



User's and Installer's Manual

Charging Station for Photovoltaic Systems


PL2085



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1 Safety instructions and liability exclusion

1.1 Identification of safety instructions

In this manual safety instructions for personal security are identified by this symbol  and are in bold type.

Information concerning the operational security of the equipment is in bold type.

The manufacturer's safety instructions for additional components you may connect to this charging station must be observed and are not cancelled by these instructions. In the event of any contradictions between different sets of instructions please contact the specialist supplier.

1.2 About this manual

This manual describes the operation and installation of a charging station for photovoltaic solar units intended for feeding solar electricity into lead storage batteries

The relevant manufacturer's installation instructions must be observed for installing the solar cells and setting up the batteries.

Tip: Before starting work please read the section entitled **Installation** (Chapter 3; page 7). Ensure that all preparatory measures have been taken before installation.

Do not start installing the equipment until you are certain that you have understood the technical instructions and only carry out the work in the order specified in this manual!

The manual must be available, to third parties as well, during all work that is carried out on the system.

This manual is an integral part of the charging station and must be handed over when the station is disposed of.

1.3 General safety instructions

For your safety it is imperative that you observe the following instructions during installation:

Avoid sparking during all work!

Photovoltaic modules generate electricity when they admit light. The voltage is at its full level even with a low incidence of light, so exercise care when working and take appropriate safety precautions.

Voltages as high as double the system voltages, that is up to 48V, can occur during assembly and electrical installation in the photovoltaic system's direct current circuit.

 **Therefore: never touch bare lead ends!**

Only use properly insulated tools!

Do not use any measuring equipment you know to be damaged or defective!

The safety control inherent in the design of the charging station can deteriorate if it is operated in a manner not specified by the manufacturer.

Obstruction of the equipment ventilation can lead to overheating and thence to breakdown of the equipment. Do not cover ventilation openings and heat dissipators.

The charging station is only suitable for indoor use, where it is protected from the effects of the weather such as rain and direct sunlight. It must not be installed and operated in damp areas (e.g. bathrooms), or in rooms in which easily combustible gas mixtures can occur, such as from gas bottles, paints, varnishes, solvents, etc!

Do not store any of the above-named materials in rooms where the charging station is installed!

The notices and markings placed on the equipment at the factory must not be altered, removed or rendered indecipherable.

All work must be carried out in accordance with the national electrical requirements and the appropriate local regulations!

Where the equipment is installed abroad information must be obtained from the relevant institutions or authorities concerning regulations and safety control.

 **Keep children away from the control electronics and the battery area!**

1.4 Liability exclusion

We cannot accept responsibility for damage caused by disregarding these instructions. This also applies to the vicinity of the charging station and even if the damage occurs as a result of malfunctions of the charging station caused by incorrect installation.

The manufacturer cannot be responsible for supervising compliance with these instructions or monitoring conditions and methods employed during the installation, operation, use and maintenance of the charging station.

Incorrect installation can lead to damage to property and consequently can endanger persons. Such damage is the responsibility of the electrician.

We therefore accept no responsibility or liability for any loss, damage or costs resulting from, or in any way connected with faulty installation, incorrect operation and incorrect use or maintenance.

We likewise accept no responsibility for violations of patent law or the violation of any other rights of third parties that result from the use of this charging station.

The manufacturer reserves the right to make modifications regarding the product, technical data and assembly and operating instructions without giving prior notice.

The use of the charging station in areas of application not defined by the manufacturer is the responsibility of the user.



Caution: The guarantee will be invalidated if the equipment is opened or operated in any way that does not comply with the regulations.

2 Description of operation

The charging station controls the charging process of up to 8 batteries simultaneously, during which the batteries are fully charged as economically as possible.

The charging station is designed for batteries such as lead storage batteries with liquid electrolyte and with solid electrolyte (e.g. gel and flow batteries).

The charging station can be used for all photovoltaic modules.

2.1 General description

An intelligent control unit in which the adjustment, operation and display functions are carried out by a microprocessor, is an essential part of the 8-battery charging station. The batteries are charged as quickly as possible and also economically, in order of priority according to when they were connected and using the latest charging process. In addition an MPP-Tracking system enables optimum use to be made of the energy available. The power components consist exclusively of low loss MOS-FET transistors with a high switch life, guaranteeing a high level of efficiency through low power loss.

IU characteristic charging is carried out from a **battery voltage of 3V** with a cut-off voltage that is dependent on the temperature. Up to 4 channels can be connected in parallel with a corresponding increase in the charging current.

An LCD display supplies all the important information about the current load of the individual channels. A rotary switch is used for changing over between individual channels. The charging of all channels can also be interrupted by means of this rotary switch.

The charging equipment has reverse battery, open circuit and short circuit protection at all inputs and outputs. The battery output is also protected from overload.

2.2 Detailed description

2.2.1 Overcharge protection

The overcharge protection prevents uncontrolled gassing in the battery cells. The development of gas is dependent on the temperature of the acid and the cell voltage. The control unit therefore monitors the ambient temperature and adjusts the battery voltage accordingly. The overcharge protection, and therefore also the voltage limitation, is not dependent on the charge of the battery, as the dissociation of the electrolytes is only dependent on the voltage and the temperature. This means that charging is already limited, although the battery is not yet fully charged.

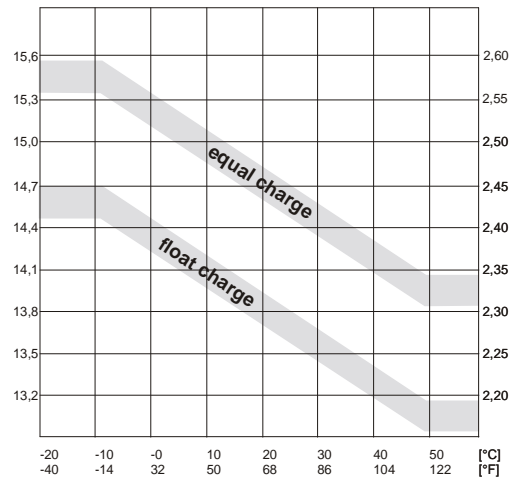
Overcharging of a battery leads to uncontrolled gassing. The electrolyte decomposes into oxygen and hydrogen. This results in harmful oxidation processes and mechanical damage because the gas bubbles pick up active material from the lead plates.

The uncontrolled gassing is worse still with closed batteries (e.g. gel and flow batteries) where the resulting gas pressure can destroy the battery housing. Frequent overcharging damages the battery storage capacity.

2.2.2 Cut-off voltage temperature tracking

With lead/acid batteries the optimum cut-off voltage decreases as the battery temperature increases. A constant setting for the cut-off voltage leads to uncontrolled gassing at higher battery temperatures. The temperature tracking lowers the cut-off voltage at high temperatures and increases it at lower temperatures.

The temperature is determined by a sensor integrated into the apparatus and the cut-off voltage is adjusted according to the reading. The integrated sensor is without maintain, and provided the control unit and batteries are situated in the same room it can be used anywhere.

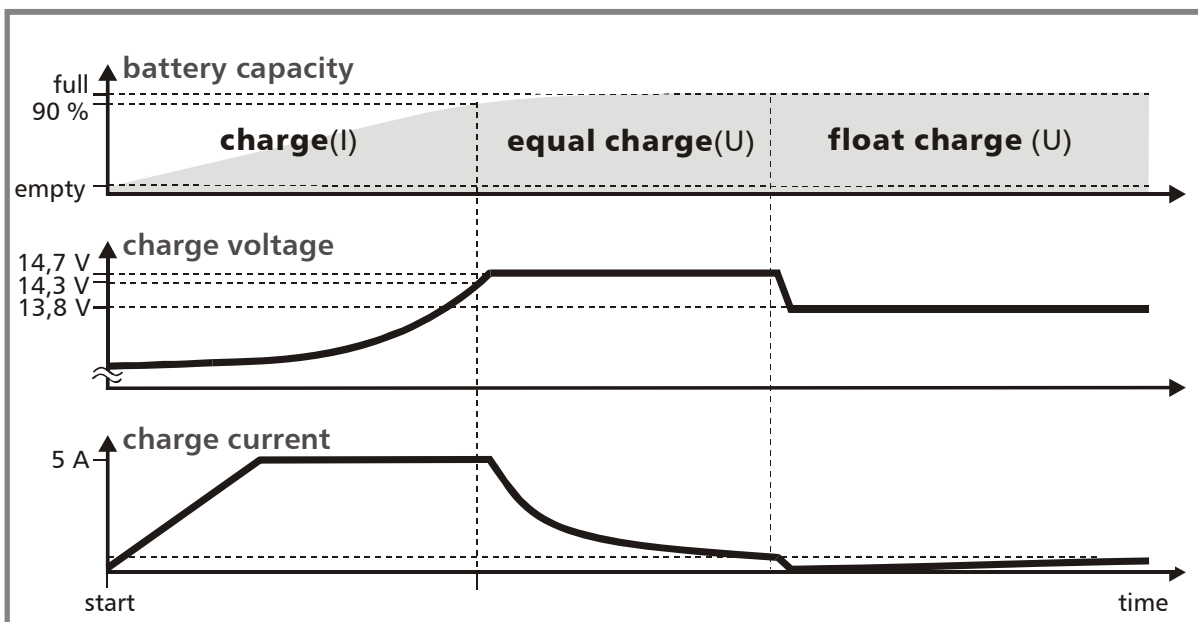


2.2.3 Charging procedures

The following charging characteristics apply to an ambient temperature of 20°C

2.2.3.1 Charging an intact battery

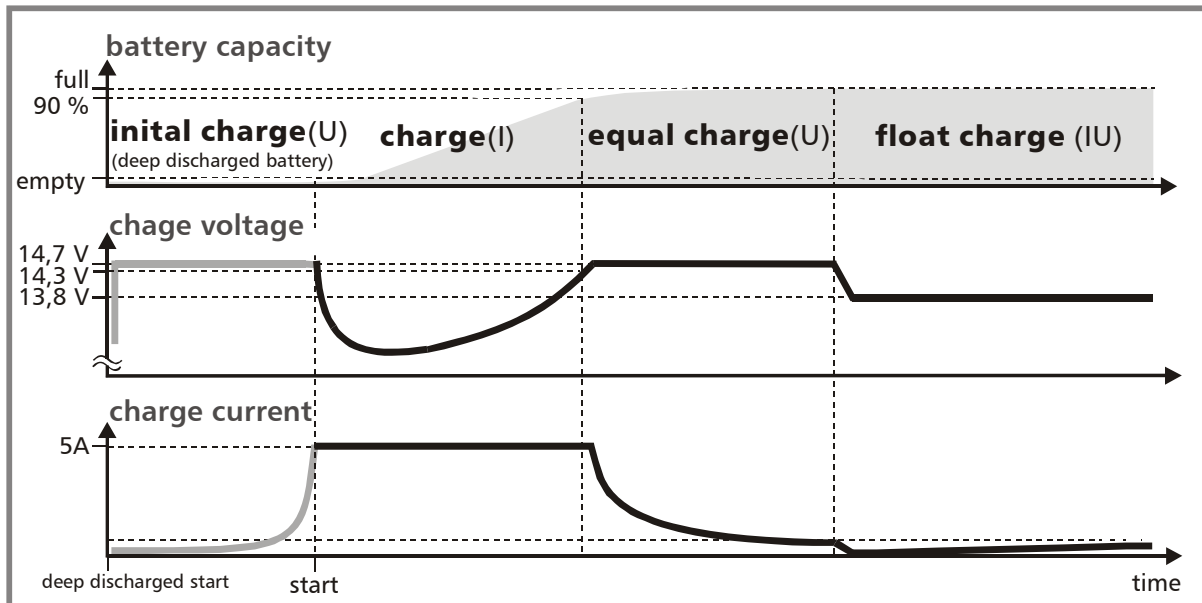
Provided enough energy is available and this battery is next in line as far as priority is concerned, the charging station starts charging an intact empty battery once it has been connected with up to 5A (first third of the characteristic curve). On reaching a voltage of 14.3V (at 20°C) the charging station moves into the equal charge phase (second third of the characteristic curve) in which it raises the cut-off voltage to 14.7V (20°C). After about 2 hours the control system moves from the equal charge phase into the float charge phase of 13.8V (at 20°C) (third third of the characteristic curve). The countdown for these 2 hours is only activated when the final charge voltage of 14,7V (at 20°C) can almost be maintained. During float charging the battery moves to the lowest priority. So the battery voltage can fall below 13.8V in this mode if too little energy is available. The charging station maintains the battery in float charge until it is disconnected. Thus any running down of the battery is compensated for.



2.2.3.2 Charging a previously damaged battery

Batteries previously damaged by deep discharge or by sulphating are characterised by a low quiescent voltage, poor current capacity and high internal resistance.

When the internal resistance of the battery measured by the charging station is over 200mΩ, the total duration of the initial and equal charging periods is set to 6 hours provided sufficient charging energy is available. During this period the battery voltage is limited to 14.7 V. After charging is completed a battery fault will be indicated on the display with details of the charged capacity (DEEP.DISCH.xxxAh).



2.2.3.3 Charging the wrong type of battery (e.g. 6 V) or a battery with cell closure

If the battery is still below 11.8V open circuit voltage after 5Ah of charged current then the charging process is halted. This is provided that the current available or specified via the priority was greater than 2A for a period of 15 minutes. A battery fault will then be indicated on the display with details of the charged capacity (BATT.DEF._CxAh).

2.2.4 Economy mode (Slow Down Mode)

When the module voltage falls below 21.5V the charging station changes to economy or night mode (Slow Down) and reduces its own consumption to about 35mA. In this mode the charging station draws its supply from a battery connected to it. This is necessary in order that important data such as the priorities and charging phases of the batteries charged during the day are not wiped out.

2.2.5 Charging in order of priority

The charging station charges the batteries connected to it in order of priority. This means that batteries are charged in the order in which they are connected. The battery that was connected first is also the first to be allocated to an available current. Any surplus energy will then be immediately passed on to the batteries that were connected next.

2.2.6 Ampere hour meter

The charging station determines the charged ampere hours from the charged current and the time that has passed. These are shown on the display. If the charging station is on float charge then the ampere-hours are no longer metered. Supplying details of the ampere-hours in this way enables the charging station operator to invoice the customer fairly. The customer only pays for the ampere-hours charged regardless of the state of the battery.

2.2.7 Rotary switch

The individual channels can be called up using the rotary switch. More detailed information on each selected channel then appears in the first line of the display. In addition the charging of all channels can be interrupted in the respective end positions of the rotary switch. This is essential when changing over batteries. Between both Channel 1 and Charge stop, and between Channel 8 and Charge stop there is an empty switch setting.

2.2.8 Display

A two-line display supplies information on important system parameters (see Chapter 4.1; Page 10).

The first line gives more detailed information on the channel selected by the rotary switch. The battery voltage, the present charging current and the capacity already charged are displayed. If there is a fault on the selected channel that too is displayed here (Chapter 7; Page 12).

In the second line all channels are represented at all times by a battery symbol. These battery symbols give information about the state of the respective channels. A small arrow in front of the battery symbol indicates which battery has been selected by the rotary switch.

The display works within a temperature range specified by the manufacturer. Outside this operating temperature range faults may occur, however these disappear again on return to within the specified range. The storage temperature range, however, must not be exceeded.

2.2.9 System voltage

On the battery side the charging station works with a system voltage of 12V and on the module side with 24V.

3 Installation

3.1 Precautionary measures

Do not install and operate PV components in rooms in which easily combustible gas mixtures can occur! Explosive electrolytic gas can be produced in the vicinity of the battery. For this reason ensure that the battery room is well ventilated and avoid sparking!



It is imperative that the following regulations for batteries are observed!

⇒ DIN VDE 0510 Part 2, Sections:

- 7. Precautions against the risk of explosion
- 8. Precautions against risks due to electrolyte (sulphuric acid)
- 9. Accommodation

⇒ National Electric Code with Article 690

3.2 Choice of location for installation

Ideally the charging station should be installed in the same well-ventilated room as the batteries (minimum clearance 30 cm) for the following reasons:

- An integrated temperature sensor reads the temperature inside the apparatus. The charging station calculates the ambient temperature, which is almost identical to the battery temperature
- The shortest possible cable routes should be observed in order to keep to a minimum the drop in voltage between charging station and battery, as well as between charging station and module.

Installation is only permissible in areas where the protective system of the charging station is adequate (see techn. data). The limits of the maximum permissible ambient temperature range must never be exceeded. The charging station must also not be installed and operated in damp areas (e.g. bathrooms), or in rooms in which easily combustible gas mixtures can occur, as from gas bottles, paints, varnishes, solvents, etc!

The charging station must be protected against the direct effects of the weather. Sunlight and warming due to nearby equipment must be avoided.



Batteries and charging station must be installed to be inaccessible to children and unauthorised persons. Therefore no precautionary measures have been taken in the design of the charging station to prevent access by unauthorised persons.



The surface on which the back of the charging station is to be mounted should not be of easily combustible material. The rear wall of the control unit (heat dissipator) heats up during operation due to dissipated energy. The place of installation should therefore be able to withstand a temperature of 85°C

3.2.1 Wall mounting

The back of the charging station must be mounted on a fireproof surface with the cable openings facing downwards. There must also be no flammable material underneath it when mounted.

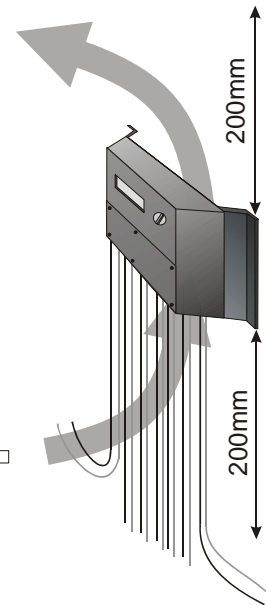
The charging station is designed for mounting on vertical walls. This is the only way the charging station can be adequately cooled by rising air (chimney effect) and so function properly. In order to ensure proper ventilation the charging station must not be obstructed. Clearance of at least 200mm must be observed.

3.2.2 Fixing the charging station

First mark the position of the holes with the enclosed drilling template, then drill holes and if required insert plugs into the wall. Screw all four screws into the wall leaving 8-10mm. Hang the charging station fixing plates onto the screws and tighten the screws.

⚠ The charging station must only ever be used as a marking template and never as a drilling template

Once the charging station has been screwed to the wall wiring can be commenced.



3.3 Cabling

3.3.1 General points

Photovoltaic modules generate electricity when they admit light. Even with a low incidence of light the voltage is at its full level. Provide the photovoltaic modules with a cover that is impervious to light, holding it in place with sticky tape. The modules can be rendered dead by covering them.

- Under no circumstances must the photovoltaic modules be switched to dead by means of a short circuit. Sparking will occur!
- Only use properly insulated tools!
- Never touch bare lead ends!
- Insulate immediately every bare lead end that is not going to be connected straight away!
- Only carry out installation work on a dry surface! Components (photovoltaic modules, cables etc.) must not be wet or damp during installation!
- It is imperative that correct polarity is observed during the cabling process!

N.B.:

Earthing of components in island units is not necessary, not usual or can be forbidden by national regulations (e.g. DIN 57100 Part 410 Ban on earthing protective low voltage circuits).

3.3.2 Cables required

(These measures only apply if no cable tree has been purchased.)

A plus and a minus cable, both round (\varnothing ca. 6.7mm), each with a cross section of 16mm² should be provided for the supply lines from the solar generator. Also the module junction box should not be more than ca. 15m away from the charging station.

A round cable (\varnothing ca. 7.5mm) should be provided for each battery with two isolated conductors for the plus and minus lines. Each isolated conductor should have a cross section of 2,5mm². Also the batteries should not be further than ca. 10m away from the charging station.

Before making a start on cabling check that the planned modules are suitable and have the correct circuits (check unit voltage of 24V).

3.3.3 Preparation

(These measures only apply if no cables have been purchased with the unit.)

in principle all the cables must be prepared before connection:

- Cut into sections
- Strip both ends and if necessary press on end sleeves or fit suitable pole shoes or holders for the batteries.

3.3.4 Connecting the cables to the charging station

It is imperative that all general safety instructions are observed (Chapter 1.3; Page 3).

It is imperative that the connection sequence described in this Chapter is observed, as this is the only way in which correct commissioning can be guaranteed

The following sequence of procedures must be adhered to without fail when connecting the charging station:

- Remove cover from terminals
- Make holes in ring seals (supplied) and slide over each round cable
- Connect battery cables to the terminal pairs on the charging station marked with the battery symbol (1-8). A pair of terminals (+ und –) is planned for each battery cable. It is imperative that correct polarity is observed. The middle terminal pair is intended for the module.
- Connect module cables to the middle terminal pair on the charging station - marked with the module symbol. Observe correct polarity.
- Place ring seal in the half-cup in the charging station housing.
- Screw terminal cover back on
- Now the batteries can be connected for charging.
- Tip: It is very helpful if the battery cables are marked at the end of the wire with the number of the relevant charging station channel

3.3.5 Removal

Removal should be carried out in reverse order of installation as described above. First disconnect all the batteries. Then the modules must be separated from the control unit. In order to avoid sparking, this must be carried out at night or with the modules covered.

3.4 Safety measures

3.4.1 Flammability

The charging station consists exclusively of non-flammable and self-extinguishing materials. A fire cannot be started even in situations where an unforeseen fault occurs provided no flammable substances are stored in the immediate vicinity of the charging station and the charging station is mounted on a fireproof surface.

3.4.2 Precision protection against surge voltage

Lightning protection was not provided in this charging station for reasons of cost and space. Lightning protection must be carried out when the equipment is installed and must be adapted to local conditions. Measures have, however, been taken to compensate for excess voltages in the atmosphere. The latter protection is adequate for this application.

3.4.3 Single and double errors

The charging equipment has reverse battery, open circuit and short circuit protection at all inputs and outputs. The battery output is also protected from overcharge. In addition the MPP-Tracking system prevents input overload.

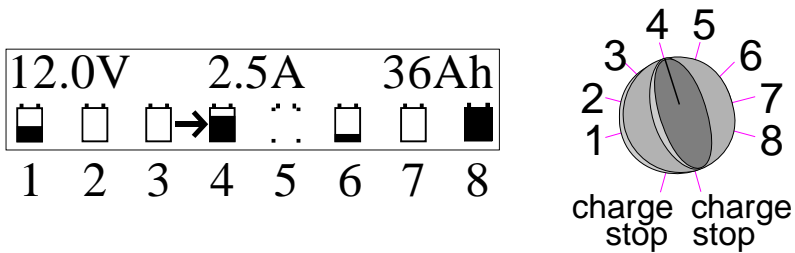
Suitable measures – mainly electronic – protect the charging station from single errors (e.g. reverse battery polarity reversal, module polarity reversal etc.).

However some double errors can lead to destruction of the control unit and components connected to it (batteries, modules):

- reversed poles module at a battery output
- an incorrect source (mains supply with 230V) at the solar input

4 Charging station operation

4.1 Display and rotary switch



The first line of the two line display shows information about the battery currently selected by the rotary switch. The state of all 8 channels is shown at all times in the second line.

The rotary switch has 12 settings of which 8 are assigned to the current channels, 2 are for the “CHARGE STOP” function, which interrupts charging on all channels, and 2 have no function assigned to them.

4.1.1 Description of first line of the display

The first line of the display always refers to the selected rotary switch setting.

When during normal operation a channel is selected with the rotary switch (setting 1-8), the first figure shown in the display is the present voltage, the second the present charging current and the third the capacity charged up to that point. If the selected channel is not connected then the display reads “OPEN BATTERY”. If there is a fault on the selected channel then this is also displayed (see Chapter 7; Page 12).


If the setting “CHARGE STOP” is selected with the rotary switch then “CHARGE STOP” is displayed and charging is interrupted on all channels.

The rotary switch positions next to “CHARGE STOP” have not been assigned a function and the display will read, “NO BATT SELECTED”. This means that the charging station is charging the batteries, but that no battery was selected for further information.

4.1.2 Description of second line of display

The charging and error states of the 8 channels are indicated in the second line of the display by means of a battery symbol. A small arrow appears before the battery symbol relating to the selected channel.

The significance of the individual battery symbols is as follows:

 no battery connected



Battery properly connected and ready for charging but no charging current allocated.



The battery is being charged, during which the battery symbol changes from $\frac{1}{4}$ through $\frac{1}{2}$ to $\frac{3}{4}$ full. Once a voltage of 14.3V is reached the charging station automatically switches to equal charging.



The battery is in the additional charging phase, during which the battery symbol changes from $\frac{1}{2}$ through $\frac{3}{4}$ to completely full. After 2 hours of equal charging at a max. voltage of 14.7V it is switched over to float charging.



The battery is fully charged and is in float charging. The battery symbol does not change. The battery moves to the lowest position in the order of priority and is kept at a voltage of 13.8V, provided there is sufficient available energy.



There is a fault with the connected battery (see Chapter 7; Page 12). This fault is described in more detail in the first line of the display when this channel is selected by the rotary switch.



The battery has been connected with the poles reversed. The display shows + and – alternately in front of the battery symbol concerned.

4.2 Sequence of operation



Caution: The charging station must be set to “Charge Stop” at the rotary switch before a battery is disconnected.

If installation has been correctly carried out and if the module is supplying a high enough voltage then the display works. The charging station is ready for operation. The empty batteries can now be connected. It is imperative that the correct polarity is observed.

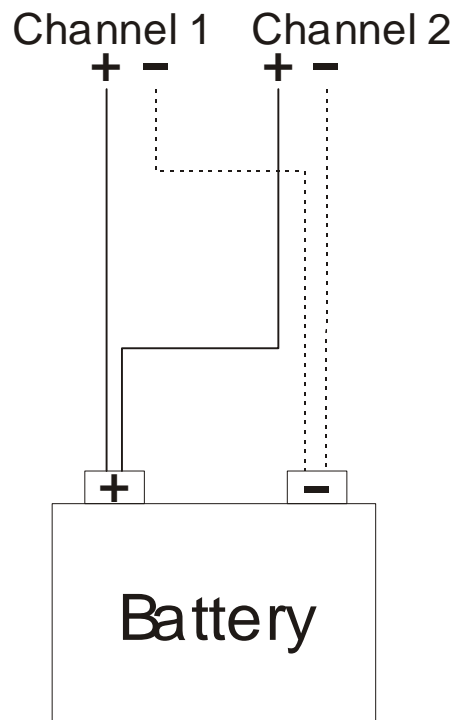
Open and closed lead storage batteries, and closed gel and flow batteries can be charged, whatever their charge.

Intended sequence of events:

- Before connecting a battery make sure that this channel shows at the display an empty battery symbol.
- Connect empty battery to a free channel
- Check the display for this channel to see that the battery symbol does not show any fault.
- The charging process starts automatically and is carried out by the charging station fully automatically provided the rotary switch is not set to “CHARGE STOP”. The battery that was connected first has priority and is charged first
- If the display shows a full, unchanging battery symbol, this means that this battery has finished charging.
- Turn the rotary switch to the same number as this full, unchanging battery symbol, and read off the ampere hours charged.
- Turn rotary switch to “CHARGE STOP” and disconnect the battery.
- Turn the rotary switch away from “Charge Stop” so that the other channels can be charged further.

The charging station determines the charged ampere-hours from the charged current and the time that has passed. These are shown on the display. If the charging station is on float charge then the ampere-hours are no longer metered. Supplying details of the ampere-hours in this way enables the charging station operator to invoice the customer fairly. The customer only pays for the ampere-hours charged regardless of the state of the battery, e.g. in €/Ah or \$/Ah, etc.

Block schematic diagram for parallel connection:



5 Maintenance

The charging station relies on its cooling surface in order to be able to fulfil its technical data requirements. The heat dissipator must therefore be inspected for dirt accumulation and cleaned if necessary.

Cables must be inspected from time to time for corrosion. Their contact resistance increases if they are corroded and the contacts can become so hot that faults can occur.




6 Technical data at 20°C

Description	PL 2085
Proposed size of solar generator	200Wp – 1,000Wp
Input voltage range	0V – 50V
System voltage	24V Module / 12V Battery
Nominal charging current	40A
Nominal charging current for each channel	5A
Max. 4 channels connected in parallel; nominal charging current	4x5A=20A
Float charge	13.8V
Equal charge	14.7V
Operating temperature range	-20°C...50°C
Storage temperature range	-20°C...70°C
Terminals	16/25mm ²
Weight	2Kg
Dimensions	365x277x75mm
Protection class	IP54

7 Malfunctions and fault finding

The charging station has been designed for many years of continuous use. Faults can however occur. The description of some common faults that follows should help the electrician and the operator to diagnose these faults, so that the system can be brought into operation as quickly as possible and unnecessary expense can be avoided. Of course not all possible causes of faults can be listed. However you will find here the most common causes of faults covering the greater proportion of the incidences of faults in connection with the charging station. Do not send the charging station in until you have established that the malfunction is not one of those described here.

The charging station is protected against destruction by a variety of measures. Nevertheless great care should be taken to ensure that the charging station is operated correctly. Some of the malfunctions are signalled by the display. However these faults can only be signalled if the system has been properly installed for them. If faults other than those described should occur, then please first check that the charging station is connected to the module and the batteries at the correct terminals and with the correct polarity.

Fault reporting on display		Meaning	Remedial action
No display		No current supply, electric power supply may be defective or it is night-time and there is no battery connected Ambient temperature <0°C Storage temperature above or below limits of range	<ul style="list-style-type: none"> Check connections Check if module is supplying current or if a battery is correctly connected Check operating temperature Install control unit again, disconnecting all batteries and module and connecting again in the correct order
OVERCURRENT GDN DISCONNECT ALL		Overcurrent was found at output, caused by incorrect procedure on connecting outputs in parallel	<ul style="list-style-type: none"> Install control unit again, disconnecting all batteries and module and connecting again in the correct order
Line 1	Line 2		
POLARITY ERROR		Battery was connected with reverse polarity	<ul style="list-style-type: none"> Check battery connection for correct polarity
BATT.DEF._C xxxAh		Defective battery or battery with incorrect nominal voltage e.g. 6V connected (see Chapter 2.2.3.3; Page 6)	<ul style="list-style-type: none"> this battery should be replaced observe nominal voltage of battery
DEEP.DISCH.xxxAh		A sulphated battery was connected with details of Ah already charged see Chapter 2.2.3.2; Page 6)	<ul style="list-style-type: none"> this battery is old or was deep discharged the owner of the battery should take precautions against deep discharge.

8 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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