**REV. 1.4**
**29/05/2020**

# HD32WSF.S12

## Solar panel battery charger

## ENGLISH

The quality level of our instruments is the result of the constant development of the product. This may produce some differences between the information written in this manual and the instrument you have purchased. We cannot completely exclude the possibility of errors in the manual, for which we apologize.

The data, images and descriptions included in this manual cannot be legally asserted. We reserve the right to make changes and corrections with no prior notice.

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# 1 DESCRIPTION

**HD32WSF.S12** is a solar panel power supply unit including a 12 Vdc / 7.2 Ah lead-acid battery and a charge regulator.

The power supply output of the unit is the unregulated voltage of the internal battery (nominal 12 V).

The unit is equipped with a NTC temperature sensor for monitoring the internal temperature and controlling the battery charging.

The **SDI-12** interface allows monitoring the temperature and the voltage of the internal battery and the voltage of the solar panel.

IP 65 housing for outdoor.

The unit is supplied with cable glands at the bottom of the housing for connecting the solar panel, the power supply output and the SDI-12 interface.

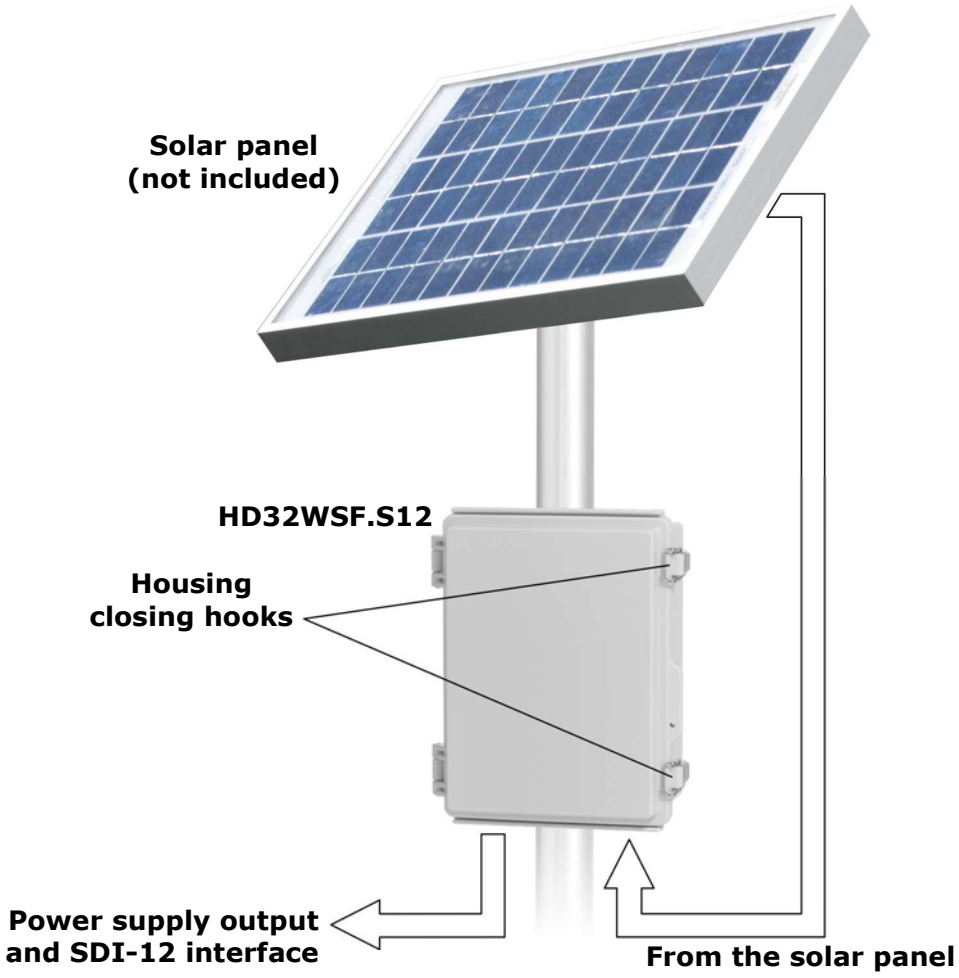



**Fig. 1.1: HD32WSF.S12 power supply unit**

# 2 ELECTRICAL CONNECTIONS

Open the housing of the power supply unit and connect the cables, through the cable glands at the bottom of the housing, to the terminals of the internal electronic board.

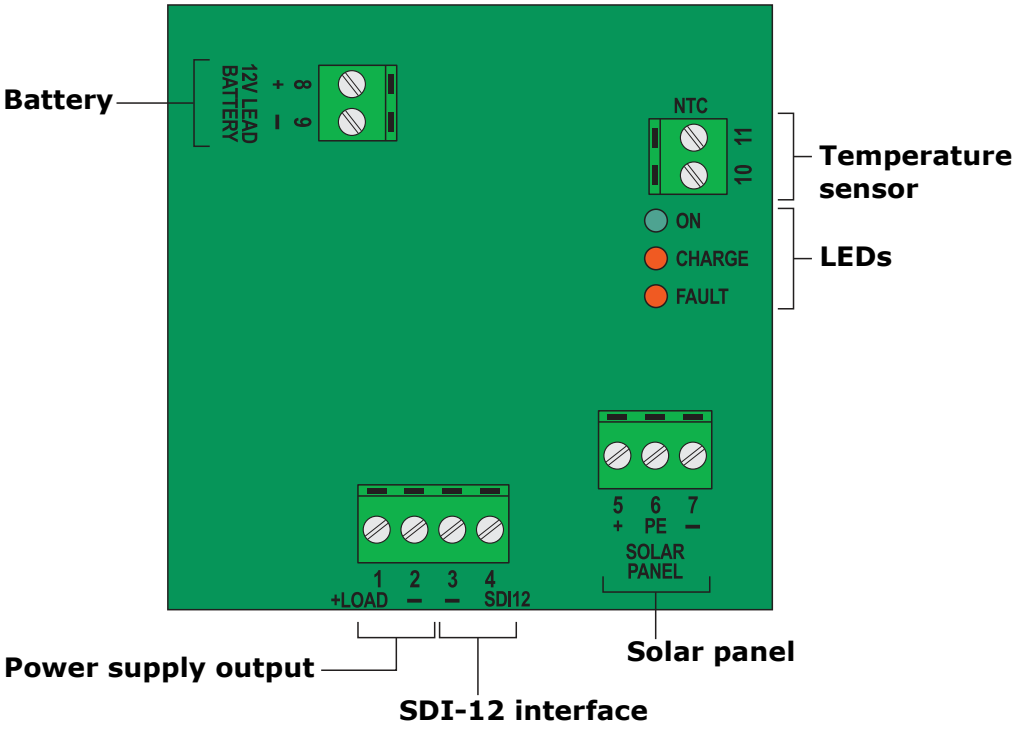



**Fig. 2.1: electronic board of HD32WSF.S12 unit**

| Terminal number | Description |
|---|---|
| 1 | Power supply output positive |
| 2 | GND (Power supply output and SDI-12 interface negative) |
| 3 | GND (Power supply output and SDI-12 interface negative) |
| 4 | SDI-12 line positive |
| 5 | Solar panel positive |
| 6 | Protective Earth (PE) |
| 7 | Solar panel negative |
| 8 | Battery positive |
| 9 | Battery negative |
| 10 | NTC temperature sensor |
| 11 | NTC temperature sensor |

**ON** LED: indicates that the board is powered

**CHARGE** LED: indicates that the battery is charging

**FAULT** LED: if the FAULT LED is on and the CHARGE LED is off, the battery is not working (it does not charge); if the FAULT and CHARGE LEDs are both on, the battery is working but the charging process is temporarily suspended because the operating limits for recharging the battery have been exceeded (for example, the measured temperature is higher than the maximum temperature, by default 50 °C, or lower than the minimum temperature, by default -15 °C, allowed for recharging).

## SDI-12 CONNECTION

More SDI-12 devices can be connected in parallel. The distance between a device and the acquisition system should not exceed 60 m. Before connecting the device to an SDI-12 network containing other devices, set the address by using the proper SDI-12 command.

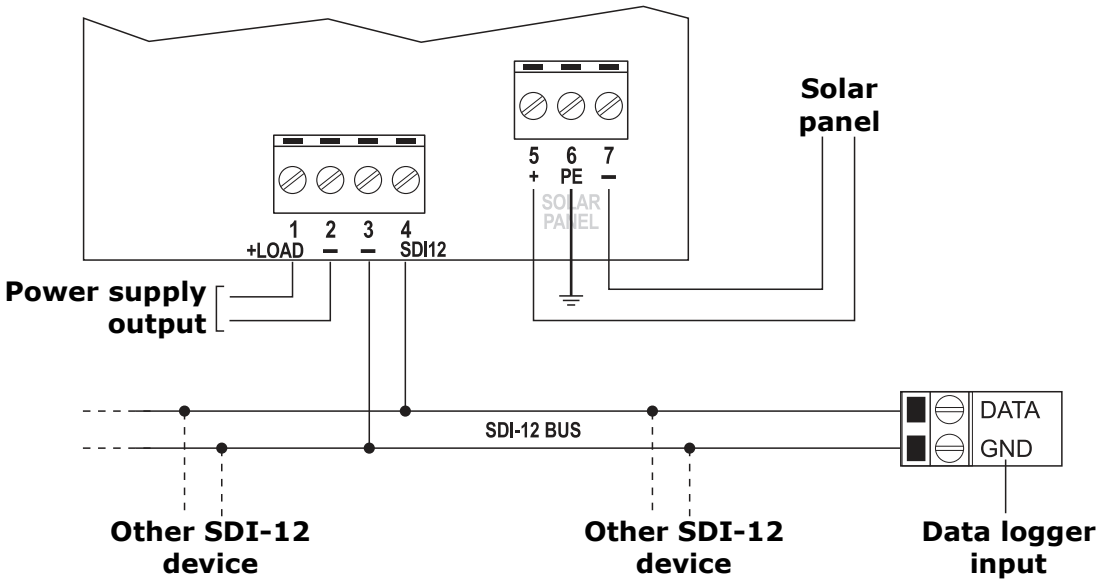



**Fig. 2.2: SDI-12 connection**

# 3 SDI-12 PROTOCOL

The **HD35WSF.S12** unit is in compliance with the version 1.3 of the protocol. The communication parameters of the protocol are:

- Baud Rate = 1200
- Data bits = 7
- Parity = Even (E)
- Stop bits = 1

Communication with the unit is performed by sending a command in the following format:

**<Address><Command>!**

With <Address> = address of the unit the command is sent to
<Command> = type of operation requested to the unit

The unit reply is as follows:

**<Address><Data><CR><LF>**

With <Address> = address of the replying unit
<Data> = information sent by the unit
<CR> = ASCII character *Carriage Return*
<LF> = ASCII character *Line Feed*

The available SDI-12 commands are shown below. For consistency with the documentation of the SDI-12 standard, the unit address is indicated with the letter **a**. The device leaves the factory with address preset to 0. The address can be changed by using the proper SDI-12 command.

**SDI-12 commands**

| Command | Instrument reply | Description |
|---|---|---|
| **a!** | a<CR><LF> | Verifies the presence of the unit. |
| **aI!** | allccccccccmmmmmmvvvssssssss<CR><LF><br>with:<br>a = address of the instrument (1 character)<br>ll = SDI-12 compliant version (2 characters)<br>cccccccc = manufacturer (8 characters)<br>mmmmmm = instrument model (6 characters)<br>vvv = firmware version (3 characters)<br>ssssssss = serial number (8 characters) | Requests for information from the unit. |
| **aAb!**<br>Where:<br>b =new address | b<CR><LF><br>Note: if the b character is not an acceptable address, the unit replies with a instead of b. | Modification of the unit address. |
| **?!** | a<CR><LF> | Request of the address of the unit. If more than one device is connected to the bus, a conflict occurs. |

| Command | Instrument reply | Description |
|---|---|---|
| **TYPE M (START MEASUREMENT) AND TYPE C (START CONCURRENT MEASUREMENT) COMMANDS** | | |
| **Solar panel and battery voltage, temperature and system status** | | |
| **aM!**<br>**aC!** | atttn<CR><LF><br>with: ttt = number of seconds necessary for the unit to make the data available (3 characters)<br>n = number of detected variables (1 character for aM!, 2 characters for aC!)<br>Note: ttt = 000 means that datum is immediately available. | Request to detect the solar panel voltage, the battery voltage, the temperature and the system status |
| **aD0!** | a+$V_P$+$V_B$+T+S <CR><LF><br>with:<br>$V_P$ = solar panel voltage in mV<br>$V_B$ = battery voltage in mV<br>T = temperature in the set unit of measurement<br>S = system status<br>S=0 ⇒ battery not in charge<br>S=1 ⇒ charging battery<br>S=2 ⇒ battery not working<br>S=3 ⇒ temperature outside the limits | Reads the solar panel voltage, the battery voltage, the temperature and the system status |
| **Solar panel and battery maximum and minimum voltage in the current charging sassion** | | |
| **aM1!**<br>**aC1!** | atttn<CR><LF><br>with: ttt = number of seconds necessary for the unit to make the data available (3 characters)<br>n = number of detected variables (1 character for aM!, 2 characters for aC!)<br>Note: ttt = 000 means that datum is immediately available. | Request to detect the solar panel and battery maximum and minimum voltage in the current charging session |
| **aD0!** | a+$V_{Pmax}$+$V_{Pmin}$+$V_{Bmax}$+$V_{Bmin}$ <CR><LF><br>with:<br>$V_{Pmax}$ = maximum solar panel voltage in mV in the current charging session<br>$V_{Pmin}$ = minimum solar panel voltage in mV in the current charging session<br>$V_{Bmax}$ = maximum battery voltage in mV in the current charging session<br>$V_{Bmin}$ = minimum battery voltage in mV in the current charging session | Reads the solar panel and battery maximum and minimum voltage in the current charging session |

| Command | Instrument reply | Description |
|---|---|---|
| **Solar panel and battery maximum and minimum voltage in the last charging sassion** | | |
| **aM2!**<br>**aC2!** | atttn<CR><LF><br>with: ttt = number of seconds necessary for the unit to make the data available (3 characters)<br>n = number of detected variables (1 character for aM!, 2 characters for aC!)<br>Note: ttt = 000 means that datum is immediately available. | Request to detect the solar panel and battery maximum and minimum voltage in the last charging session |
| **aD0!** | a+$V_{Pmax}$+$V_{Pmin}$+$V_{Bmax}$+$V_{Bmin}$ <CR><LF><br>with:<br>$V_{Pmax}$ = maximum solar panel voltage in mV in the last charging session<br>$V_{Pmin}$ = minimum solar panel voltage in mV in the last charging session<br>$V_{Bmax}$ = maximum battery voltage in mV in the last charging session<br>$V_{Bmin}$ = minimum battery voltage in mV in the last charging session | Reads the solar panel and battery maximum and minimum voltage in the last charging session |
| **Charge duration** | | |
| **aM3!**<br>**aC3!** | atttn<CR><LF><br>with: ttt = number of seconds necessary for the unit to make the data available (3 characters)<br>n = number of detected variables (1 character for aM!, 2 characters for aC!)<br>Note: ttt = 000 means that datum is immediately available. | Request to detect the duration of the current and last charging sessions |
| **aD0!** | a+$D_{CC}$+$D_{LC}$ <CR><LF><br>with:<br>$D_{CC}$ = duration of the current charging session in s<br>$D_{LC}$ = duration of the last charging session in s | Reads the duration of the current and last charging sessions |
| **Temperature limits for charging the battery** | | |
| **aM4!**<br>**aC4!** | atttn<CR><LF><br>with: ttt = number of seconds necessary for the unit to make the data available (3 characters)<br>n = number of detected variables (1 character for aM!, 2 characters for aC!)<br>Note: ttt = 000 means that datum is immediately available. | Request to detect the temperature limits for charging the battery |
| **aD0!** | a+$T_{max}$+$T_{min}$ <CR><LF><br>with:<br>$T_{max}$ = maximum temperature, in the set unit of measurement, for charging the battery<br>$T_{min}$ = minimum temperature, in the set unit of measurement, for charging the battery | Reads the temperature limits for charging the battery |

| Command | Instrument reply | Description |
|---|---|---|
| **TYPE R (CONTINUOUS MEASUREMENTS) COMMANDS** | | |
| **aR0!** | a+$V_P$+$V_B$+T+S <CR><LF><br><br>with:<br>$V_P$ = solar panel voltage in mV<br>$V_B$ = battery voltage in mV<br>T = temperature in the set unit of measurement<br>S = system status<br>S=0 ⇒ battery not in charge<br>S=1 ⇒ charging battery<br>S=2 ⇒ battery not working<br>S=3 ⇒ temperature outside the limits | Reads the solar panel voltage, the battery voltage, the temperature and the system status |
| **aR1!** | a+$V_{Pmax}$+$V_{Pmin}$+$V_{Bmax}$+$V_{Bmin}$ <CR><LF><br><br>with:<br>$V_{Pmax}$ = maximum solar panel voltage in mV in the current charging session<br>$V_{Pmin}$ = minimum solar panel voltage in mV in the current charging session<br>$V_{Bmax}$ = maximum battery voltage in mV in the current charging session<br>$V_{Bmin}$ = minimum battery voltage in mV in the current charging session | Reads the solar panel and battery maximum and minimum voltage in the current charging session |
| **aR2!** | a+$V_{Pmax}$+$V_{Pmin}$+$V_{Bmax}$+$V_{Bmin}$ <CR><LF><br><br>with:<br>$V_{Pmax}$ = maximum solar panel voltage in mV in the last charging session<br>$V_{Pmin}$ = minimum solar panel voltage in mV in the last charging session<br>$V_{Bmax}$ = maximum battery voltage in mV in the last charging session<br>$V_{Bmin}$ = minimum battery voltage in mV in the last charging session | Reads the solar panel and battery maximum and minimum voltage in the last charging session |
| **aR3!** | a+$D_{CC}$+$D_{LC}$ <CR><LF><br><br>with:<br>$D_{CC}$ = duration of the current charging session in s<br>$D_{LC}$ = duration of the last charging session in s | Reads the duration of the current and last charging sessions |
| **aR4!** | a+$T_{max}$+$T_{min}$ <CR><LF><br><br>with:<br>$T_{max}$ = maximum temperature, in the set unit of measurement, for charging the battery<br>$T_{min}$ = minimum temperature, in the set unit of measurement, for charging the battery | Reads the temperature limits for charging the battery |

In addition to the above-mentioned commands, the unit also implements the corresponding commands with CRC, that require to add a 3-character CRC code at the end of the reply before <CR><LF>. The format of these commands is obtained from the previous by adding the letter C: aMC!, aMC1!, aMC2!, aMC3!, aMC4!, aCC!, aCC1!, aCC2!, aCC3!, aCC4!, aRC0!, aRC1!, aRC2!, aRC3!, aRC4!.

For more information about the SDI-12 protocol, visit the website "www.sdi-12.org".

## EXTENDED SDI-12 COMMANDS

The extended SDI-12 commands allows setting the conditions for charging the battery, as for example the minimum and maximum temperature to allow charging the battery, etc.

**The charging parameters are already factory preset and optimized for the supplied battery. It is recommended not to change the parameters unless absolutely necessary. The modification of the parameters, if required, must be carried out by personnel with appropriate technical knowledge.**

The editing of the operating parameters requires sending a password via the command **aXDPWD***password***!** (**a** is the address of the power supply unit). By default, the password is not set (the *password* field is blank); therefore, it is sufficient to send the command **aXDPWD!** without password to change the parameters. To protect the parameters from unauthorized changes, it is advisable to set a password with the command **aXDSUP***password***!**.

For example, to set °F as temperature unit of measurement in the device with address 0, send:

0XDPWDmypass! *Sends the password (assuming password=mypass)*
0XDTUWF! *Sets °F*

The password remains active for 10 minutes, after which you must resubmit it.

In the commands described below, the column "PWD" indicates whether the execution of the command is password protected.

### Password

| Command | Description | PWD |
|---|---|---|
| **aXDPWD***x…x***!** | Sends the password *x…x* (8 characters max.).<br>Reply of the device:<br>USER ACCESS OK if the password is accepted<br>WRONG PASSWORD if the password is not accepted | --- |
| **aXDSUP***x…x***!** | Sets the string *x…x* (8 ASCII characters max.) as password.<br>Reply of the device:<br>PASS: *x…x* if the password is accepted<br>INVALID PASSWORD if the password is not accepted | Yes |

### Date and time

| Command | Description | PWD |
|---|---|---|
| **aXDDS***yyyy/mm/dd hh:mm:ss***!** | Sets the date *yyyy/mm/dd* (year/month/day) and the time *hh:mm:ss* (hour/minutes/seconds) in the device.<br>Reply of the device:<br>&\| if date and time are accepted<br>? if date and time are not correct | Yes |
| **aXDDG!** | Reads the date (year/month/day) and the time (hour/minutes/seconds) set in the device.<br>Reply of the device: *yyyy/mm/dd hh:mm:ss* | No |

### General info

| Command | Description | PWD |
|---|---|---|
| **aXDIR!** | Reads the manufacturer, the model, the firmware version and the serial number of the device.<br>Reply of the device: *v…vm…mf…fs…s*, with:<br>*v…v* (8 characters) = name of the manufacturer<br>*m…m* (6 characters) = model<br>*f…f* (3 characters) = firmware version<br>*s…s* (max. 13 characters) = serial number | No |

### Unit of measurement

| Command | Description | PWD |
|---|---|---|
| **aXDTUW***u***!** | Sets the temperature unit of measurement: *u*=C ⇒ °C, *u*=F ⇒ °F<br>Factory setting: °C.<br>Reply of the device:<br>&\| if the unit of measurement is accepted<br>? if the character *u* is not correct | Yes |
| **aXDTUR!** | Reads the unit of measurement of the temperature.<br>Reply of the device:<br>C if the unit of measurement is "°C"<br>F if the unit of measurement is "°F" | No |

### Temperature and voltage limits for charging the battery

| Command | Description | PWD |
|---|---|---|
| **aXDWTU***n…n***!** | Sets *n…n* as maximum temperature for charging the battery: the battery is not charged if the measured internal temperature is higher than *n…n*.<br>The value must be between +15.0 and +100.0 and is considered in the unit of measurement (°C o °F) set in the device.<br>Factory setting: +50.0 °C.<br>Example: 0XDWTU+40.0! sets +40 °C or +40 °F, depending on the unit of measurement set, as maximum temperature in the device with address 0.<br>Reply of the device:<br>&\| if the value *n…n* is accepted<br>? if the value *n…n* is not correct | Yes |
| **aXDGTU!** | Reads the maximum temperature for charging the battery. The value is considered in the unit of measurement (°C or °F) set in the device. | No |
| **aXDWTL***n…n***!** | Sets *n…n* as minimum temperature for charging the battery: the battery is not charged if the measured internal temperature is lower than *n…n*.<br>The value must be between -80.0 and +10.0 and is considered in the unit of measurement (°C o °F) set in the device.<br>Factory setting: -20.0 °C.<br>Example: 0XDWTL-5.0! sets -5 °C or -5 °F, depending on the unit of measurement set, as minimum temperature in the device with address 0.<br>Reply of the device:<br>&\| if the value *n…n* is accepted<br>? if the value *n…n* is not correct | Yes |

| Command | Description | PWD |
|---|---|---|
| **aXDGTL!** | Reads the minimum temperature for charging the battery. The value is considered in the unit of measurement (°C or °F) set in the device. | No |
| **aXDWVL***n…n***!** | Sets *n…n* as minimum voltage in mV for charging the battery at low temperature: the battery is not charged if it has voltage lower than *n…n* and the measured internal temperature is lower than the value set with the command **aXDWTVL…!**.<br>The value must be between 3000 and 15000 mV.<br>Factory setting: 10500 mV (10.5 V).<br>Example: 0XDWVL+10000! sets 10 V as minimum voltage in the device with address 0.<br>Reply of the device:<br>&\| if the value *n…n* is accepted<br>? if the value *n…n* is not correct | Yes |
| **aXDGVL!** | Reads the minimum voltage in mV for charging the battery at low temperature (lower than the value set with the command **aXDWTVL…!**). | No |
| **aXDWTVL***n…n***!** | Sets *n…n* as temperature below which the battery is not charged if it has voltage lower than the value set with the command **aXDWVL…!**.<br>The value must be between -80.0 and +10.0 and is considered in the unit of measurement (°C o °F) set in the device.<br>Factory setting: -15.0 °C.<br>Example: 0XDWTVL-10.0! sets -10 °C or -10 °F, depending on the unit of measurement set, as minimum temperature in the device with address 0.<br>Reply of the device:<br>&\| if the value *n…n* is accepted<br>? if the value *n…n* is not correct | Yes |
| **aXDGTVL!** | Reads the temperature below which the battery is not charged if it has voltage lower than the value set with the command **aXDWVL…!**. | No |

*Note on the minimum temperatures for charging the battery*: the command **aXDWTL***n…n***!** sets the temperature below which the battery is never charged, while the command **aXDWTVL***n…n***!** sets the temperature below which the battery is not charged only if it has voltage lower than a certain value (defined with the command **aXDWVL***n…n***!**).

### Enabling/disabling the battery charging

By default, the battery is charged as a function of the temperature and voltage limits set with the commands aXDWTU…!, aXDWTL…!, aXDWVL…! e aXDWTVL…!. The battery charging can be made independent from these limits, or permanently disabled.

| Command | Description | PWD |
|---|---|---|
| **aXDFCAS!** | Enables the battery charging regardless of the limits set with the commands aXDWTU…!, aXDWTL…!, aXDWVL…! and aXDWTVL…!).<br>Reply of the device: &\|<br>*Note*: enabling the charging is effective only if not explicitly disabled with the command aXDFCSS!. | Yes |

| Command | Description | PWD |
|---|---|---|
| **aXDFCAR!** | Cancels the command aXDFCAS! and re-enable the battery charging as a function of the temperature and voltage limits set with the commands aXDWTU…!, aXDWTL…!, aXDWVL…! e aXDWTVL…!. | Yes |
| **aXDFCAS!** | Permanently disables the battery charging.<br>Reply of the device: &\| | Yes |
| **aXDFCSR!** | Cancels the command aXDFCSS! and re-enable the battery charging. | Yes |
| **aXDGFCS!** | Reads the enable status of the battery charging.<br>Reply of the device: +*a*+*b*<br>*a*=0, *b*=0 ⇒ charging as a function of the set limits is enabled (default)<br>*a*=1, *b*=0 ⇒ charging regardless of the set limits is enabled<br>*a*=0, *b*=1 ⇒ charging is disabled<br>*a*=1, *b*=1 ⇒ charging is disabled (the command aXDFCSS! prevails) | No |

### Charging in case of dead battery

If the system detects that the battery is dead (it does not charge), the charging process is definitively stopped after a certain number of attempts (by default 5). The number of charging attempts before the final stop is configurable.

| Command | Description | PWD |
|---|---|---|
| **aXDAREE!** | Enables the recharging attempts in case of dead battery.<br>Reply of the device: &\| | Yes |
| **aXDARED!** | Disables the recharging attempts in case of dead battery.<br>Reply of the device: &\| | Yes |
| **aXDRARE!** | Reads the enable status of the recharging attempts in case of dead battery.<br>Reply of the device: +*r*<br>*r*=0 ⇒ recharging attempts disabled (default)<br>*r*=1 ⇒ recharging attempts enabled | No |
| **aXDWARN*n*!** | Sets *n* recharging attempts in case of dead battery. If *n*=0, the number of attempts is unlimited (and not zero attempts).<br>Factory setting: 5.<br>Reply of the device: &\| | Yes |
| **aXDRARN!** | Reads the number of recharging attempts in case of dead battery. | No |
| **aXDRARA!** | Reads the number of recharging attempts made until now. | No |
| **aXDARAR!** | Resets the number of recharging attempts made until now.<br>Reply of the device: &\| | Yes |

**Status**

| Command | Description | PWD |
|---|---|---|
| **aXDGSCF!** | Reads the device operating status.<br>Reply of the device: *+s+c+f*<br>*s*=0 ⇒ LED ON is off<br>*s*=1 ⇒ LED ON is on<br>*c*=0 ⇒ LED CHARGE is off<br>*c*=1 ⇒ LED CHARGE is on<br>*f*=0 ⇒ LED FAULT is off<br>*f*=1 ⇒ LED FAULT is on | No |

**Reset**

| Command | Description | PWD |
|---|---|---|
| **aXDHRS!** | Resets the electronic board. | Yes |

# 4 TECHNICAL CHARACTERISTICS

| | |
|---|---|
| **Input voltage** | 18…27 Vdc |
| **Charging current limit** | 1 A typical |
| **Output voltage** | 12 V unregulated from battery |
| **Output current** | 1,6 A max. |
| **Battery capacity** | 7.2 Ah |
| **Battery type** | Lead-acid |
| **Operating temperature** | -40…+60 °C |
| **Digital interface** | SDI-12 |
| **Dimensions** | 218 x 175 x 132 mm |
| **Material** | Polycarbonate |
| **Protection degree** | IP 65 |

# 5 UNIT STORAGE

Unit storage conditions:

- Temperature: -40...+60 °C.
- Humidity: less than 90 %RH no condensation.
- In storage, avoid places where:
    - the unit is exposed to a high temperature source;
    - high vibration levels are present;
    - the instrument may be exposed to vapor, salt and/or corrosive gas.

# 6 SAFETY INSTRUCTIONS

**General safety instructions**

The unit has been manufactured and tested in accordance with the safety standard EN61010-1:2010 "Safety requirements for electrical equipment for measurement, control and laboratory use" and has left the factory in perfect safety technical conditions.

The unit proper operation and operating safety can be ensured only if all standard safety measures as well as the specific measures described in this manual are followed.

The unit proper operation and operating safety can be ensured only in the climatic conditions specified in this manual.

Do not use the unit in places where there are:

- Corrosive or flammable gases.
- Direct vibrations or shocks to the unit.
- High-intensity electromagnetic fields, static electricity.

**User obligations**

The unit operator shall follow the directives and regulations below that refer to the treatment of dangerous materials:

- EEC directives on workplace safety.
- National law regulations on workplace safety.
- Accident prevention regulations.

# 7 ORDERING CODES

**HD32WSF.S12** Solar panel power supply unit. Includes a 12 Vdc / 7.2 Ah lead-acid battery and a charge regulator. The power supply output is the un-regulated voltage of the internal battery. SDI-12 interface. IP 65 housing. Fixing accessories included.

**NOTES**

## NOTES

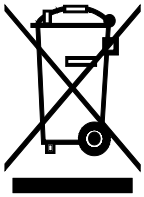
**WARRANTY**

The manufacturer is required to respond to the "factory warranty" only in those cases provided by Legislative Decree 6 September 2005 - n. 206. Each instrument is sold after rigorous inspections; if any manufacturing defect is found, it is necessary to contact the distributor where the instrument was purchased from. During the warranty period (24 months from the date of invoice) any manufacturing defects found will be repaired free of charge. Misuse, wear, neglect, lack or inefficient maintenance as well as theft and damage during transport are excluded. Warranty does not apply if changes, tampering or unauthorized repairs are made on the product. Solutions, probes, electrodes and microphones are not guaranteed as the improper use, even for a few minutes, may cause irreparable damages.
The manufacturer repairs the products that show defects of construction in accordance with the terms and conditions of warranty included in the manual of the product. For any dispute, the competent court is the Court of Padua. The Italian law and the "Convention on Contracts for the International Sales of Goods" apply.

**TECHNICAL INFORMATION**

The quality level of our instruments is the result of the continuous product development. This may lead to differences between the information reported in the manual and the instrument you have purchased.
We reserves the right to change technical specifications and dimensions to fit the product requirements without prior notice.

**DISPOSAL INFORMATION**



Electrical and electronic equipment marked with specific symbol in compliance with 2012/19/EU Directive must be disposed of separately from household waste. European users can hand them over to the dealer or to the manufacturer when purchasing a new electrical and electronic equipment, or to a WEEE collection point designated by local authorities. Illegal disposal is punished by law.

Disposing of electrical and electronic equipment separately from normal waste helps to preserve natural resources and allows materials to be recycled in an environmentally friendly way without risks to human health.

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