

WaterBox Solar System

Installation and Operating Manual



THINK TO INNOVATE

Index

1. Introduction to the solar water system.....	3
2. Safety Instruction.....	5
3. Stocking conditions.....	7
4. Packing continent.....	7
5. Mounting system installation.....	9
5.1 Identification of the parts.....	9
5.2 Definition of the layout.....	10
5.3 Frames/Racks assembly.....	11
5.4 Frames/Racks and solar modules installation.....	12
5.5 Fixation of the anchors.....	14
6. Solar modules installation.....	15
6.1 General warning.....	15
6.2 Electrical layout.....	16
6.3 Cables and wirings.....	16
6.4 Electrical connection of the modules.....	17
6.5 Maintenance of the modules.....	17
7. Pump installation.....	19
7.1 Introduction to the 4hs Multipower submersible pumps range.....	19
7.2 General warning.....	20
7.3 General technical features.....	20
7.4 Installing pump in the well.....	21
7.5 Pump cable.....	21
7.6 Use of the waterproof connection kit.....	21
8. Cables and cabinets installation.....	24
8.1 View of the product and connection.....	24
8.2 Internal connection.....	25
8.3 Positions of the switch.....	26
8.4 Installation of the connectors.....	26
9. Troubleshooting.....	28

1. Introduction to the solar water system

Dear Customer, thanks for buying this solar water system.

WATERBOX is a complete “plug&play” solution for the most simple installation of a solar borehole pumping system

The 4hs pump: the heart

The 4hs pump is a multisource submersible, all in one pump. The pumping unit includes the centrifugal pump, the motor and the inverter.

Each component of the pumping unit has been developed for ease of use and absolute minimum maintenance requirements:

Only stainless steel AISI 304 for maximum durability.

- Water rotor motor conceived with respect for the environment.
- Built in inverter for a maintenance free system even in situations of temperature fluctuations.
- Only one cable for both DC and AC power supply.
- High water flow performance ratio.
- Developed and made completely in Vicenza (Italy).

Photovoltaic modules: the engine

- Designed specifically for 4hs pumps. We developed and made solar modules with the right output voltage and current to work in perfect harmony with our multisource pumps.
- Strong alloy profiles for high mechanical resistance and 4 mm tempered, shock resistant glass.
- Dimensions and weight designed to be transported easily in any van or pickup.

Tree mounting system: the idea

A patented Italian idea to mount the PV modules free-standing with just a hammer. No need for any machinery or special tools and no need for special ballast to allow for high wind effect.

We just looked at nature!... And we fix our structure in the same way a tree fixes itself: with the roots.

Forget the tools

Inside the WATERBOX you will find all the tools and accessories necessary to assemble the system:

- DC cables
- IP65 switch with supplementary input for existing AC generators (if any)
- Clean, contaminants free cable certified for drinking water uses
- Waterproofing connection kit
- Fast DC and AC connectors
- Tool kit with hammer, keys, screwdrivers

2. Safety instructions and general warning

PV Line does not assume responsibility and expressly disclaims liability for losses, damages, or expenses arising out of, or in any way connected with this Installation and User Manual.

The information in this manual is believed to be reliable, but does not constitute an expressed or implied warranty.

PV Line reserves the right to make changes to the products, their specifications, or this manual without prior notice.

PV Line is not liable for any damages caused by inappropriate installation, use, or maintenance of PV modules, and other equipment, including without limitation damages, losses, and expenses caused by non-observance of the instructions of this manual or caused by or in connection with products of other manufacturers.

PV modules are designed to meet the requirements for the standards IEC 61215 and IEC 61730, application class A.. Modules are made observing IEC 61730-1 and IEC 61730-2 and within this application class are considered to meet the requirements for safety class II.

Failure to comply with the requirements listed in this manual will invalidate the Limited Warranty for PV Modules as provided by PV Line at the time of sale to the direct customer. Additional recommendations are provided to enhance safety practices and performance results. Please provide a copy of this manual to the PV system owner for their reference, and inform them of all relevant aspects of safety, operation, and maintenance

Electrical

PV modules can produce current and voltage when exposed to light of any intensity. Electrical current increases with higher light intensity. DC voltage of 30 Volts or higher is potentially lethal. Contacting the live circuitry of a PV system operating under light can result in lethal electric shock.

De-energize PV modules by removing them entirely from light or by covering their front surface with an opaque material. Regard the safety regulations for live electrical equipment when working with modules that are exposed to any light. Use insulated tools and do not wear metallic jewelry while working with PV modules

In order to avoid arcing and electrical shock, do not disconnect electrical connections under load. Faulty connections can also result in arcing and electrical shock. Keep connectors dry and clean, and ensure that they are in proper working condition. Never insert metallic objects into the connectors, or modify them in any way in order to secure an electrical connection.

Do not touch or handle PV modules with broken glass, separated Frame/racks or a damaged backsheet unless the PV modules are first disconnected and you are wearing proper PPE.

Avoid handling PV modules when they are wet unless cleaning the PV modules as directed in this manual. Never touch electrical connections that are wet without protecting yourself with insulated gloves



We strongly suggests to reading carefully this operation manual before using and installing its products

Any operation (installation, maintenance and repair) must be carried out by trained, skilled and qualified personnel.

Failure to observe and follow the instruction of this manual may result fatal in dangerous electric shock.

Solar modules work with high voltage DC power. The voltage is present even there is a really low irradiation on the modules surface.

KEEP CHILDREN OUT OF THE SYSTEM AND ALL OF ITS PARTS

 	<p>Solar modules have high DC voltage</p> <p>The system must be installed by qualified personnel</p> <p>The unit must be connected to the power supply by a switch granting the complete visual disconnection (separation) from the line before any operation.</p> <p>Disconnect the unit from the power supply before any operation.</p> <p>4HS MP and pump system must be grounded properly before any operation.</p> <p>Do not start the pump for any reason if not completely immersed in water.</p>
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3. Stocking conditions

- Solar modules contain tempered glass. Please move and manage carefully.
- Store the product on its packaging in a dry and well ventilated environment within a temperature range from -20 ° C and 70 ° C.
- If the pump remains in stock for more than a year is recommended to disassemble the rotating parts and test their functionality. It 'also need to power the electric pump (without running the motor) to allow charging of electrolytic capacitors of the inverter module.
- If the pump has already been put into operation and is then placed in storage, the minimum storage temperature is 4 ° C. Alternatively you need to add anti-freeze fluid.

4. Packing content

NAME	DESCRIPTION	PIECES 12mod./6mod
Mounting system – Top Frame/racks	Frame/racks - identification part TREE001	8 (4)
Mounting system – Bottom Frame/racks	Frame/racks - identification part TREE002	8 (4)
Mounting system – Connection	Connection - identification part TREE003	8 (4)
Mounting system – Base of modules	Base of the modules on the Frame/racks – TREE004	24 (12)
Mounting system – Middle clamps	Middle clamp - identification part TREE005	8 (4)
Mounting system – End clamps	End clamp - identification part TREE006	16 (8)
Mounting system - Screws	Screws M8 x 70 - identification part TREE007	48 (24)
Mounting system – Screws	Screws M8 x 35 - identification part TREE008	64 (32)
Mounting system – Nuts	Nuts - identification part TREE009	112 (56)
Mounting system – Anchor pole	60 cm poles - identification part TREE010	56 (28)

**(number) identify the number
of pieces for the WaterBox
versions with 12 or 6 solar
modules**

NAME	DESCRIPTION	PIECES
------	-------------	--------

Photovoltaic module	VPS-4hs-225W photovoltaic module, Sizes 1517 x 997 x 40mm	12 (6)
4hs Solar pump	Model inserted: ()	1
4hs waterproof kit	Connection kit for submersed cable	1
Cabinet AC/DC	IP65 Electrical cabinet with fast connectors and switch input1/input2/output	1
Solar cable Red	Solar cable 4mm , 30 meters	1
Solar cable Black	Solar cable 4mm , 30 meters	1
“Drinking cable”	Drinking cable 3 x 2.5mm, 50 meters	1
Connectors	MC IV fast connectors	8 (4)
Tools kit	Tool kit with: 1 screwdriver, 1 hammer, 1 allen key	1
Instruction manual	Instruction manual. Language: english	1

**(number) identify
the number of pieces for the WaterBox
versions with 12 or 6 solar modules**

5. Mounting system Installation

5.1 Identification of the parts



TREE001 - Top Frame/rack



TREE002 - Bottom Frame/rack



TREE003 - Connection



TREE004 - Module base



TREE005 - Middle Clamp



TREE006 - End clamp



TREE007
Screw M8 x 70



TREE008
Screw M8 x 35



TREE009 - Nut M8

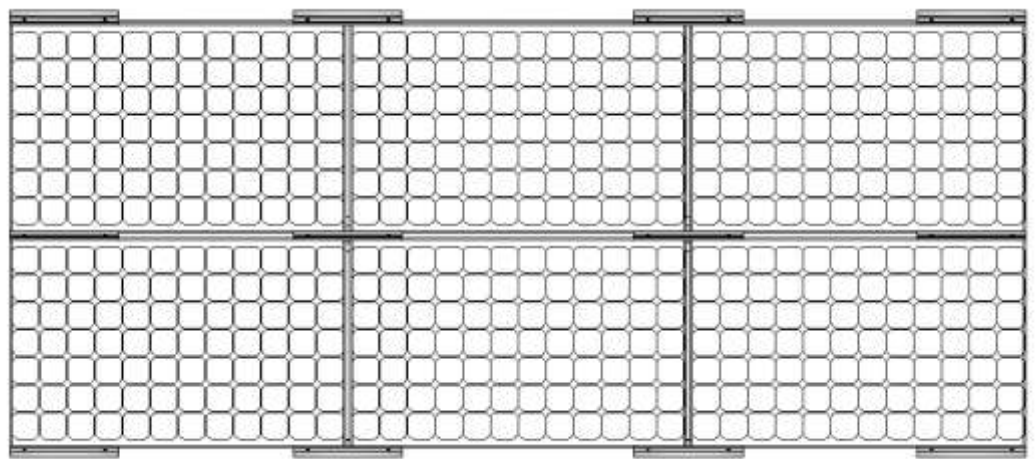


TREE010 - Anchor

5.2 Definition of the layout

The mounting system is given to build arrays by six (6) modules each. For application with twelve modules we suggest the construction of two separate arrays

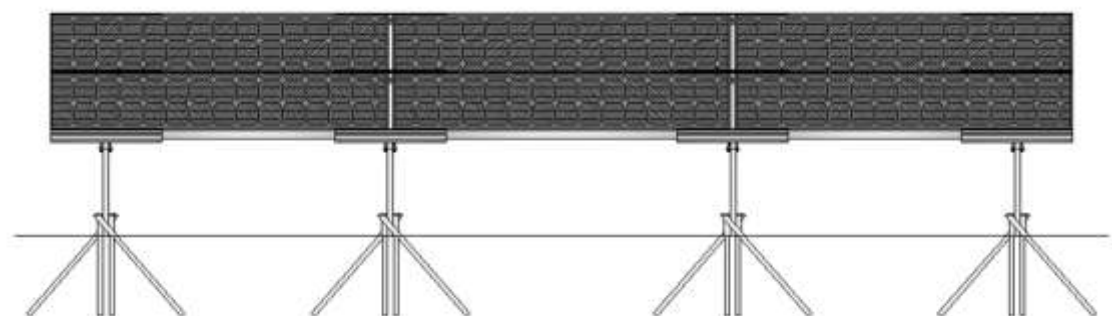
Top View



Lateral View



Frontal View



5.3 Frame/racks assembly

Assembling of the Frame/racks

Connect the top Frame/rack and the bottom Frame/rack using the connector and the M8 x 35 screws + M8 nuts as showed in the picture.

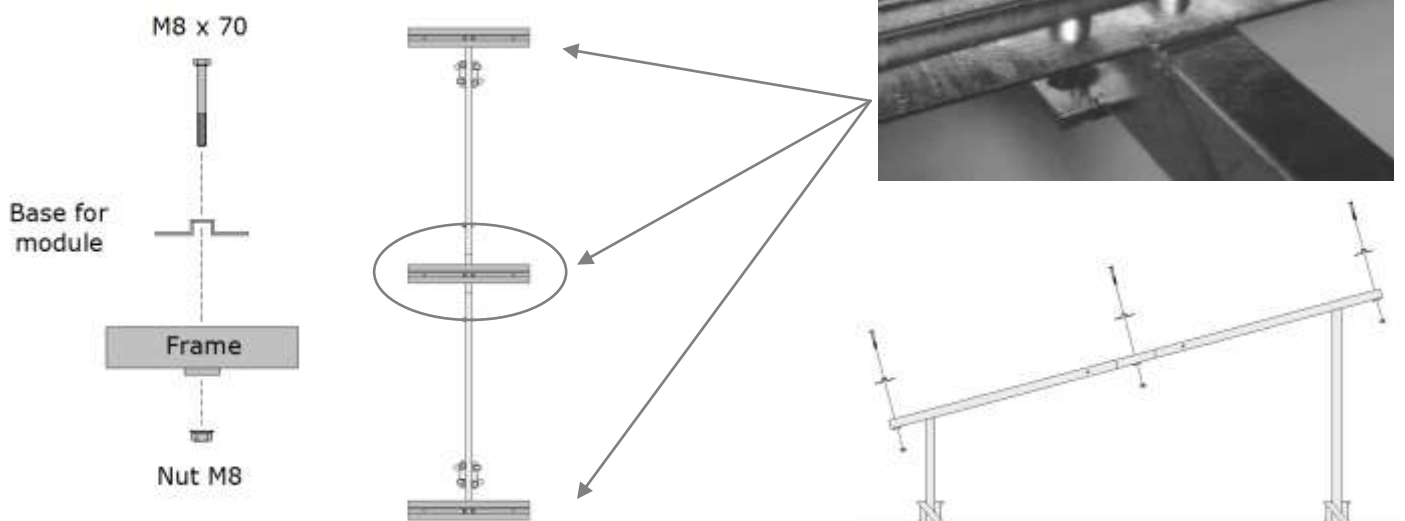
The welded plate has to be in the bottom side



Fixation of the modules bases

Please install the parts referred TREE004 as showed in the pictures below with M8 x 70 screws

Any complete Frame/rack needs three (3) bases for modules



Positioning of the Frame/racks

Please leave the Frame/racks on the ground ready to be installed together with the modules

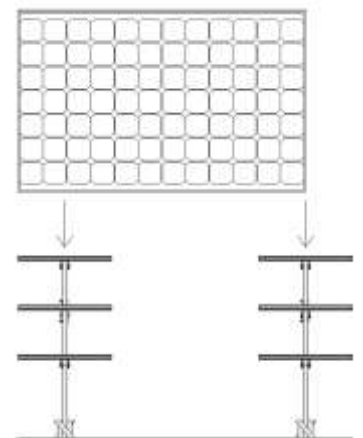


5.4 Frame/racks and solar modules installation

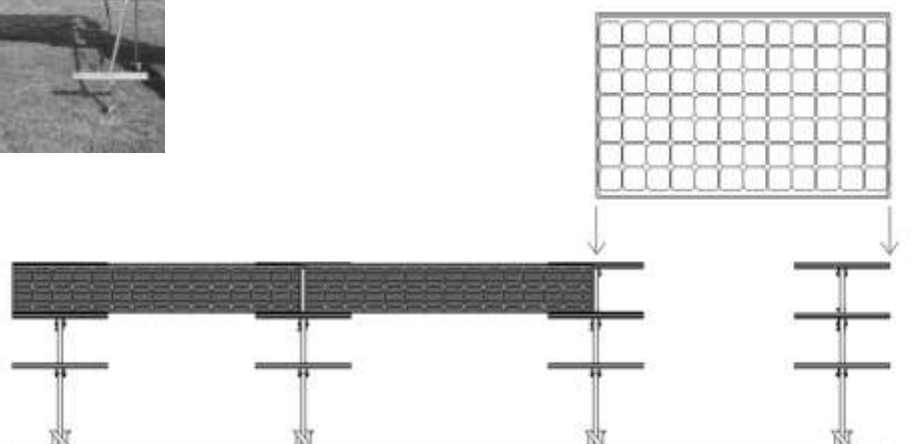
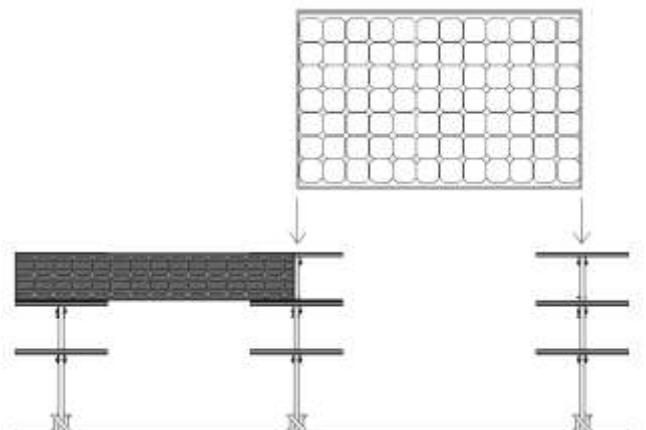
Positioning of the first Frame/rack

The distance between the Frame/racks is derived from the width of the PV module. Please place vertically the first Frame/rack of structure and align the PV module with the base for modules and find the position of the second Frame/rack

Solar modules have to be installed in landscape orientation

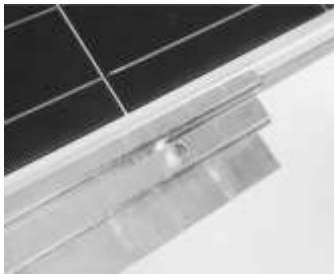


After fasten the first module to the Frame/rack as shown below, please place the third Frame/rack and the second module and so on

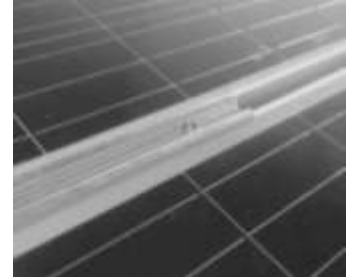


Note! Please pay attention at the right position of each Frame/rack (see the previous picture)

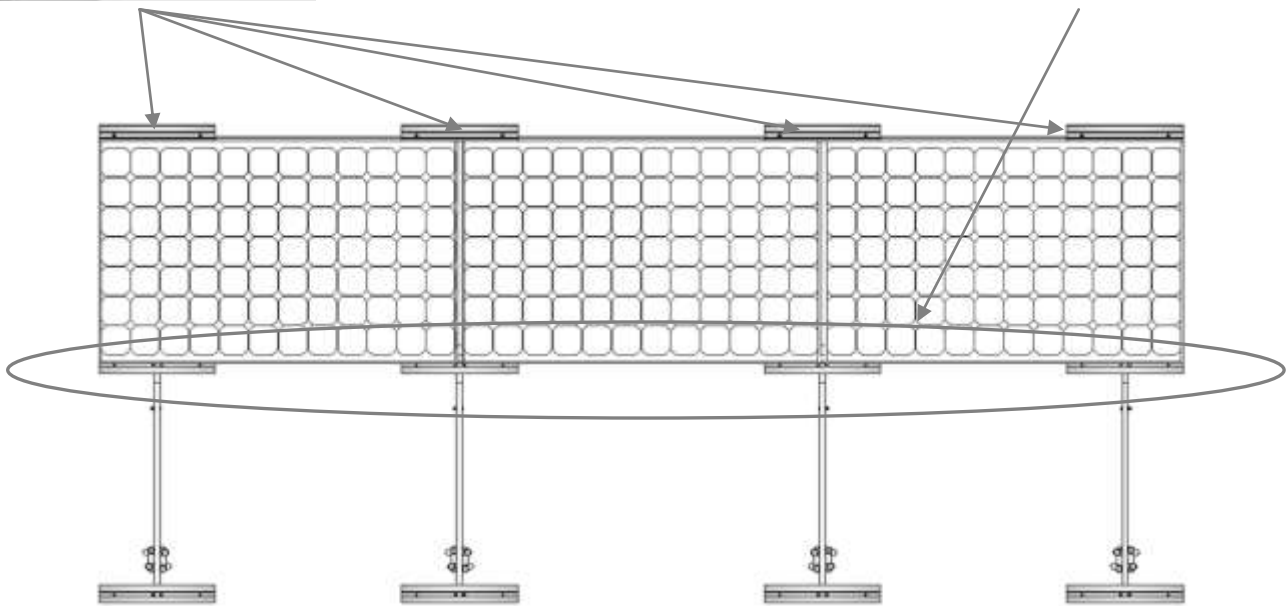
Install as first, the three modules in the top row, using the end clamps and the middle clamps as in the below picture with M8 x 35 screws



end
clamps



middle
clamps



Note! Before installing the second row, please fix strongly the structure trough the anchors to avoid any impact of the hammer with the modules. Then, install the second row of modules

Read below, how to fix the anchors



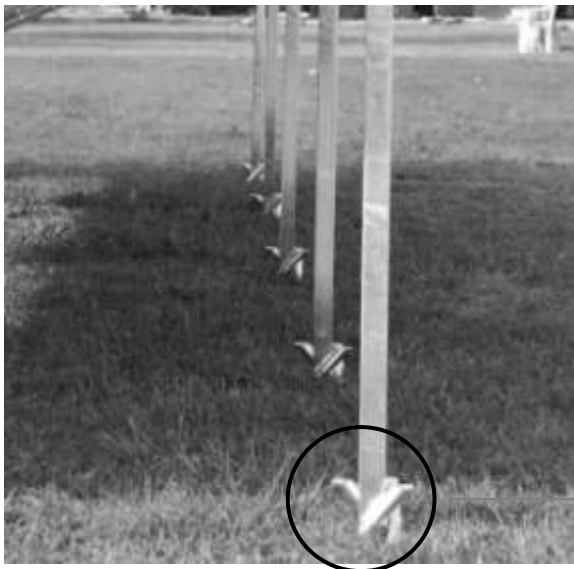
Note! The system include a total of 8 complete Frame/racks for systems which use twelve (12) solar modules and four (4) complete Frame/racks for systems which use 6 solar module. This amount allows to create separated arrays by 6 modules each. In case of need to create one single array by 12 modules the total number of racks needed is 7

5.5 Fixation of the anchors

Using the hammer included in the tool kit, please insert the anchor as showed in the below picture



Before



After



The structure, normally stabilizes itself after two months.

!! Please refer to the declaration of conformity for maximum loads admitted !!

6. Solar modules installation

6.1 General warning

PV modules are designed to meet the requirements for the standards IEC 61215 and IEC 61730, application class A.. Modules are made following IEC 61730-1 and IEC 61730-2 and within this application class are considered to meet the requirements for safety class II.

PV modules can produce current and voltage when exposed to light of any intensity. Electrical current increases with higher light intensity. DC voltage of 30 Volts or higher is potentially lethal. Contacting the live circuitry of a PV system operating under light can result in lethal electric shock.

De-energize PV modules by removing them entirely from light or by covering their front surface with an opaque material. Regard the safety regulations for live electrical equipment when working with modules that are exposed to any light. Use insulated tools and do not wear metallic jewelry while working with PV modules

In order to avoid arcing and electrical shock, do not disconnect electrical connections under load. Faulty connections can also result in arcing and electrical shock. Keep connectors dry and clean, and ensure that they are in proper working condition. Never insert metallic objects into the connectors, or modify them in any way in order to secure an electrical connection.

Do not touch or handle PV modules with broken glass, separated Frame/racks or a damaged backsheet unless the PV modules are first disconnected and you are wearing proper PPE.

Avoid handling PV modules when they are wet unless cleaning the PV modules as directed in this manual. Never touch electrical connections that are wet without protecting yourself with insulated gloves

We strongly suggests to reading carefully this operation manual before using and installing its products

Any operation (installation, maintenance and repair) must be carried out by trained, skilled and qualified personnel.

Failure to observe and follow the instruction of this manual may result fatal in dangerous electric shock.

Solar modules work with high voltage DC power. The voltage is present even there is a really low irradiation on the modules surface.

6.2 Electrical layout



Under normal conditions, a photovoltaic module is likely to experience conditions that produce more current and/or voltage than reported at Standard Test Conditions (STC: 1000 W/m², AM 1.5, and 25°C cell temperature).

The short-circuit current (ISC) should be multiplied by a factor of 1.25 and the open-circuit voltage (VOC) should be multiplied by a factor of up to 1.25 based on the lowest ambient temperature recorded for the installation location when determining component voltage ratings, conductor current ratings, fuse sizes, and size of controls connected to the PV output.

Voltages are additive when PV modules are connected directly in series, and module currents are additive when PV modules are connected directly in parallel, as illustrated in Figure 5.

PV modules with different electrical characteristics must not be connected directly in series. The use of suitable third-party electronic devices connected to PV modules may enable different electrical connections and must be installed according to the manufacturer's specified instructions.

6.3 Cables and wiring

PV modules are provided with two (2) stranded, sunlight resistant output cables that are terminated with PV connectors ready for most installations. The positive (+) terminal has a female connector while the negative (-) terminal has a male connector. The module wiring is intended for series connections [i.e. female (+) to male (-) interconnections], but can also be used to connect suitable third-party electrical devices that may have alternative wiring configurations so long as the manufacturer's instructions are followed. Use field wiring with suitable cross-sectional areas that are approved for use at the maximum short-circuit current of the PV module. Product recommend installers use only sunlight resistant cables qualified for direct current (DC) wiring in PV systems. The minimum wire size should be 4mm².

Cables should be fixed to the mounting structure in such a way that mechanical damage of the cable and/or the module is avoided. Do not apply stress to the cables. For fixing, use appropriate means, such a sunlight resistant cable ties and/or wire management clips specifically designed to attach to the PV module Frame/rack. While the cables are sunlight resistant and waterproof, where possible, avoid direct sunlight exposure and water immersion of the cables.

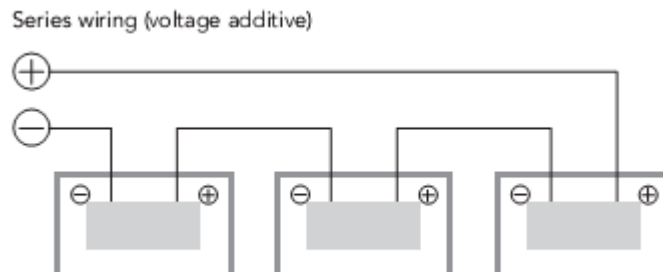
Connectors

Keep connectors dry and clean, and ensure that connector caps are hand tight before connecting the modules. Do not attempt making an electrical connection with wet, soiled, or otherwise faulty connectors. Avoid sunlight exposure and water immersion of the connectors. Avoid connectors resting on the ground or roof surface.

Faulty connections can result in arcs and electrical shock. Check that all electrical connections are securely fastened. Make sure that all locking connectors are fully engaged and locked.

6.4 Electrical connection of the system

All the modules must be connected in series as showed in the below image



Connect the cables to the electrical cabinet as last installing operation, to avoid any use under presence of voltage

Use the ties to tie the cables

6.5 Maintenance of the modules

PV Line recommends that PV systems be periodically inspected by the installer, or other qualified person.

The purpose of the PV system inspection is to ensure that all system components are functioning properly.

At a minimum, this inspection should confirm the following:

- All cables and connector attachments are undamaged and properly secured
- No sharp objects are in contact with the PV module surfaces
- PV modules are not shaded by unwanted obstacles and/or foreign material
- Mounting and grounding components are tightly secured with no corrosion

Cleaning

Over time, dirt and dust can accumulate on the glass surface of the module, reducing its power output. PV Line recommends periodic cleaning of PV modules to ensure maximum power output, especially in regions with low precipitation.

In order to reduce the potential for electrical and thermal shock, Producer recommends cleaning PV modules during early morning or late afternoon hours when solar radiation is low and the modules are cooler, especially in regions with hotter temperatures.

Never attempt to clean a PV module with broken glass or other signs of exposed wiring, as this presents a shock hazard.

Clean the glass surface of the PV modules with a soft brush using soft, clean water with a recommended pressure less than 690kPa, which is typical of most municipal water systems. Water with high mineral content may leave deposits on the glass surface and is not recommended.

PV Line PV modules may contain a hydrophobic anti-reflective coating on the glass surface to enhance power output and reduce dirt and dust buildup. In order to avoid module damage, do not clean PV modules with a power washer or pressure washer. Do not use steam or corrosive chemicals to facilitate the cleaning of modules. Do not use aggressive tools or abrasive materials that could scratch or damage the glass surface.

Failure to comply with these requirements may adversely affect the PV module performance.

PV Line PV modules are designed to withstand high snow loads.

However, if removing snow is desired to enhance production, use a brush to gently remove snow. Do not try to remove frozen snow or ice from PV modules

7. Pump installation

7.1 Introduction to the 4HS MultiPower submersible pumps range

4HS MultiPower (4HS MP) is a 4" centrifugal submersible pump for clean water composed by:

- three phase motor with wet rotor and canned type resin filled stator.
- Built-in inverter on board.
- Multi stage pump entirely made of AISI 304 stainless steel.

Pump driving made by inverter allows:

- Modify the pump speed. In this way the pump is operated only and when needed thus avoiding unnecessary waste of energy and granting longer system life.
- Implement the soft start and the soft stop to increase the system life and reducing the current peaks.
- Protect the motor from overloading and dry running , overvoltage, undervoltage and possible abnormal conditions.

4HS is used on residential and industrial sectors for water pressurized systems, granting:

- Energy saving.
- Simplified and quick installation.
- Long life reliability.

4HS MultiPower pumps can be fed both AC and DC with wide margins of operating voltage (90-265 VAC or 90-340 VDC). This means that the same pump can be powered by photovoltaic panels, by wind or diesel generator or by batteries. The hydraulic performance will be adjusted automatically according to the power source and the power available.

In the application with photovoltaic panels an MPPT algorithm maximizes, for various conditions of irradiation and temperature, the electric power obtained from the panels thus the amount of water extracted.

Pump speed is adjusted in relation to solar irradiation. When solar irradiation increases, pump will run faster thus pumping more water. When solar irradiation decreases (clouds moving or different hours of the day) pump will reduce its frequency and so delivery but it continues pumping till solar irradiation reaches the minimum value necessary for working.

4HS MultiPower pumps can be installed with or without the surface control module.

When installed, the CM MultiPower monitors and records:

- Running hours.
- Input voltage, current and power.
- Alarms: dry running, overload, overvoltage.



Digital inputs make it possible to connect a float switch, a pressure switch, a start and stop signal, etc...

Running and alarm status are given by two digital outputs.

7.2 General warning

We strongly suggests to reading carefully this operation manual before using and installing its products Any operation (installation, maintenance and repair) must be carried out by trained, skilled and qualified personnel.

Failure to observe and follow the instruction of this manual may result fatal in dangerous electric shock.

	<p>The unit must be connected to the power supply by a switch granting the complete visual disconnection (separation) from the line before any operation.</p> <p>Disconnect the unit from the power supply before any operation.</p>
	<p>4HS MP and pump system must be grounded properly before any operation.</p> <p>Do not start the pump for any reason if not completely immersed in water.</p>

Avoid any shock or serious impact during transportation.

Damages due to transportation, incorrect installation, or improper use of the device will null and void the warranty.

7.3 General technical features

PUMP 4HS	
Max. temperature of pumped liquid	35 °C (92 °F)
Min. speed of water flow on motor case	0.2 m/s
Characteristics of pumped liquid	clean, non-corrosive, non-explosive, free of particles and fibers, with a maximum sand content of 50 g/m ³
Grade of protection	IP68
Used Materials	Impellers and diffusers in AISI 304 stainless steel
Cable	Flat cable ACS – WRAS

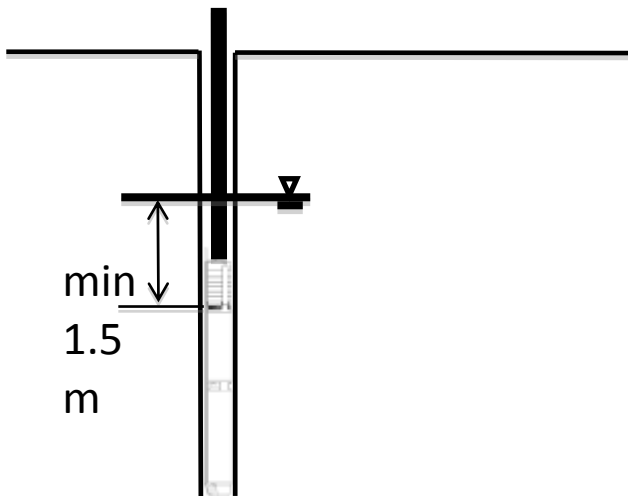
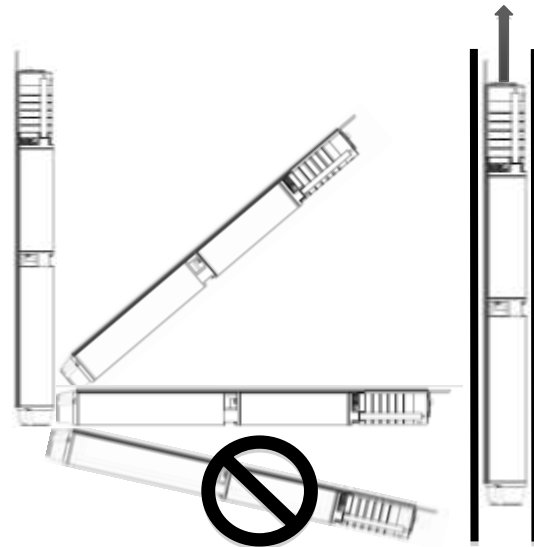
7.4 Installing pump in the well



Entire installation procedure must be performed verifying that pump is not connected to the power supply.

Pump can be installed both vertically and horizontally, but the outlet should never be below the horizontal line. Minimum head of 10% than max pump head must be granted.

If the pump is not installed in a well, to grant a proper cooling, a cooling sleeve must be used; doing so the minimum speed of the pumped liquid has to be granted.



To reduce noise transmission it is advised to use plastic pipes.

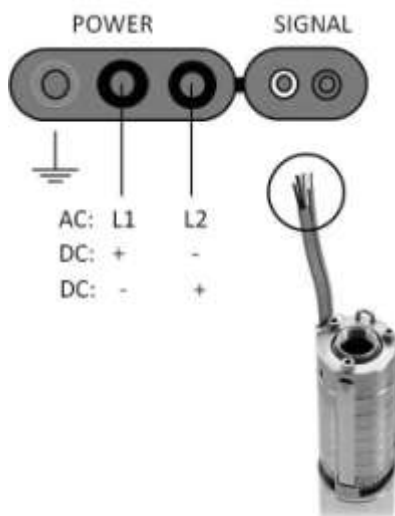
The pump must always be secured in the well through a special rope attached to loop on the pump head. It is recommended not to drop the pump in the well by using the electric cable, its integrity must be preserved in all operations. In this regard it is recommended to fix the cable on cable support or on the pipe. During operation the pump suction must always remains at least 1.5 meters below the dynamic water level.



**Do not drop the pump in the well by using the electric cable
Make sure about the electric cable integrity during all the operations.
Ensure the pump in the well with a stainless steel rope to be fixed to the hole in the pump head**

7.5 Pump cable

4HS MultiPower are equipped, in their standard configuration, with 2,5 meter flat cable length.



4HS MP pump communicates with CM MP (surface control module) (if installed) by signal wires. If CM is not installed it's recommended to insulate signal wires.



To make the junction is necessary to follow carefully the instructions inside the kit.

At the time of joining and electrical connection is essential to maintain the correspondence between the signal cables.

After cable joining and placed the pump in the well you must perform, before connecting to power supply, a test of insulation: join together the two power cables and, applying a voltage of 500V, an insulation resistance from the ground higher than 100 Mohm must be verified. Join together the two signal cables and, applying a voltage of 500V, an insulation resistance from the ground higher than 100 Mohm must be verified.

7.6 Use of the waterproof connection kit

This kit allows the connection between the power conductors, the ground conductor and signal cables in the jacketed cable from the pump to the drop cable coming from the CM control module.

The junction, when properly performed, provides:

- Electrical continuity in the power phases and the ground wire
- Electrical continuity in the two signal wires,
- Insulation between the phases, between each phase and ground, and between each phase and the signal wires
- Watertight seal up to a maximum depth of 150 m / 500 ft submergence.

The kit consists of:




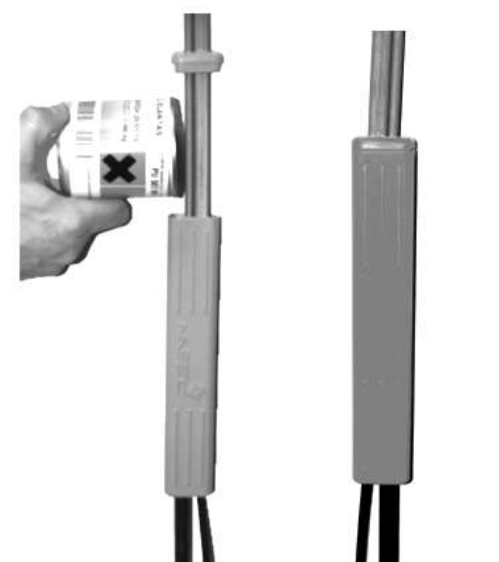
- qty. 3 connectors for cables up to 2.5 sq. mm / 14 AWG (signal) in red.
- qty. 5 connectors for cables up to 2.5 sq. mm / 14 AWG (power) in blue.
- qty. 5 connectors for cables up to 6 mm² / 10 AWG (power) in yellow.

The type of connector used corresponds to the section of cable that you are joining (see Sections table in the installation and operating manual).

- A resin container sleeve (with cap on the cable jacket) to contain and protect the junction and casting resin.
- A jar of resin, a jar of hardener, and a mixing palette.

Regardless of the section being joined, the minimum diameter of the cable junction should be (in order to prevent leakage of the sealing resin during the casting) 12mm / 1/2 in. for the power cable (big hole) and 8 mm / 5/16 in. for the signal cable (small hole).

Procedure for proper splicing

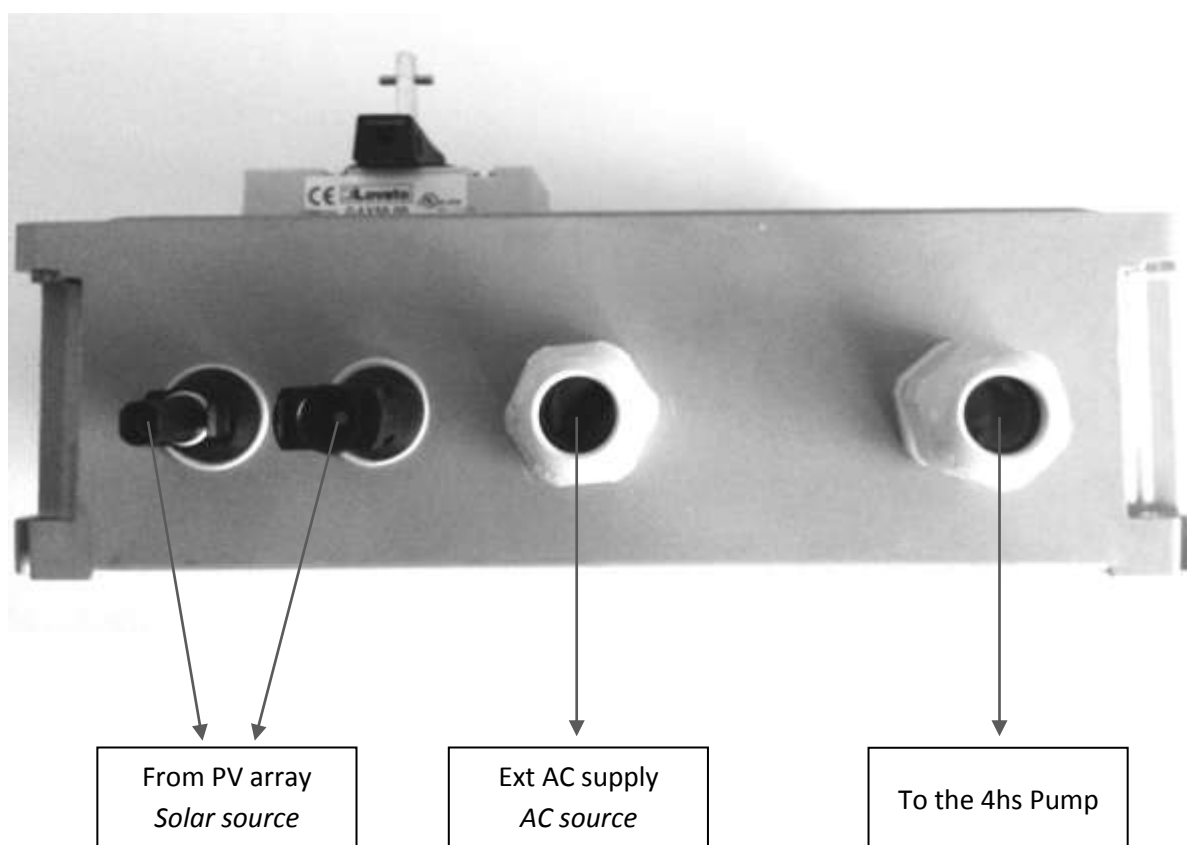
Slide the resin container cap over the pump lead wire jacket oriented as shown. Strip the wires from the jacket to a length of 50 mm / 2 in. and cut into staggered lengths as shown. Strip the ends of the pump lead wires and the drop cable wires.	
Slide the orange resin container sleeve onto the two drop cables (power and signal) as shown. Make the connection between the pump lead wires and drop cables with the crimp connectors provided.	
Pulling from the drop cables, slide the orange resin container sleeve so that it is centered over the electrical connections.	
Orient the junction so that it is upright with the drop cables facing down and the pump lead cable facing up.	
Pour the epoxy resin into the catalyst and mix thoroughly using the mixing palette.	
Pour the resin mixture into the orange resin container sleeve to within approximately 10 mm / 1/4 in. of the top.	
Slide the resin container cap down the pump lead cable to close the orange resin container sleeve.	
Wait at least 3 hours (with an ambient temperature above 16 ° C / 60 ° F) before moving the joint.	

After completing the connection, the integrity and continuity of the ground connection must be checked prior to use. A resistance measurement taken between the motor housing / pump and the ground terminal of the cable connection must provide a value of less than 3 Ohm.

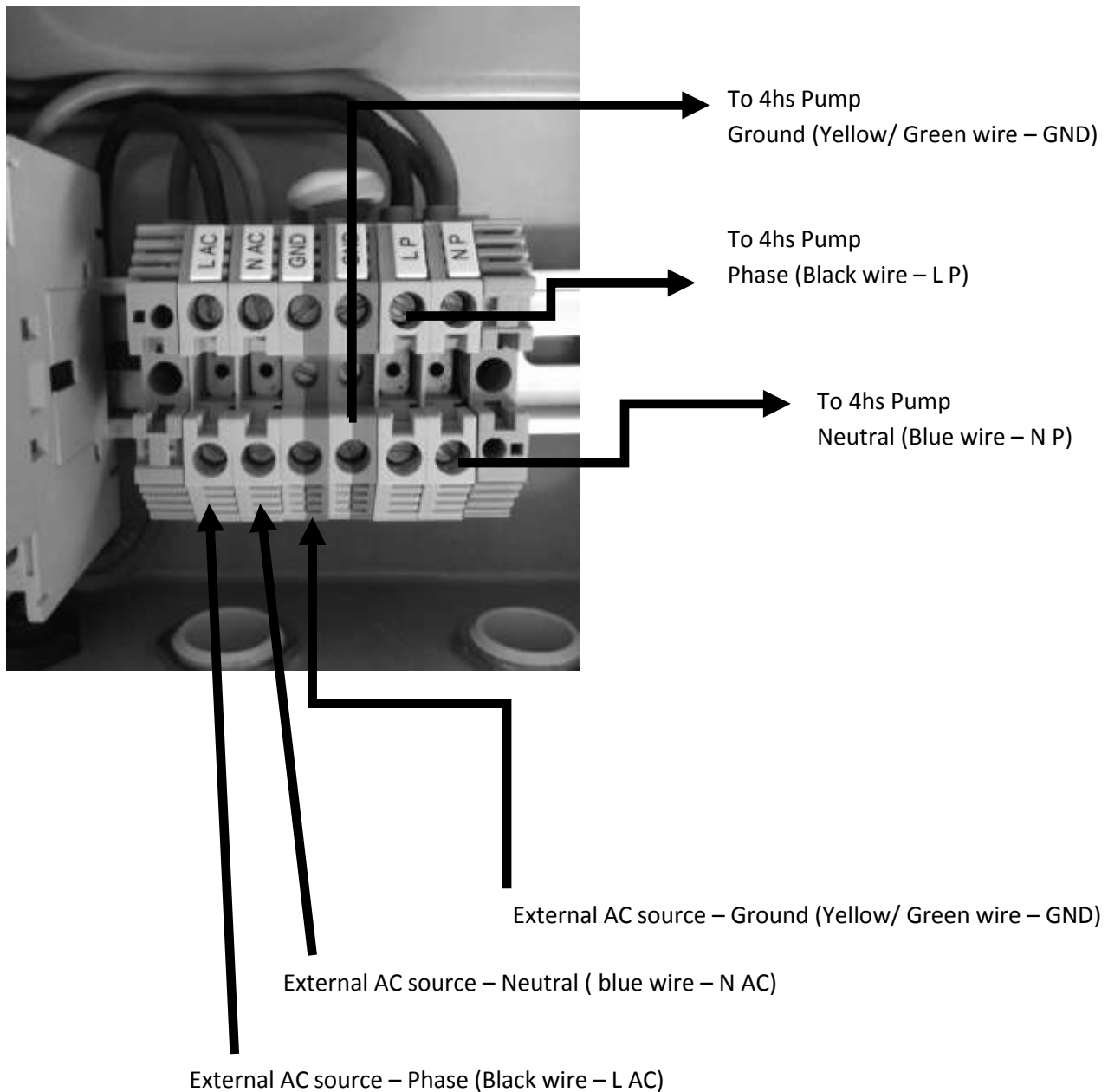
After joining the cables and placing the pump in the well you must perform a test of insulation prior to making the connections inside the CM Control Module: wire the two power cables together and, applying a voltage of 500V, check insulation resistance from the ground to verify a resistance higher than 100 M Ohm. Wire the two signal cables together and, applying a voltage of 500V, check insulation resistance from the ground to verify a resistance higher than 100 M Ohm.

8. Cables and cabinets installation

8.1 View of the product and connection



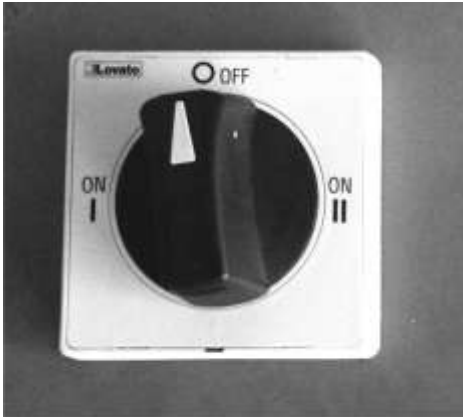
8.2 Internal connections



General warnings

- It's strictly forbidden to work under voltage presence
- Respect the connections as above showed in the pictures
- Assure that all screw are well closed and cables are fully inserted on the terminals

8.3 Position of the switch



ON I - System is turned on. The 4hs pump works with solar energy

ON II - System is turned on. The 4hs pump works with AC external supply

O off – System is turned off

!! AC external supply is optional. The system can work independently with the only use of the solar source!!

8.4 Installation of the connectors

PV Connectors are needed to connect PV modules to the main wires and the electrical cabinets

Use RED cables for positive DC side, and black cables for negative DC side. Plug two different connectors (MALE – FEMALE) in any spare cable, respectively one different in each side of the cable

Wires to be cabled

- For systems with 6 modules

One RED cable (one female connector and one male connector). This is the connection from PV array to the main cabinet

One RED cable (one female connector and one male connector). This is the connection from PV array to the main cabinet

- For systems with 12 modules

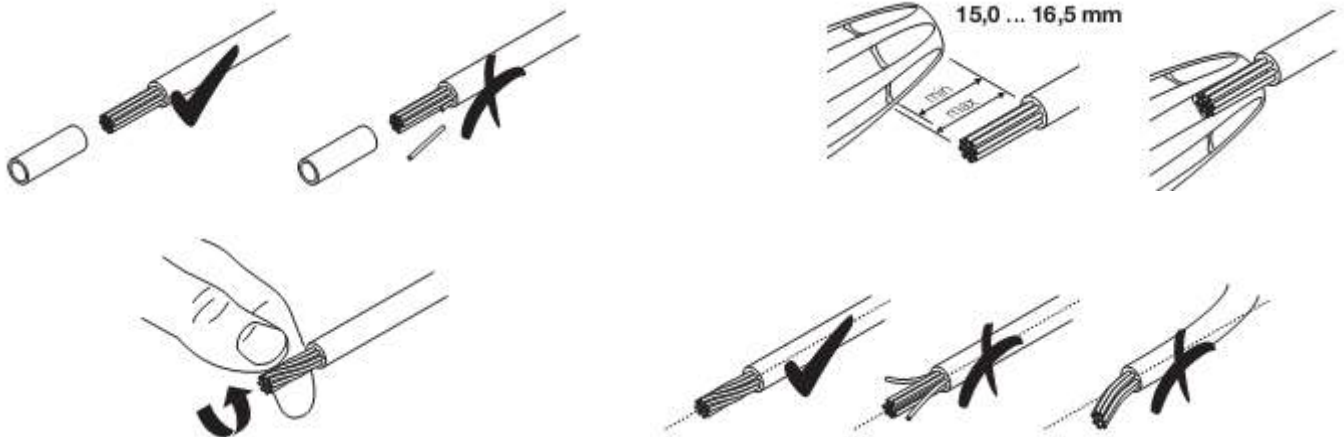
One RED cable (one female connector and one male connector). This is the connection from PV array to the main cabinet

One RED cable (one female connector and one male connector). This is the connection from PV array to the main cabinet

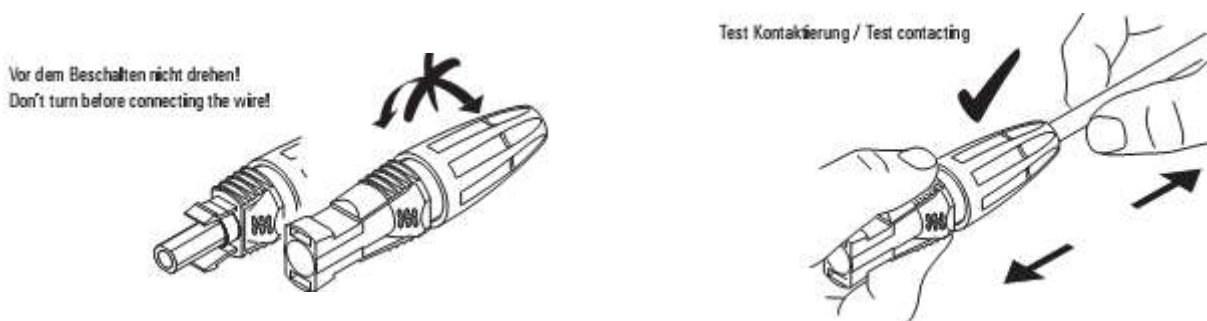
One RED cable (one female connector and one male connector). This is the needed connection in case of separation of two PV arrays from the mounting system

Connectors installation

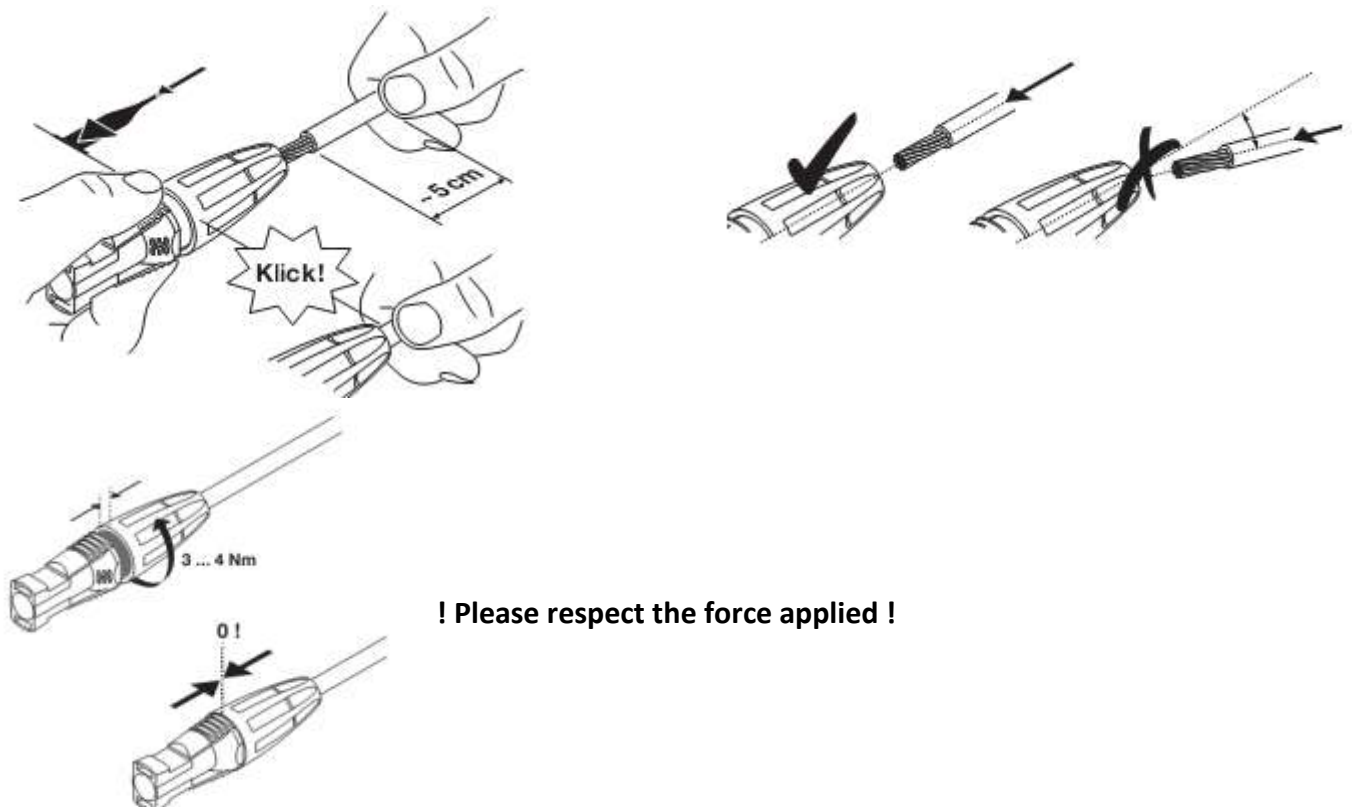
1) Preparation of the cable



2) Inserting of the cable



3) Closing of the connectors



9. Troubleshooting

If the pump, after the installation and power supply connection, doesn't provide any water please verify:

- correct wiring.
- voltage conditions (90 – 340 VDC, 90 – 265 VAC).
- enough power available (solar irradiance).
- water presence: if pump during operation runs dry, an alarm occurs and pump will stop. Every 5 minutes pump will attempt to restart the operation after 5 minutes.