharging damages the battery casing. The charging process and the overcharge protection are thus regulated by a new hybrid System-Manager utilising pulse width modulation in order to insure smooth battery charging. The user in particular should not choose a float voltage too high via user settings. If you want to program this value individually from the System-Manager's factory setting, please take note of the battery manufacturers' recommendations.

3.1.2 Temperature Compensation Of Final Charge Voltage

As the battery temperature increases, the battery's optimal final load voltage decreases. In the case of higher battery temperatures, and undercharging in case of low temperatures, temperature compensation software algorithm decreases the final charge voltage at higher and increases them at lower ones. The compensation system with the sensor the System-Manager influences all three thresholds.

The integrated sensor makes maintenance installation easier and can be properly used following circumstances:

- System-Manager and battery must be in the same room
- the System-Manager's own warming-up is compensated by substantial calculations. However, even if the sensor was outside the System-Manager, the room temperature itself only corresponds to the battery pole temperature, so actual electrolyte temperature inside the battery may be actually different by a bigger margin of error.
- However, an external sensor can be installed if the most accurate sensing is desired.



3.1.3 Boost Charging (Lead&Sealed) And Equalisation Charging (Only Lead)

For this charging cycle, the System-Manager increases the battery charge voltage for a certain period of time after the battery has fallen below a certain voltage. The Boost Charge countdown is only activated when the desired battery voltage has been reached. This is the reason why it is important to pay attention to the fact that the solar module will be able give out sufficient charge energy with the corresponding final voltages.



If the Boost Charge voltage level is too high in comparison with the module voltage (reduced by wire losses) the countdown may never be started and your battery is therefore charged at a higher voltage with no time control.

Equalising charge works similar to the above Boost Charging but is at an even higher voltage. Using equalisation charging is only possible and can only then be programmed if the battery has been configured to be of liquid electrolyte type. It is activated when the battery falls below a certain voltage

3.1.4 Automatic Monthly Mixture Of Electrolyte

Batteries that are shallow cycled will never trigger the equalisation cycle, so an automatic function has been added so the final charge voltage is increased for a limited time every month. In this case, either Boost or Equalise charging is activated depending on the electrolyte configuration. This function prevents harmful acid layering which occurs especially after remaining a long time at a certain charge status.

3.1.5 Display

The display scrolls every 3rd second. Pressing once the **OK button** stops the scrolling at the actual window. Pressing this key will start the scrolling again.

The LCD works correctly only within the operating temperature range specified by the manufacturer. When this temperature range is exceeded, disturbances may occur which prevent reading the display. The display will return to normal when the operating temperature range is again reached. The storing temperature range, however, must not be exceeded or permanent damage may occur.

3.1.6 Overdischarge Protection

Overdischarging leads to sulphation and as result a loss of your battery's capacity. The overdischarge protection feature disconnects the loads if the battery is becoming too discharged and re-connects them after sufficient re-charging. The loads can also be manually switched on/off, so the System-Manager can be used as a main DC load disconnect switch.

3.1.7 Control Keyboard

By using the tact switches underneath the LCD screen, the factory set values can be configured to the user's custom requirement. Freely programmable values can only be changed within a pre-set window. These minimum-maximum values are selected in a way that even extreme adjustments do not lead to severe damage to the lead batteries. However, the operating elements are not protected or locked with a child-proof lock (code). For this and many other safety reasons, we would highly recommend that you make the System-Manager as well as the battery room inaccessible to children

3.1.8 System Voltage

The System-Manager adjusts itself automatically to 12 or 24 V system. For this it is necessary that the battery of the proper voltage is connected to the System-Manager first.

There are two variants of the System-Manager: one for the system voltages of 12/24V and another 48V version. The 12/24V System-Manager 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 System-Manager fits the desired system voltage.

4 Indication Of Status

The display constantly changes its information. All values and system information are indicated alpha-numerically. The following displays can only be seen during regular operation (not while programming). You can stop the scrolling in one of the following windows while pressing once the right **Menu key**.

U Bat = 13.70V "U Bat": Since the voltage drop between controller and battery can be calculated without sensor wires, this display shows the battery's actual voltage at the battery poles, and not the voltage at the controller's connection terminals.

I in = 00009.5A "I_in" is the charging currents flowing into the battery. Whenever the battery is full and not able to consume any charge current "I_in" could be zero even the sun is shining with high intensity.

I out = 00017.0A "I_out" is the discharge currents flowing out of the battery and is composed of the load current running through the controller.

I mod = 00013.5A I_mod is the charging current produced by the solar modules. When the voltage of the battery is getting near the final charge voltage, the module current "I_mod" is substantially higher than the charge current (I_in). "I_in" will be regulated by the controller in order to protect the battery from being overcharged. The controller can determine night time from the solar module current. The condition "night" is shown instead of the actual module current. Another feature of the controller recognises whether a solar module has been connected or not (I_mod = no modul).

I accu = 000-5.3A I_accu is the balance of the 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.

overtemperat Messages such as "over-temperature", "load current", "low voltage" and "high voltage" are warning. The controller automatically takes steps in order to protect itself, the battery and the loads. After the error condition ceases to exist, the controller resumes normal function. See **Malfunctions And Errors**(chapter 9, page 15)

float charge Charge regulator status such as "float charge", "boost charge" and "equal charge" indicate which stage of charging is in process. After a certain period of time of operating in the "boost" and "equal" charging modes, the float charge mode is resumed. "Deep protection" (meaning the controller has decided to disconnect the loads to protect the battery from deep discharge) is also indicated on the display, even when automatic load disconnection has been deactivated.

fixed electrolyt System configuration settings such as the selection of the electrolyte " **electrolyte liqui**" for liquid batteries or " **electrolyte fixed**" for sealed batteries as well as manual load disconnection " **manu discon auto**", " **manu discon off**" or " **manu discon on**" are indicated.

Some windows are monitoring several values. You can stop scrolling and fix your display in one of the following windows to get an overview of your system.

13.7V IN04 OUT12 This window monitors the battery voltage (13,7V) as well as the **IN**put charge current (IN04) and the **OUT**put discharge current (OUT12). The explanation of tension (voltage [V]), **IN** and **OUT** waste too much space to allows a accurate current monitoring.

13.7V+0.3A-12.4 This window monitors also battery voltage (13.7) as well as charge current (+04.3) and the discharge current (-12.4) with more accurate values.

5 Operating The System-Manager

5.1 Safety Cover

The safety cover is a plastic lid covering the programming keys and safety fuses. The lid can be removed if desired. In order to avoid undesired modification of important settings, however, it is recommended that the lid be left on the System-Manager. Intentionally, the lid is designed to be difficult to open. This is to prevent unwanted changes from being easily made. The lid can be easily opened with following trick.

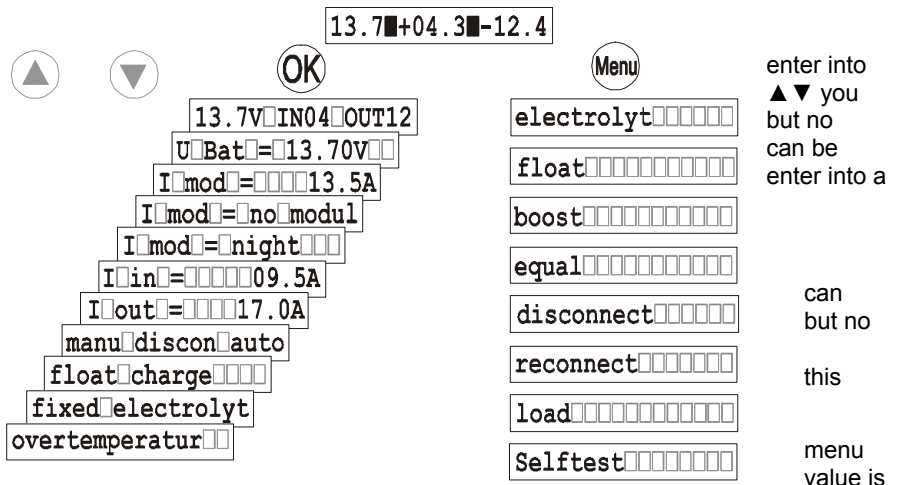
Hint: To open the cover, using your left-hand, stick your fingernail into the slot, move it along the slot and pull open the cover.

When putting the lid on the case again, please make sure to put the turning joint into the case first and then into the snap-in hole.

Using one of the option you can break the rated point on the left side.

5.2 Main Menu

Pressing the **MENU** button you will the menu. With the arrow keys can scroll through the menu items, values appear and no parameters changed by this scrolling action. To selected window press **OK**.



⇒ With the arrow keys ▲▼ you scroll through the menu items, values appear and no parameters can be changed by scrolling action.

⇒ By pressing **OK** the displayed window is activated, and the indicated. Pressing **OK** once again leads to a closure of the window without adjustment.

⇒ After a menu window is activated and its value is displayed, use the arrow keys ▲▼ to can change the value. When the maximum value has been reached, the parameter starts at the lowest value again. By constantly pressing the key, the value starts to scroll in small steps.

⇒ Confirmation and storage of the new value is done by pressing **OK**

⇒ if no selection of another menu is made within 5 seconds after OK is pressed, the System-Manager will automatically exit from all menus and the normal indication of running status appears .

⇒ If there are no adjustments for 2 minutes on an activated submenu value being changed, the display indication jumps to the main menu and the adjustment in the open window is not stored or applicable.

⇒ The **MENU** key will bring the display back to the status indicator display.

5.3 Sub Menu

Here you have the possibility to directly influence the System-Manager's behaviour

load Within this window, the load can manually be connected or disconnected. By pressing **OK** you enter this window and you may then switch ▲▼ from "load on" to "load off" or "auto". However, the battery will still be protected from the worst discharge by an emergency cut-off that cannot be overridden by the manual control function. "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 deep discharged.

Selftest
possibilities for programming: *load on, load off, auto*

Before this menu function is activated, it is necessary to disconnect the solar PV modules and all loads. Before **Uninstalling** (chapter 6.5, page 13) please refer to the related information. After having scrolled to this window, a self test can be started by pressing **OK**. The System-Manager examines its performance components: software and parts of the hardware. When the window appears "TEST: SUN+ LOAD+", the operation and hardware have been verified to be in good condition. If "TEST: SUN- LOAD+" or TEST: SUN+ LOAD- appears, re-start the Test again after you have verified that the modules and loads were properly disconnected. If the failure message appears again, disconnect all connections and please return the System-Manager to your authorised dealer.

electrolyt
Within this menu, the battery electrolyte type can be set. After having entered this menu, by pressing **OK** you may toggle between **▲ ▼ fixed** to **liquid** electrolyte. Setting this to **fixed** deactivates the window for programming the acid density as well as disabling the **equal charging** mode since gassing must be prevented where sealed batteries are used.
possibilities for programming: *liquid, fixed*

float
The end of charge "float" voltage serves for maintaining the charge in the battery for long periods and preventing self-discharge. This voltage should not be too high, since this may lead to permanent gassing, which damages the battery. Maximum values are stated on the battery data sheet of your battery
possibilities for programming: *13,0V...14,5V
26,0V...29,0V
52,0V...58,0V*

boost
Increasing the charge voltage over a limited period of time (boost or "bulk" charging) is not harmful for lead battery types, if within certain parameters. Maximum values are stated on the battery data sheet. After having entered the window by pressing **OK**, you can change the voltage values by pressing the arrow keys **▲ ▼**. This setting can be confirmed and stored by **OK**.
Possibilities for programming: *13,5V...15,0V 27,0V...30,0V
54,0V...60,0V*

equal
The equalisation charging can be programmed similar to adjusting the boost charging. Press **OK** to enter, edit the equalisation charge voltage by pressing the arrow keys **▲ ▼** and confirm setting by pressing **OK**. The equalisation charging can only be adjusted for batteries with liquid electrolyte, since high equalising voltages are harmful for sealed batteries. The maximum equalising voltage value should be stated on the battery manufacturers' data sheet. This window is deactivated if you have selected "electrolyte fixed" "Fehler! Verweisquelle konnte nicht gefunden werden." presumes liquid electrolyte batteries.
Possibilities for programming: in the period from *14,0V...15,5V 56,0V...62,0V
28,0V...31,0V*

⚠ Battery charging voltage is passed on directly to the loads by the System-Manager! Therefore, during equalise charging, high charging voltages can be programmed that may damage some loads. Please select this equalise charge voltage very carefully and compare the desired value to the battery and load (appliance) manufacturers' data sheets.

disconnect
The discharge threshold at which the loads are automatically disconnected can be programmed by the user. When you have reached this window by pressing the arrow keys **▲ ▼**, you may open it for editing by pressing **OK**. Afterwards you may alter the disconnect threshold by pressing the arrow keys **▲ ▼** within given values. Press **OK** to store the setting. NOTE: the difference between disconnect and reconnect threshold must be at least 0,13V/cell. If you wish disconnect at higher state of charge you have to first adjust the reconnect threshold (as per below) to 0,13V/cell above the desired disconnect threshold.
Possibilities for programming by voltage regulation: *11,0V...12,5V
22,0V...25,0V
44,0V...50,0V*

reconnect
The charge threshold at which the loads are automatically reconnected, can also be programmed by the user. The reconnect setting window is reached by pressing the arrow keys **▲ ▼**. Enter the window by pressing **OK**, and alter the values within the window. Press **OK** to store the setting. The reconnect level can only be reduced to 0,13V/cell above disconnect threshold (see above).
Possibilities for programming: by voltage regulation: *11,8V...13,3V
23,6V...26,6V
47,2V...53,2V*

6 Installation

6.1 Precautions

Do not install any PV or electronic components in rooms where flammable gas mixtures may occur!

Within the battery's immediate surroundings, explosive gases may be generated. So please see that the battery room is adequately ventilated and avoid generating sparks.



The following instructions for batteries must be adhered. We recommend these basic precautions for any country. Check your local electric and safety codes for all applicable precautions in dealing with DC wiring and battery installations.

⇒ DIN (German) VDE 0510 part 2, sections:

- 7. Precautions against explosion danger
- 8. Precautions against risks occurring by electrolyte gas (hydrogen sulphide)
- 9. Location

⇒ National Electric Code including article No. 690. The unit shall be installed according to this regulation

6.2 Location Of Installation

The System-Manager must be connected to the solar PV array, the battery and the loads. The line loss and drops in voltage should be kept to a minimum, so the System-Manager must be installed in a way that the shortest cable possible and the most direct access can be used. This is a major decisive factor for the battery's location as well as for the solar PV array's location. The cable lengths to the loads have a lesser effect on System-Manager site selection since distribution throughout the building or site is necessary.

The ideal location for the battery is a well-ventilated battery room (keeping a minimum safety distance of 30 cm from the System-Manager) inside the building but nearest to the solar PV array. Since both charging and discharging currents are running via the battery cable connections, close proximity and short thick cables to the battery are recommended. This battery cable connection is the point where the losses have the worst effect on the PV system's efficiency and performance.

The solar PV array should be installed in a way that – in the most unfavourable case – the voltage drop is not so high that the battery can not be charged completely again. Within the limited period of time for equalise charging, the battery is charged at a high voltage level. However, if the drop in voltage along the PV array cables is too high, this equalizing charge voltage cannot be reached. The timer for the equalize charge stage will not start running until the equalise voltage is reached, so the timer will be “stuck” and the System-Manager will stay in equalise mode permanently until the situation is corrected. For example, if the MPP voltage at the PV array connection is 16.5V, minus 1.0V drop in voltage on the PV array-to-System-Manager wiring, minus 0.3V drop in voltage at the System-Manager and the safety fuses, the maximum voltage reaching the battery is only 15.2V.

The System-Manager must not be installed in locations with easily flammable liquids or mixtures such as gas bottles, paint, varnish, solvents etc.. Installation is only permitted in areas where the System-Manager's environmental specifications are not exceeded (see technical data) . Furthermore, the System-Manager must not be installed and operated in very humid rooms e. g. bathrooms.

The System-Manager must be protected from direct exposure to weather. Sun and external warming from nearby devices should also be avoided.



The battery and the System-Manager must be installed in a place out of reach of children's and unauthorised persons. Therefore, we have not taken any precautions on the System-Manager itself in order to prevent unauthorised use.



The surface on which the System-Manager is to be installed should not be easily flammable. During operation, the backside of the System-Manager heats up. So the materials at the location for installation should be able to withstand a constant temperature of 85°C without damage or risk of fire.

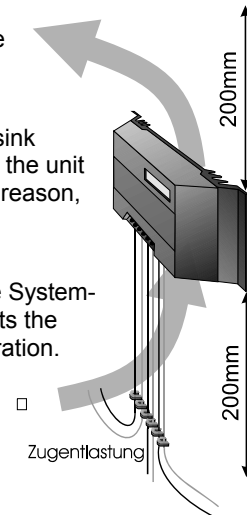
6.2.1 Installation On Walls

The System-Manager has to be mounted on fire-proof surface. Furthermore, no flammable material should be allowed under the place where the System-Manager is mounted.

The System-Manager is to be installed on vertical walls. This is the only way that the System-Manager can be cooled by naturally rising air (chimney effect) and work correctly.

The System-Manager is screwed to the wall with the four holes drilled into the heat sink flanges. The System-Manager is designed without an integrated strain relief, so that the unit can be adapted to the prevailing conditions of various types of installations. For this reason, you must install a strain relief (e. g. cable clips) approx. 200 mm below the System-Manager before the cables spread out to the individual components.

When the System-Manager is in operation, the high currents being regulated by the System-Manager warm up the heat sink and air naturally rising past the heat sink fins extracts the heat. This chimney effect is necessary for proper cooling and System-Manager operation. Do not confine the System-Manager in a closed space, since this would make ventilation and cooling impossible. Adhere to a safety distance of min. 200 mm below and above the unit.



After screwing the System-Manager to the wall, you can start wiring.

6.2.2 Rules for mounting the System-Manager

The System-Manager must be installed with cable openings down.

⚠ For marking the mounting holes use the System-Manager as a stencil, but never as a stencil for drilling!

Make sure that the heat sink is well ventilated when mounting.

6.3 Preparations

6.3.1 Assemblies

Before installation, lay out all cables, junction boxes and safety fuses:

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

6.3.2 Preparation Of Wiring

⚠ Wires that are not permanently connected to the building must be strain-relieved outside the System-Manager!

Please make sure that the wire diameter is in accordance with the System-Manager's expected currents. The following table states the minimum cross sections that are necessary for constant currents that may occur during a period of time of approx. 30 min. This chart will allow the maximum distance from System-Manager to PV array junction box of approx. 10m; to battery approx. 2m; and to load distribution box approx. 5m.

Before wiring, please check if the batteries are the right type and size, and always double check if they are connected to the System-Manager in the right polarity with a voltmeter, and it is a good idea to check battery bank voltage with voltmeter! Also make sure that the solar PV array's maximum solar PV array current does not exceed the specifications of the System-Manager.

Current	diameter	AWG	Isolation
20A	10mm ²	8	85°C
30A	16mm ²	6	85°C
40A	16mm ²	6	85°C
50A	25mm ²	4	85°C

6.3.3 Cabling

Solar PV modules create current whenever light strikes them. The current created varies with the light intensity, but even in the case of low levels of light, full voltage is given by the modules. Always cover the solar modules with an opaque lid that is fixed with tape while working on the PV array wiring or joining to the System-Manager. Due to this cover, the

modules will be free of voltage and current so the chances of damage to the System-Manager or injury to the installer is greatly reduced.

- Solar modules must in no case be short circuited to zero out the voltage from the PV array! Spark development can damage wiring, connections, cause fire, or even damage electronics due to the high spikes of current!
- Only use well-isolated tools!
- Never touch bare cable ends! High DC voltage can be present and is dangerous!
- Insulate each bare cable end with tape or other non-conducting material if it is not to be connected immediately!
- Work only on dry ground! Components (solar module, cables etc.) must not be wet or moist during installation!
- Pay attention to the right polarisation during cabling! Double check with volt meter in case something was labelled wrong or connected backwards by someone else.

The battery stores a substantial quantity of energy that may be set free in a dramatic and dangerous way during a short circuit, and the resulting heat and sparks may evoke fire. Therefore, it is indispensable to install a safety fuse directly on the battery pole. This fuse insures the safety of the cables between System-Manager and battery.

Hint: For isolated systems, it is not necessary, common or even permitted by some countries' laws to ground-connect the components (e. g. DIN 57100 part 410). For further instructions, please see **Safety Measures** (chapter 6.6, page 13)

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 System-Manager, it is necessary to follow the chronological sequence described in the following chapters.

6.4.1 Connecting The Battery Bank To The System-Manager

- open the safety lid of the System-Manager and remove both safety fuses .
- Lay both battery cables (B+, B-) between the System-Manager and battery bank in parallel.
- Insert the battery cable bare ends to the System-Manager's battery connection terminals (the symbol shows a rectangular battery with + and – indicators) and tighten securely with a proper slot screwdriver.
- Pay attention to the right polarity and make sure the battery cables have been labelled and connected correctly.
- Fix a fuseholder block for an external safety fuse (not included) for the battery cable near the battery's pole with a short length of battery cable: **DO NOT INSTALL THE SAFETY FUSE YET!**
- Connect battery cable B+ to the battery's positive pole.
- Connect battery connecting cable B- to the fuseholder block at the battery's negative pole

⇒ Install external safety fuse on the battery pole, and double verify that the battery voltage now appears at the System-Manager's battery connection terminals, in the right polarity.

⇒ Install either one of the two safety fuses in the System-Manager. Now the System-Manager should start operation.

6.4.2 Connecting The Solar PV Module Array To The System-Manager

- Insert the module array's M+ and M- bare wires into the System-Manager's PV terminals (labelled with a symbol of a slanted PV module) and tighten the screws securely. Pay attention to the right polarity.
- Remember the + and – terminals are shorted to each other internally by the System-Manager to regulate current. Therefore, it is IMPORTANT to connect ONLY solar PV modules as charging energy source. NO grid-operated battery charging or DC power devices, diesel sets, or wind generators should be connected, as these will be shorted out and severe damage to these devices and the System-Manager can result.

6.4.3 Connecting The Loads

- Protect each load circuit by a safety fuse
- Disconnect all loads before joining the load cables in order to prevent spark development which may damage sensitive loads.
- Connect the main load cables to the System-Manager's Load terminals (labelled with a round light bulb) and securely tighten the screws. Pay attention to the right polarity!

Connect any vital urgent loads that must never be disconnected by the System-Manager (e.g. emergency light, radio link) directly to the battery! Note that there is increased risk of damaging discharge to the battery since the System-Manager

no longer controls these loads! Here user training and awareness is vital to protect the customer's batteries from damage. Protect these direct loads by installation of safety fuses.

Finally, secure all cables within the System-Manager's immediate surrounding by strain reliefs. All other components must also have their wiring be strain-relieved.

6.5 Uninstalling

Uninstall the System-Manager in the opposite way like installing. Firstly all consumer appliances and loads must be switched off by hand and then the L+/L- main load cables disconnected from the System-Manager. Secondly, the PV modules' M+/M- cable must be disconnected. To avoid any sparking, the modules must be disconnected at night or covered with opaque material before disconnecting the wires. Now, the safety fuses can be removed and the System-Manager's display should go blank.

In order to avoid short circuits while removing the B+/B- cables, you have to remove the safety fuse from the block installed at the – battery pole, and also it is a good idea to remove the B+/B- cables from the battery poles before you disconnect the cables from the System-Manager. Before reinstalling the System-Manager, it should be reset to the factory pre-set adjustments and reprogrammed for the site.

6.6 Safety Measures

All safety measures we have designed into the System-Manager for its protection cannot prevent damage caused by wrong installation outside the System-Manager. This is the reason why we urgently recommend the installation of a safety device on the battery pole in order to prevent damage from short circuits between battery and System-Manager.

6.6.1 Electronic Short Circuit Safety

An electronic short circuit safety device is built into the System-Manager and prevents both destruction of the System-Manager and the blowing of the safety fuse in case of short circuits on the load terminals. The display indicates this error as "load current". After elimination of this fault, the System-Manager automatically switches back to normal operation after about 30 seconds.

6.6.2 Hardware Safety

In addition to the electronic fuse device mentioned above, the System-Manager has also been protected by regular fuses which have been rated far beyond nominal currents to prevent false blowing of the fuses during surges. The System-Manager's nominal current must not be mistaken from the safety fuses values. The **Performance** (chapter 2.1, page 5) must be taken from the SOAR diagram.

The safety fuses are wired in parallel. In order to prevent fuses from blowing in the case of high currents over a short period of time, a high value has been selected. Before the fuses blow, the electronic safety fuse should prevent any excessive current flow.

The safety fuses are only for the System-Manager's protection from being connected in reverse polarity to the battery. After reverse connection, both fuses have to be exchanged. Moreover, the system's safety is considerably increased by the fact that even in the rare case of an electronic breakdown of the System-Manager (and thereby its internal electronic safety fuse) there is no danger at all to the site, as the 2 safety hardware fuses will still be operational.

6.6.3 Flammability

The System-Manager 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 of the System-Manager mounting site, and if the System-Manager has been installed above a fire-proof flooring material.

6.6.4 Overvoltage Protection

Due to cost and space, it has not been possible to integrate a full high-voltage protection system in a System-Manager 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, some measures have been taken to compensate atmospheric static high voltage. In most applications, this protection is sufficient. Nevertheless, for fully professional installations with expensive emergency communications or life-saving equipment being powered, you should consider additional protection.

6.6.5 Simple And Double Errors

The System-Manager is protected from simple errors (e.g. load short circuit, battery reverse polarity connection, module reverse polarity connection etc.) by appropriate measures, mainly electronic or by fuses.

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

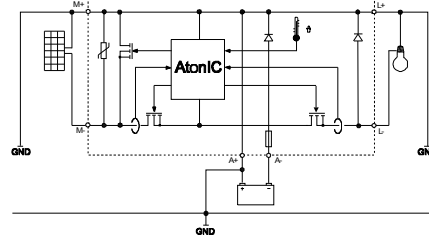
- reverse polarity battery connection on the solar PV terminals
- One battery wire on the module terminal, the other on the load terminal.
- A wrong voltage source (grid current with 230VAC) on the solar PV terminals

6.7 Grounding

By grounding the negative poles of the loads, battery and modules together, the electronic components that are necessary for the regulation and the safety fuse are bypassed. In this way, internal protection components are also deactivated and the System-Manager can be destroyed, as well as damage to the PV system may occur.

6.7.1 Positive Grounding

The following passages describe some of the technical a positive + grounding scheme. The aim is to always System-Manager's proper functions and still achieve all the main components. National regulations of the area must be adhered to by the installing electrician. Loss of low voltage status" arising from grounding has to be by corresponding insulation methods of active parts against direct contact).



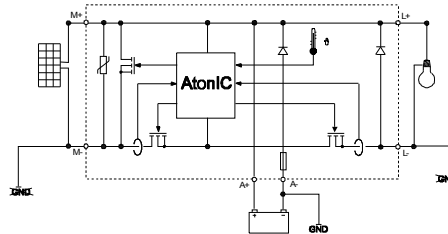
possibilities of maintain the grounding to operational the "safety compensated (protection

When grounding at the plus-side is done, it can also be considered as common ground for all system components. All plus connections are internally connected anyway in the System-Manager.

6.7.2 Negative Grounding

If Negative Grounding is used, only one minus connection one the components, i.e. module, battery or load can be

When your solar system requires a minus ground (e. g. minus), only this component can be connected to ground. A with further minus poles (module or load) bypasses the elements and the fuse. This can lead to a malfunction and of the System-Manager.



from any grounded.

battery connection control destruction

grounding

In systems with required load-minus-grounding (e.g. of aerials), all further components have to be connected with the grounds floating.

7 Maintenance

The System-Manager depends on its heat sink's cooling area to meet its technical specifications. Therefore, the heat sink must be kept clean of dust and debris that hampers cooling efficiency.

As far as the fuse and the cables are concerned, they must be checked for corrosion periodically. Due to corrosion, the transfer resistance increases and the contacts could become so hot that damage occurs.

8 Technical Data

8.1 Performance Data

Reglertyp	2401		4401
System voltage	12V	24V	48V
Max. input voltage	48V		90V
Nominal load current at 20°C	40A		40A
Nominal discharge current at 20°C	10A		10A
max. current for 10s	55A		55A
Surge current for 0,5s	60A		60A
max. pulse current (200ms)	180A		180A
Own consumption	14 mA		
Temp. range during operation	-25°C...50°C		

storage temperature	-25°C...80°C
Connecting screws	16/25mm ²
Weight	400g
Dimensions	188x128x49mm
Type of protection	IP22

8.2 Controlling Data at 25°C

		2401		4401
end of charge (float) voltage	programmable	13,0V...14,5V	26;0V...29,0V	52,0V...58,0V
	Factory adjustment	13,7V	27,4V	54,8V
Quick charging boost charging	programmable	13,5V...15,0V	27;0V...30,0V	54,0V...60,0V
	Factory adjustment	14,4V	28,8V	57,6V
	activation	< 12,7V	<25,4V	< 50,8V
equal charging	programmable	14,0V...15,0V	27;0V...30,0V	56,0V...62,0V
	Factory adjustment	14,7V	29,4V	58,8V
	activation	< 12,4V	<24,8V	< 49,6V
Deepcharging protection	programmable	11,0V...12,5V		
	Factory adjustment	11,4V		
Load reconnection	programmable	11,8V...13,3V		
	Factory adjustment	12,6V		
Charging process	IU-characteristic with PWM at 20Hz			
low voltage	< 10,5V	<21,0V	< 44,0V	
high voltage	increasing the programmed value by 0,3V			
high temperature	75°C inside, reset occurs automatically at 50°C			
Voltage tolerance	+/- 50mV	+/- 100mV	+/-200mV	
Current tolerance <40% nominal current	5%	5%	5%	
Nominal current	10%	10%	10%	

9 Malfunctions And Errors

The System-Manager 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 in the System-Manager itself, but in the peripheral system components. The following description should be used as a helpful guide 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 symptoms covering the major part of all possible errors. Send in the System-Manager only when you are sure that none of the below-described errors has occurred.

The System-Manager is protected against damage by various measures. Nevertheless, always take utmost care in the proper operation of the System-Manager. Short hints of the malfunctions are indicated with the help of the LCD display. However, errors are only properly indicated in which the system has been properly installed. If there are other malfunctions than the ones described below, please check first of all if the System-Manager has been connected to the battery, the module and the loads correctly in the right polarity. Afterwards, check the safety fuses. In each case of malfunction, the System-Manager automatically switches off the load.

Error message / Symptoms	Meaning	Remedy
Defective fuses	Usually caused by wrong polarity at the battery connections	<ul style="list-style-type: none"> Check the proper polarity of the connections and after having fixed the error, install the spare fuses
The indication on the LCD display went out	<ul style="list-style-type: none"> There is no current or voltage feed from the battery, the reason could be a defective fuse current operating temperature is too high or too low above/below the operating temperature, causing LCD not to function 	<ul style="list-style-type: none"> Check the battery connections and fuses Check the working temperature Reinstall the System-Manager disconnect everything and connect it again in the right order
"module	The PV module current exceeds the max. currents allowed.	<ul style="list-style-type: none"> The solar PV array exceeds the

current"	Although this will not cause an immediate defect, the heat sink will become very hot and could cause injury. The load is disconnected in order to avoid further self-heating. After the current has decreased, the load will be reconnected automatically and the error message disappears.	nominal currents. The system must be split into smaller PV arrays units on separate System-Managers.
"load current"	<ul style="list-style-type: none"> 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 high surge appliances. A short circuit has been caused. After the problem has been solved, the System-Manager reconnects the load about 30 seconds later. 	<ul style="list-style-type: none"> Switch off some loads by hand Clear the short circuit
"over temperature"	The maximum allowable temperature has been exceeded. In order to reduce further heat generation the loads are disconnected automatically. As soon as the System-Manager has cooled down, normal operation will resume.	<ul style="list-style-type: none"> Check the ventilation at the back heat sink and clean it if necessary Protect the System-Manager from direct sunshine Reduce warming caused by appliances near the System-Manager Reduce the loads or PV modules.
"over voltage"	In particular, the recharge process through back-up generators or chargers tied directly to the battery causes voltages which are harmful for some appliances. Therefore these loads are disconnected when high battery voltages are present.	<ul style="list-style-type: none"> Disconnect external chargers adjust external chargers for less voltage
"low voltage"	To protect the battery, all loads powered by the System-Manager will be disconnected. They will be reconnected automatically after the battery voltage has reached the load reconnecting level.	<ul style="list-style-type: none"> Reduce loads or hours of operation of loads to keep the battery from being discharged deeply, or increase solar array to add energy to the system Connect all loads through the System-Manager to avoid strong discharge of the battery
"no module"	No module is connected, otherwise module, module internal blocking diodes, or array is defective.	<ul style="list-style-type: none"> Check contacts and junctions
	no module is connected but there is no detection of "no modul"	<ul style="list-style-type: none"> disconnect both wire (M+ and M-) at the terminal of the regulator wait up to 1 hour
"EEProm defect"	The EEPROM memory chip inside of the System-Manager cannot be read or accessed any longer by the System-Manager's circuitry.	<ul style="list-style-type: none"> Disconnect the System-Manager and reconnect it in the order described. If the indication remains, the System-Manager must return to the dealer for repair.
"self test failure"	The self-test could not be carried out correctly, since the solar PV array or the load was not disconnected, or one of the components in the System-Manager is defective	<ul style="list-style-type: none"> Disconnect all components, except the battery and try again. If the self-test still failed, the System-Manager should be sent to the dealer for service.
night	"Night" appears at daytime	<ul style="list-style-type: none"> wrong polarity module
	"Night" appears not at night only "no module"	<ul style="list-style-type: none"> string diodes block measurement 20kΩ parallel to string diode

10 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.



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