

Operation Manual of Solar Controller SolCon-016 for Split Solar System



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1. Safety information

1.1 Installation and commissioning

- When laying wires, please ensure that no damage occurs to any of the constructional fire safety measures presented in the building.
- The controller must not be installed in rooms where easily inflammable gas mixtures are present or may occur.
- The permissible environmental conditions can't be exceeded at the site of installation.
- Before connecting the device, make sure that the energy supply matches the specifications that controller requires.
- All devices connected to the controller must conform to the technical specifications of the controller.
- All operations on an open controller are only to be conducted cleared from the power supply. All safety regulations for working on the power supply are valid.
- Connecting and /or all operations that require opening the collector (e.g. changing the fuse) are only conducted by specialists.

1.2 About this manual

This manual describes the installation, functions and operation of a solar controller. When installing the remaining components e.g. the solar collectors and the tank unit, please be sure to observe the appropriate installation instructions provided by each manufacturer. Installation, electrical connection, commissioning and maintenance of the device may only be performed by trained professional person. The professional person must be familiar with this manual and follow the instructions contained herein.

1.3 Liability waiver

The manufacturer can't monitor the compliance with these instructions or the circumstances and methods used for installation, operation, utilization and maintenance of this controller. Improper installation can cause damages to material and person. This is the reason why we do not take over responsibility and liability for losses, damages or cost that might arise due to improper installation, operation or wrong utilization and maintenance or that occurs in some connection with the aforementioned. Moreover we do not take over liability for patent infringements or infringements – occurring in connection with the use of this controller on the third parties rights. The manufacturer preserves the right to put changes to product, technical data or installation and operation instructions without prior notice. As soon as it becomes

evident that safe operation is no longer possible (e.g. visible damage). Please immediate take the device out of operation. Note: ensure that the device can't be accidentally placed into operation.

1.4 Important information

We have carefully checked the text and pictures of this manual and provided the best of our knowledge and ideas, however inevitable errors maybe exist. Please note that we cannot guarantee that this manual is given in the integrity of image and text, they are just some examples, and they apply only to our own system. Incorrect, incomplete and erroneous information and the resulting damage we do not take responsibility.

1.5 Signal description



Safety indication: Safety instructions in the text are marked with a warning triangle. They indicate measures which can lead to injury of person or safety risks.
Operation steps: small triangle "▶" is used to indicate operation step.
Notes: Contains important information about operation or functions.

1.6 HMI button



- Controller is operated with the 5 buttons besides the screen
- "IIII " holiday button
- "SET" button: confirm / selection
- "↑" up button: increase the value
- "↓" down button: reduce the value

• "ESC" button return/ exit : return to previous menu

Note: 1. .Tc1 display on screen means maximum temperature of tank1;; 2.Tc2 display on screen means maximum temperature of tank2; 3.Tc3 display on screen means maximum temperature of tank2;

2. Overview

2.1 Controller introduction

- TFT colorful screen display
- 8* relay outputs
- 5 * sensor inputs
- 1 * Grundfos Direct Sensor TM (VFS) simulation input
- 1 * Grundfos Direct Sensor TM (RPS) simulation input
- 1 * FRT digital flow meter input
- Data saved on the TF card (Micro SD)
- 485 communication port
- 3 systems for choose

2.2 Delivery list

- 1 * SolCon-016 controller
- 1 * accessory bag
- 2 * Flat head screws and plastic expansion pipes
- 1 * PT1000 temperature sensor (φ6*50mm,cable length 10meter)
- 2 * NTC10K temperature sensor (φ6*50mm,cable length 5meter)
- 3* Sensor pocket
- 1 * Clamp bag
- 1 * Power cord

2.3 Technical data

• Input: 1* PT1000 temperature sensors

4* NTC10K, B=3950 temperature sensors



- 1* Grundfos Direct Sensor (VFS type)
- 1* Grundfos Direct Sensor (RPS type)
- 1* FRT digital flow meter
- Output: 8* Electromagnetic relay, Max. current 1A

Functions: operating hours counter, tube collector function, thermostat function, external heat exchange, adjustable system parameters and optional functions (menu-driven), balance and diagnostics

- Power supply : 100...240V ~(50...60Hz)
- Rated impulse voltage:: 2.5KV
- Data interface : TF (Micro SD)
- 485 current supply: 60mA
- Housing: Plastic ABS
- Mounting: Wall mounting
- Indication / Display: System-Monitoring-Display, for visualization of the systems, TFT colorful display, and background illumination
- Operation: 5 push buttons at the front cover
- Protection type: IP40
- Protection class: I
- Ambient temperature: 0 ... 40 °C
- Degree of pollution: 2
- Dimensions: 208*158*43mm

I Note: TF (Micro SD) isn't included in the delivery list

3. Installation

Note: The unit must only be located in the dry interior rooms. Please separate routing of sensor wires and mains wires. Make sure the controller as well as the system is not exposed to strong electromagnetic fields.

3.1 Mounting controller

Follow the below steps to mount the controller on the wall.

- Unscrew the crosshead screw from the cover and remove it along with the cover from the housing.
- Mark the upper fastening point on the wall. Drill and fasten the enclosed wall plug and screw leaving the head protruding.
- Hang the housing from the upper fastening point and mark the lower fastening points (centers 180 mm).
- Drill and insert lower wall plugs.
- Fasten the housing to the wall with the lower fastening screw and tighten.



- Carry out the electrical wiring in accordance with the terminal allocation
- Put the cover on the housing. Attach with the fastening screw.

3.2 Wiring connection

According to the way of installation, wire can be connected from hole A on the bottom plate or from hole B, using a suitable tool (like knife) to cut the plastic of A. Note: wires must be fastened by fixing clamps on position C.



3.3 Terminal connection

Note: before opening the housing! Always disconnect the controller from power supply and obey the local electrical supply regulation.

• Input terminals



• Input terminals

Ts: PT1000 temperature sensor, for measuring the temperature of collector and thermal energy calculation.

Tc1~Tc3, Tbc: NTC10K, B=3950 temperature sensor, for measuring temperature of tank and pipe.

485-A, 485-B communication interface: It is an ELA485 communication module interface, and the A/B line cannot be connected reversely.

ALM-A, ALM-B interfaces: external alarm (switch signal)

VFS: For Grundfos flowmeter sensor

• Advice regarding the installation of temperature sensors:

- ① Only original factory equipped Pt1000 temperature sensors are approved for using with the collector, it is equipped with 1.5m silicon cable and suitable for all weather conditions, the cable is temperature resistant up to 280oC, connect the temperature sensors to the corresponding terminals with either polarity.
- ② Only original factory equipped NTC10K,B=3950 temperature sensors are approved for using with tank and pipe, it is equipped with 3m PVC cable, and the cable is temperature resistant up to 105°C, connect the temperature sensors to the corresponding terminals with either polarity.
- ③ All sensor cables carry low voltage, and to avoid inductive effects, must not be laid close to 230 volt or 400 volt cables (minimum separation of 100mm).
- ④ If external inductive effects are existed, e.g. from heavy current cables, overhead train cables, transformer substations, radio and television devices, amateur radio stations, microwave devices etc., then the cables to the sensors must be adequately shielded.
- (5) Sensor cables may be extended to a maximum length of ca. 100 meter, when cable's length is up to 50m, and then 0.75mm2 cable should be used. When cable's length is up to 100m, and then 1.5mm2 cables should be used.
- Output terminal



Input Ports L N: for power connection, L: live wire, N: zero wire, protective wire Output P1: Electromagnetic relays, designed for pump control, Max. Current: 1A

Output P2: Electromagnetic relays, designed for pump control, Max. Current: 1A

Output RE1: Electromagnetic relays, designed for back-up heating device, Max. Current: 1A Output RE2: Electromagnetic relays, designed for back-up heating device, Max. Current: 1A Output RE3: Electromagnetic relays, designed for back-up heating device, Max. Current: 1A Output CV: Electromagnetic relays, designed for pump or 3-ways electromagnetic valve, Max. Current: 1A

3.4 TF (MicroSD) Card

Controller is equipped with a slot for TF (Micro SD) card. With TF (MicroSD) card, following functions can be carried out:

- Save the measurement and balance values onto the MicroSD card. After transferring the data to a computer, the values can be opened and visualized, e. g. in a spreadsheet.
- Prepare adjustments and parameterizations on a computer and transfer them via the MicroSD card to the controller.
- Save adjustments and parameterizations on the MicroSD card and, if necessary, retrieve them from there.
- Copy the updated firmware and install them on the controller via MicroSD card.

Output BCP: Electromagnetic relays, designed for high temperature protection pump or electromagnetic valve,



I Note: TF (MicroSD) card is not listed in the standard delivery package, self-purchase if need, more detailed about TF (MicroSD) see paragraph 5.3 (25) OSDC)

4.System

4.1 System1



4.2 System2



4.3 System3



5. Functions and options

5.1 Overview of menu structure



5.3 Menu operation description

- Access main menu
- ▶ press "SET" button to access main menu
- ▶ Press "↑", "↓" to select menu
- ▶ Press "SET" button to enter the submenu
- Access submenu
- ▶ Press "SET" button to access submenu
- ► Press "SET" button to enter option interface, select "ON" to open this option, select "OFF" to close this option
- ▶ Press "SET" button to enter the value adjust interface
- ▶ Press "↑", "↓" to adjust value
- ▶ Press "SET" to confirm the value you set

Note: Enter the menu adjustment interface, if you don't press any button within 5 minutes, screen will exit the adjustment and turn to main interface.

5.4 Check value

At the normal operation mode, press "↑", "↓" button, you can view the temperature of collector, and tank, accumulated pump running time, current day thermal energy, accumulated thermal energy, flow, controller running time, software version. (Blue color means: normal value, red color means: faulty. grey color means: function is deactivated.)



Note: enter the value check interface, if you don't press any button within 5 minutes, screen will exit the check interface and turn to main interface.

5.5 Menu function

(1)Date (Time/ Date set)



- ADST: Switch on/off the auto summer function
 When you deactivate the "auto summer function", controller still can run, "ADST" is only referring Europe 200/84/EG, only suitable for Europe union country.
- Time: Set clock and time; firstly adjust hour, then minute.
- Date: Set date, in sequence day, month, and year.

Note: In the case power to controller is switched-off, date and time will be remembered in controller for 36 hours.

(2)Light (Screen lightness adjustment)



• Adjust desired TFT screen lightness.

(3) Timed Heat1 (Timing heating)

Menu stru	icture diag	gram				
Heater1	(Main	menu) 🤇	3)			
T_Sense SMT_F tH 1C tH 1F tH 2C tH 2F tH 3C tH 3F		s	Submenu			
Main	Subme	Subme	Factory	Adjustment	Adjust	Description
menu	nu1	nu2	default	range	ment	
menu	nu1	nu2	default	range	ment amplit	
menu	nu1	nu2	default	range	ment amplit ude	
menu Heater1	nu1	nu2	default	range	ment amplit ude	Tank1 heating
menu Heater1	nu1	nu2 T_sens	default Tc1	range Default	ment amplit ude	Tank1 heating Object sensor of
menu Heater1	nu1	nu2 T_sens or	default Tc1	range Default	ment amplit ude	Tank1 heating Object sensor of tank1
menu Heater1	nu1	nu2 T_sens or SMT_H	default Tc1 OFF	Default ON/OFF	ment amplit ude	Tank1 heating Object sensor of tank1 Intelligent Heating
menu Heater1	nu1	nu2 T_sens or SMT_H T	default Tc1 OFF	Default ON/OFF	ment amplit ude	Tank1 heating Object sensor of tank1 Intelligent Heating mode
menu Heater1	nu1	nu2 T_sens or SMT_H T t H10	default Tc1 OFF 00:00	range Default ON/OFF 00:00-23:59 /	ment amplit ude 0.5 °C	Tank1 heating Object sensor of tank1 Intelligent Heating mode 1st time switch on
menu Heater1	nu1	nu2 T_sens or SMT_H T t H10	default Tc1 OFF 00:00 /50°C	range Default ON/OFF 00:00-23:59 / 0.0-93 °C	ment amplit ude	Tank1 heating Object sensor of tank1 Intelligent Heating mode 1st time switch on clock and Temp.
menu Heater1	nu1	nu2 T_sens or SMT_H T t H10 t H1F	default Tc1 OFF 00:00 /50°C 23:59/55	range Default ON/OFF 00:00-23:59 / 0.0-93 °C 00:00-23:59 /	ment amplit ude 0.5 °C	Tank1 heatingObject sensor oftank1Intelligent Heatingmode1st time switch onclock and Temp.1st time switch off
menu Heater1	nu1	nu2 T_sens or SMT_H T t H1O t H1F	default Tc1 OFF 00:00 /50°C 23:59/55 °C	range Default DN/OFF 00:00-23:59 / 0.0-93 ℃ 00:00-23:59 / 0.0-95 ℃	ment amplit ude 0.5°C 0.5°C	Tank1 heatingObject sensor oftank1Intelligent Heatingmode1st time switch onclock and Temp.1st time switch offtemperature
menu Heater1	nu1	nu2 T_sens or SMT_H T t H1O t H1F t H2O	default Tc1 OFF 00:00 /50°C 23:59/55 °C 00:00 /	range Default Default ON/OFF 00:00-23:59 / 0.0-93 ℃ 00:00-23:59 / 0.0-95 ℃ 00:00-23:59 /	ment amplit ude 0.5℃ 0.5℃ 0.5℃	Tank1 heatingObject sensor oftank1Intelligent Heatingmode1st time switch onclock and Temp.1st time switch offtemperature2st time switch on
menu Heater1	nu1	nu2 T_sens or SMT_H T t H1O t H1F t H2O	default Tc1 OFF 00:00 /50°C 23:59/55 °C 00:00 / 50°C	range Default Default ON/OFF 00:00-23:59 / 0.0-93 ℃ 00:00-23:59 / 0.0-95 ℃ 00:00-23:59 / 0.0-93 ℃	ment amplit ude 0.5℃ 0.5℃ 0.5℃	Tank1 heatingObject sensor oftank1Intelligent Heatingmode1st time switch onclock and Temp.1st time switch offtemperature2st time switch onclock and Temp.
menu Heater1	nu1	nu2 T_sens or SMT_H T t H1O t H1F t H2O t H2F	default Tc1 OFF 00:00 /50°C 23:59/55 °C 00:00 / 50°C 00:00 /	range Default Default ON/OFF 00:00-23:59 / 0.0-93 ℃ 00:00-23:59 / 0.0-93 ℃ 00:00-23:59 / 0.0-93 ℃ 00:00-23:59 / 0.0-93 ℃ 00:00-23:59 / 0.0-93 ℃	ment amplit ude 0.5℃ 0.5℃ 0.5℃	Tank1 heatingObject sensor oftank1Intelligent Heatingmode1st time switch onclock and Temp.1st time switch offtemperature2st time switch onclock and Temp.2st time switch offclock and Temp.2st time switch offclock and Temp.2st time switch off
menu Heater1	nu1	nu2 T_sens or SMT_H T t H1O t H1F t H2O t H2F	default Tc1 OFF 00:00 /50°C 23:59/55 °C 00:00 / 50°C 00:00 / 55°C	range Default Default ON/OFF 00:00-23:59 / 0.0-93 ℃ 00:00-23:59 / 0.0-95 ℃ 00:00-23:59 / 0.0-93 ℃ 00:00-23:59 / 0.0-93 ℃	ment amplit ude 0.5℃ 0.5℃ 0.5℃	Tank1 heatingObject sensor oftank1Intelligent Heatingmode1st time switch onclock and Temp.1st time switch offtemperature2st time switch onclock and Temp.2st time switch offclock and Temp.2st time switch offclock and Temp.

		50 ℃	0.0-93 ℃		clock and Temp.
	t H3F	00:00 /	00:00-23:59 /	0.5 ℃	3st time switch off
		55 ℃	0.0-95 ℃		clock and Temp.

• T_Sensor: Object sensor for timing heating.

Timing heating function is independent of solar system; it is used to control back-up heat source to heat tank.

Timing heating function is run at the preset time section, 3 time sections can be set, start time and close time can be set by press button, per press means 1 minute. If you set the start time and close time with a same value, which means within this time section, the timing heating function is switched-off. For example, if you want to run the back-up heating from 06:00 am to 09:00 am, then you set t10 is 06:00 am, set t1F is 09:00 am, default the first timing section is 06:00 am to 22:00 pm, if all time is set with 00:00 value, that means the timing heating function is switch-off.

SMT_HT: Intelligent heating

At the case that solar energy is insufficient to heat the tank, in order to ensure user has sufficient hot water, controller will check the temperature of tank aromatically at the preset time, if tank's temperature is not reached to the desired temperature, then back-up heat device will be triggered, and when tank's temperature rises up to the desired value, then back-up heat device stops.

(4) Timed Heat2 (Timing heating)



		55℃	0.0-95 ℃		clock and Temp.
	t H3O	00:00 /	00:00-23:59 /	0.5 ℃	3st time switch on
		50 ℃	0.0-93 ℃		clock and Temp.
	t H3F	00:00 /	00:00-23:59 /	0.5 ℃	3st time switch off
		55 ℃	0.0-95 ℃		clock and Temp.

(5) Timed Heat3 (Timing heating)



	Т				mode
	t H10	00:00	00:00-23:59 /	0.5 ℃	1st time switch on
		/50 ℃	0.0-93 ℃		clock and Temp.
	t H1F	23:59/55	00:00-23:59 /	0.5 ℃	1st time switch off
		°C	0.0-95 ℃		temperature
	t H2O	00:00 /	00:00-23:59 /	0.5 ℃	2st time switch on
		50° C	0.0-93 ℃		clock and Temp.
	t H2F	00:00 /	00:00-23:59 /	0.5 ℃	2st time switch off
		55 ℃	0.0-95 ℃		clock and Temp.
	t H3O	00:00 /	00:00-23:59 /	0.5 ℃	3st time switch on
		50° C	0.0-93 ℃		clock and Temp.
	t H3F	00:00 /	00:00-23:59 /	0.5 ℃	3st time switch off
		55 ℃	0.0-95 ℃		clock and Temp.

(6)Password

Menu structure diagram									
Password (Main menu) 6									
0000	Subme	าม							
Main	Submenu	Factory	Adjustment	Adjustment	Description				
menu	1	default	range	amplitude					
Password		0000			password				

Passwords can be used to restrict users from entering certain parameter settings. For security reasons, a 4-digit password is set, with a default of 0000.

(7) SYS System select



Main menu	Subme nu1	Factory default	Adjustm ent range	Adjustm ent amplitu de	Description
Password		0000			password
SYS					System
	SYS	1	13		System select

Each system has many pre programmed options and settings that can be enabled or changed as needed. First, make a system selection (1-3 systems).

(8) TANK1 Heating Setting

Menu stru	cture dia	igram						
TANK1 (Main menu) (8)								
DTO DTF SMX SMAXS HYST]	Submer	าน					
Main	Subme	Subme	Factory	Adjustm	Adjustm	Description		
menu	nu1	nu2	default	ent	ent			
				range	amplitu			
					de			
TANK1						Tank1 heating setting		
	DTO		6K	1-50K	0.5K	Tank1 swtich on		
						temperature difference		
	DTF		4K	0.5-49.5	0.5K	Tank1 swtich off		
				К		temperature difference		
	SMX		70° ℃	4-95 ℃	1°C	Tank1 maximum		
						temperature		
	SMAXS		Tc1			Tank 1 maximum		
						reference sensor		

HYST	2К	0.1-10K	0.1K	Lag value of maximum
				temperature of tank 1
				(return difference)

• DT Temperature difference

The controller works as a standard differential controller. If the temperature reaches or exceeds the switch-on temperature difference, the pump switches on. When the temperature difference reaches or falls below the adjusted switch-off temperature difference, the respective relay switches off.



• SMX Maximum tank temperature protection set

If the tank temperature reaches the adjusted maximum temperature, the tank will no longer be loaded in order to avoid damage caused by overheating. If the maximum tank temperature is exceeded, Max is displayed.

The sensor for tank maximum limitation (SMAXS) can be selected. The maximum limitation always refers to the sensor selected. The switch-on hysteresis (HYST) is selectable. Default is 2° C, for example, when tank maximum temperature is set to 70° C, then at 68 °C, Maximum tank temperature protection function is deactivated automatically.

(9) TANK2Heating Setting



Main menu	Subme nu1	Subme nu2	Factory default	Adjustm ent	Adjustm ent	Description
				range	amplitu	
					de	
TANK2						Tank2 heating setting
	DTO		6K	1-50K	0.5K	Tank2 swtich on
						temperature difference
	DTF		4K	0.5-49.5	0.5K	Tank2 swtich off
				К		temperature difference
	SMX		70 ℃	4-95 ℃	1 °C	Tank2 maximum
						temperature
	SMAXS		Tc2			Tank 2 maximum
						reference sensor
	HYST		2K	0.1-10K	0.1K	Lag value of maximum
						temperature of tank 2
						(return difference)

(10) TANK3 Heating Setting

Menu structure diagram									
TANK3 (Main menu) (10)									
DT30 DT3F S3MX SMAXS HYST3	s	Submen	u						
Main	Subme	Subme	Factory	Adjustm	Adjustm	Description			
menu	nu1	nu2	default	ent	ent				
				range	amplitu				
					de				
TANK3						Tank3 heating setting			
	DTO		6K	1-50K	0.5K	Tank3 swtich on			

				temperature difference
DTF	4K	0.5-49.5	0.5K	Tank3 swtich off
		К		temperature difference
SMX	70° ℃	4-95 ℃	1°C	Tank3 maximum
				temperature
SMAXS	Tc3			Tank 3 maximum
				reference sensor
HYST	2K	0.1-10K	0.1K	Lag value of maximum
				temperature of tank 3
				(return difference)

(11)COL Collector functions



					shutdown
	CEM	130°C	80-200 ℃	1℃	Collector emergency
					shutdown
					temperaure(return
					difference 10 $^\circ \!\!\! ^\circ \!\! ^\circ \!\!\! ^\circ \!\! ^\circ \!\!$
0000		OFF			Collector cooling
	CMAX	110°C	70-160 ℃	1°C	Collector cooling
					temperatuer(return
					difference 5 $^\circ \!\!\!\mathrm{C}$)
OCMI		OFF			Collector minimum
					temperature
	CMIN	10° C	10-90 ℃	1°C	minimum
					temperature
OCFR		OFF			Collector antifreeze
	CFRO	4 ℃	-40-8 ℃	0.5 ℃	Antifreeze switch on
					temperature
	CFRF	5℃	-39-9℃	0.5 ℃	Antifreeze switch off
					temperature
OTCO					Tube collector
	TCST	07:00	00:00-23:00	30min	Tube collector turn on
					clock
	TCEN	19:00	00:00-23:00	30min	Tube collector turn
					off clock
	TCRU	30s	30-300s	1s	Tube collector run
					time
	TCIN	30min	5-60min	1min	Tube collector stop
					time

CEM Collector emergency shutdown

When the collector temperature exceeds the adjusted collector emergency temperature, Then solar pump (R1 / R2) switches off in order to protect the system components against overheating (collector emergency shutdown). If the maximum collector temperature is exceeded, Emerg is displayed.

1 Note: In systems with east- / west collectors, 2 separate menus (COL and COL 2) will be displayed.

Warning! Risk of injury! Risk of system damage by pressure surge! If water is used as the heat transfer fluid in pressure systems, water will boil at 100 °C. Do not set the collector limit

temperature higher than 95 °C.

• OCCO Collector cooling

The collector cooling function keeps the collector rise temperature within the operating range by heating the tank. If the tank temperature reaches 95 °C the function will switch off for safety reasons.

When the tank temperature exceeds the adjusted maximum tank temperature, then solar system switches off. If the collector temperature increases to its adjusted maximum collector temperature, the solar pump is switched on until the collector temperature falls below the maximum collector temperature. The tank temperature may then exceed its maximum temperature, but only up to 95°C (emergency shutdown of the tank), and Emerg is displayed, system stops.

If the collector cooling is active, Cooling is displayed.

This function is only available if the system cooling function and the heat transfer function are not activated.

In systems with east- / west collectors two separate menus (COL and COL 2) will be displayed.

• OCMI Collector minimum temperature

The minimum collector temperature is the minimum switch-on temperature which must be exceeded for the solar pump (R1 / R2) to be switched on. If the collector temperature falls below the adjusted minimum temperature, Min is displayed.



Note: In systems with east- / west collectors two separate menus (**COL** and **COL 2**) will be displayed.

• OCFR Collector antifreeze function

Collector antifreeze function activates the loading circuit between the collector and the tank when the collector temperature falls below the adjusted temperature **CFR O**. This will protect the fluid against freezing or coagulating. If **CFR F** is exceeded, the solar pump will be

switched off again.

If collector antifreeze function is activated, Antifreeze is displayed.



Note: Since this function uses the limited heat quantity of the tank, the antifreeze function should be used only in regions with few days of temperatures around the freezing point.

• OTCO Tube collector function

This function is used for improving the switch-on behavior in systems with non-ideal sensor positions (e. g. with some tube collectors).

This function operates within an adjusted time section. It activates the collector circuit pump for an adjustable runtime between adjustable pauses in order to compensate for the delayed temperature measurement.

If the runtime is set to more than 10s, the pump will be run at 100% for the first 10s of the runtime. For the remaining runtime, the pump will be run at the adjusted minimum speed.

If the collector sensor is defective or the collector is blocked, this function is suppressed or switched off.

Menu structure diagram							
PUMP P1D P2D	(Main menu) ГР ГР		—Subme	enu			
Main	Submenu	Submen	Factory	Adjust	Adjustme	Descri	Main menu
menu	1	u2	default	ment	nt	ption	
				range	amplitude		
PUMP							P1/P2 Timer

(12) PNMP Pump Control

					logic relationship
P1DTP		15	1-240	1	P1 running time
P2DTP		5	1-240	1	P2 running time

When the temperature difference meets the opening condition:

Step 1: First, P1 starts and runs for 15 minutes, then stops;

Step 2: P2 starts and runs for 5 minutes, then stops;

Step 3: Repeat steps 1 and 2.

When the temperature difference meets the closing condition:

Step 4: Stop running regardless of P1 or P2.

The next new cycle starts and the above four steps are repeated.

I P1/P2 operation time is adjustable, and setting it to 0 means that the corresponding water pump is shut down.

(13) COOL Cooling function



OSYC		OFF	ON/OFF		System cooling
OSTC		OFF	ON/OFF		Tank cooling
	DTCO	20K	1-30K	0.5K	Cooling switch on
					temperature
					difference
	DTCF	15K	0.5-29.5K	0.5K	Cooling switch off
					temperature
					difference
OHDP		OFF	ON/OFF		external radiator
					heat transfer
					(Depending on the
					system, there are
					redundant output
					ports to enable this
					function.)
	OTST	90° ℃	20-160 ℃	1°C	Heat transfer
					temperature setting
					(return difference
					5℃)
	OTPU	ON	OTPUM		Logical selection of
	М		ON=Pump logical		pumps and valves
			OTPUM OFF=Valve		
			logic		

Three cooling functions for different equipment can be activated: system cooling, water tank cooling, and external radiator heat transfer

• OSYC System cooling

The system cooling function aims to keep the solar system operational for a longer time. The function overrides the maximum tank temperature to provide thermal relief of the collector field and the heat transfer fluid on hot days. If the tank temperature is higher than the adjusted maximum tank temperature and the switch-on temperature difference **DTCO** is reached, the solar pump remains switched on or will be switched on. Solar loading is continued until either the temperature difference falls below the adjusted value **DTCF** or the collector emergency shutdown temperature **CEM** is reached. When the system is cooling, the display shows "System Cooling".

i

Note: This function will only be available when the collector cooling function, external radiator heat transfer functions are not activated.

OSTC Tank cooling

When the tank cooling function is activated, the controller aims to cool down the tank during the night in order to prepare it for solar loading on the following day. If the adjusted maximum tank temperature SMAX1, SMAX2, SMAX3 is exceeded and the collector temperature falls below the tank temperature and down to the switch on temperature difference DTCO of this cooling function, then system will be activated in order to cool down the tank by releasing the energy through the collector. When the water tank is cooling and running, the display screen displays Store Cooling.

I Note: if tank temperature reaches to 95 oC, all cooling functions will be locked. Hysteresis switch on temperature difference is 5K.

• OHDP external radiator heat transfer

External radiator heat transfer function can be used to direct excess heat generated by strong solar irradiation to an external heat exchanger (e. g. fan coil) in order to keep the collector temperature within the operating range.

When the temperature of the collector is higher than 90 $^{\circ}$ C (OTST), the CV opens. The CV shall be operated for a minimum of 2 minutes until the collector cools to 85 $^{\circ}$ C and the CV is closed.

External radiator heat transfer function can either control an additional pump or valve (**OTPUM ON** = pump logic, **OTPUM OFF** = valve logic).

Below is the example of this application for reference.



(14) CLEAN Timing cleaning function

Menu structure diagram								
CLEAN (Main menu) 14 DTSC tSCO SCRU SCRU								
Main								
IVIdIII	Subme	Subme	Factor	Adjustment	Adjustme	Description		
menu	Subme nu1	Subme nu2	Factor y	Adjustment range	Adjustme nt	Description		
menu	Subme nu1	Subme nu2	Factor y default	Adjustment range	Adjustme nt amplitude	Description		
CLEAN	Subme nu1	Subme nu2	Factor y default	Adjustment range	Adjustme nt amplitude	Description Timing cleaning		
CLEAN	Subme nu1	Subme nu2	Factor Y default	Adjustment range	Adjustme nt amplitude	Description Timing cleaning function		
CLEAN	Subme nu1 DTSC	Subme nu2	Factor y default 30	Adjustment range 1-120	Adjustme nt amplitude 1	Description Timing cleaning function Interval Days		
CLEAN	Subme nu1 DTSC tSCO	Subme nu2	Factor y default 30 01:00	Adjustment range 1-120 00:00-23:00	Adjustme nt amplitude 1	Description Timing cleaning function Interval Days Switch on time		

After this function is enabled, it is started every 30 days (DTSC) by default at 01:00 (tSCO). Open a valve RE3 to flush the solar panel, and stop after running for 10 minutes.

(15) MAN Manual funciton



Main menu	Subme nu1	Subme nu2	Factory default	Adjustme nt range	Adjustm ent	Description
				_	amplitu	
					de	
MAN						Manual mode
	P1		OFF	ON/OFF		P1 on and off
	P2		OFF	ON/OFF		P2 on and off
	RE2		OFF	ON/OFF		RE2 on and off
	CV		OFF	ON/OFF		CV on and off
	RE3		OFF	ON/OFF		RE3 on and off
	RE1		OFF	ON/OFF		RE1 on and off

When using the device for the first time or when debugging the system, the controller outputs (P1, P2, RE2, CV, RE3, RE1) can be manually "On/Off" output.

Note: After the manual function is turned on, the display screen displays MAN (the remaining outputs of the controller will be turned off, with manual output taking precedence). After running for 15 minutes, the output port will automatically close, and the controller will exit the manual state.

(16) AUX Auxiliary function



BEEP		OFF	ON/OFF	Buzzer alarm function
				(temperature sensor
				failure, system
				overpressure and low
				pressure, no flow
				OFLOW)
BLPR		OFF	ON/OFF	Blockage protection
				function
PROT		OFF	ON/OFF	
	Tbc	70 ℃	5-95 ℃	

BEP Buzzer fault alarm

When the system encounters (temperature sensor failure, system overpressure, low pressure, no flow meter), it will give a warning for the failure

• BLPR Blockage protection

In order to protect the pump from clogging due to long-term inactivity after a cycle stop occurs in the system, the controller has designed a clogging protection function that allows each relay to operate one by one for 10 seconds at 100% speed at 12:00 a.m. every day.

When the blocking protection is running, the display screen sequentially displays the countdown time of BLPR P1 to BLPR CV.

• PROT High temperature protection

When the Tbc set temperature is 60 oC, when the Tbc reaches 75 oC, the Tbc high temperature protection function is activated, and when the temperature drops to 60 oC, the high temperature protection is turned off.

Trigger conditions	Trigger Results	Screen status indication
When Tbc>="X"	BCP OFF	Always on display
Description		
 "X" value, Users can set it by themselves 		
2. X"setting arange: 30 °C <= "X" < = 60 °C		Tbc
3. "X" default=60 $^\circ \! \mathbb{C}$, (return differnece2 $^\circ \! \mathbb{C}$)Tbc rise up to default, BCP off		

Tbo Des 1. 2.	c <= "X"-10C scription: BCP switch on and off temperature default 10 °C ,Fixed value cannot be modified "X" default=60 °C ,"X"-10 °C = 50 °C; BCP ON.	BCP ON	
Tbo	c>="X"+15C	P1,P2,RE1,RE2,R	
Des	scription	E3	Flashing display
1.	When Tbc rise up to "X"+15 ℃, Trigger	BCP,all OFF	
2	high temperature protection. When "X" default=60C "X"+15=75 $^{\circ}$:		
2.	BCP keep off and switch off		Tbc
	"P1,P2,RE1,RE2,RE3" at the same time.		
3.	Only when Tbc $<$ "X", the system returns		
	to normal,and "P1,P2,RE1,RE2,RE3"		
	return normal working condition.		
4.	Only when Tbc $<$ "X"-10 $^\circ\!\mathrm{C}$, The system		
	returns to normal, that is, the BCP		
	returns to its normal working state.		

• (17) OTDIS Thermal disinfection



DDIS	10min	1-120	1min	Heating period
TDIS	70 ℃	0-90 ℃	1°C	Temperature setting
SDIS	18:00	00:00-21:	1:00	Switch on time of
		00		Thermal disinfection

This function helps to prevent the spread of Legionella in DHW tanks by systematically activating the after-heating. One sensor and one relay can be selected for this function.

For thermal disinfection, the temperature at the allocated sensor has to be monitored. This protection is ensured when, during the monitoring period PDIS, the disinfection temperature is continuously exceeded the disinfection temperature TDIS for the entire disinfection period DDIS. Thermal disinfection can only be completed when the disinfection temperature is exceeded for the duration of the disinfection period without any interruption.

The monitoring period PDIS starts as soon as the temperature at the allocated sensor falls below the disinfection temperature TDIS, once the monitoring period PDIS ends, disinfect period SDIS starts, the allocated reference relay activates the after-heating, and SDIS disinfect time count down "Disinfect 15" displays and flashes on the screen.

If the temperature at the allocated sensor exceeds the disinfection temperature, thermal disinfection heating period DDIS starts, disinfect 15 counts down time displays, count down time ends, thermal disinfection function stops.





Main menu	Subme nu1	Submen u2	Factory default	Adjustm ent	Adjustm ent	Description
				range	amplitu	
					de	
OHQM			OFF	ON/OFF		Heat quantity
						measurement
	FTYPE					Flow meter selection
		flowmet	flowmet			Mechnical flow meter
		er	er			
		VFS				VFS Grundfos flow meter
		FRT				FRT flow meter
	FMAX		6L/min	0.5-100L /min	0.1	Flow input
	MEDT		3	0-3		Media Type
						0; Water
						1; Propylene glycol
						2; Glycol
						3Tyfocol LS/G-LS;
	MED%		45%	20-70%	1%	Medium concentration

The heat quantity measurement can be carried out in 3 different ways:

- > Fixed flow rate (with flow meter)
- > With Granados flow rotor VFS.
- > FRT flow meter

Heat quantity measurement with fixed flow rate value

The heat quantity measurement calculation (estimation) uses the difference between the flow T1 and return T6 temperatures and the entered flow rate (at 100 % pump speed).

i Note: sensor of flow and return pipe for heat quantity measurement is default set in every system, it can not be set.

Under menu FTYPE to set the flow rate type Î

Read the flow rate (I/min) and adjust it in the FMAX menu

Adjust the antifreeze type and concentration of the heat transfer fluid under menu **MEDT** and **MED%**.

Antifreeze type:

- > 0: Water
- > 1: Propylene glycol
- > 2: Ethylene glycol
- > 3: Typhoo? LS / G-LS

i Note: Heat quantity measurement is not possible in systems with 2 solar pumps

Heat quantity measurement with Grundfos Direct SensorTM VFS:

The heat quantity measurement uses the difference between flow T6 and return TVFS temperature and the flow rate transmitted by the VFS sensor.

TVFS: Grundfos Direct sensor VFS

i Note:

- Sensor of flow and return pipe for heat quantity measurement is default set in every system, it can not be set.
- Flow checking function is only available when a VFS type Grundfos Direct Sensor is connected to the system.
- If select Grundfos sensor VFS to calculate heat quantity, firstly you should activate VFS function under menu GFDS, and select measurement range, default value is 1-12L/min.

Under menu FTYPE to set flow rate type VFS and measurement rang, default is 1-12L/min Adjust the antifreeze type and concentration of the heat transfer fluid under menu **MEDT** and **MED%**

For the systems with 2 collector fields, sensor should be installed on the general flow and return pipe for heat quantity measurement.

T6: Flow sensor

TVFS: Return sensor



Display unit of heat quantity for current day is DkWh, Accumulated heat quantity displays as

kWh or MWh, sum of current day quantity and accumulated quantity becomes total energy output.

(19) FS Flowmeter type selection



Flow monitoring

The flow monitoring function (OFLOW) is used to detect flow stagnation due to system functional errors and to close the corresponding water tank. This will protect the system from damage, such as avoiding dry running of the pump (dry running)

If the assigned relay is energized, the flow of the corresponding flow sensor will be monitored. If the flow rate of the sensor is not detected after the delay time (DELAY), a fault message will appear.

If the off option for the flow monitoring function has been enabled, the tank being heated will stop further heating until the fault message is cleared, and another tank will be heated as an alternative. If possible, the monitoring function will be activated again when the error message is cleared.

1 Note: If the flow sensor in use is removed, the flow monitoring function will be turned off.



(20) OSDC SD card

REMC	YES		Completing the logging
			process, remove the card
			from the slot
FORM	YES		Formatting the SDcard
C_BMP	YES		Clear all system pictures

The controller is designed with a MicroSD memory card slot. With a MicroSD card, the following functions can be performed:

Record measured and compared values: Record the measured and compared values on a MicroSD card. After saving these recorded values on a computer, the recorded values can be opened for browsing, such as in a spreadsheet format.

Backup and Restore Settings Parameters: Backup the adjustments and parameter settings made on the MicroSD card. If necessary, you can restore the backed up data from the card to the controller.

After the card is inserted into the card slot, the MicroSD card icon will appear on the main screen. If the card is full, the main screen will display a warning, and there will be a prompt on the query interface that the card storage is full.

• Running firmware software updates

When it is necessary to update firmware, the controller first cuts off the power supply, inserts a MicroSD card that requires the latest version of firmware into the card slot of the controller, and then presses and holds the "HOLIDAY" key to power on the controller. The update query will appear on the display screen (depending on the situation, different prompts will be displayed. If only firmware updates are required, only firmware updates will be provided, and if images need to be updated, an update prompt for the images will be added).

Press the "SET" button to confirm and update the firmware or image

The update occurs automatically after the update is completed. Press the "SET" key to restart the controller and enter the main program according to the prompts.

"To skip the update, press the" "ESC" "key.", The controller will resume normal operation.

If the operation is incorrect, just restart the machine.

Note: The controller will only find a file named "SR1568.bin" on the root directory of MicroSD memory card for the firmware update, find the file named BmpList.txt to update the pictures.

• Starting the logging

Insert the MicroSD card into the slot, Logging will start immediately.

Adjust the desired logging interval under menu OSDC-LOGI.

• Completing the logging process (REMC)

Select the menu item **REMC**, **"YES" displays**, **press "SET" to move the cursor to "YES"**, **continues press "SET"** to run the extract card order, running finished, "SUCC" will displays, then card can be taken out.

• Formatting the MicroSD card (FORM)

Select the menu item **FORM**, "YES" displays, **press "SET**" **to move the cursor to "YES**", **continues press "SET**" " WAIT" displays, formatting order starts to run, it lasts ca. 10 seconds, running finished, "SUCC" will displays, The content of the card will be deleted and the card will be formatted with the FAT file system.

• Storing controller adjustments (SAVE)

To tank the controller adjustments on the MicroSD card, select the menu item **SAVE**. Select the menu item **FORM**, "YES" displays, **press "SET" to move the cursor to "YES", continues press "SET"** to run save order, running finished, "SUCC" will displays. The controller adjustments are taken as "SR1568.DAT" file on the MicroSD card.

• Loading controller adjustments

To load controller adjustments from an SD card to controller, firstly find the file named "SR1567.DAT" on SD card, and then select the menu item LOAD. "YES" displays, press "SET" to move the cursor to "YES", continues press "SET" to run file loading, and then SUCC will be indicated on the display.

• Clear all system's pictures(C_BMP)

When system pictures appear errors, you can clear all the pictures from the flash card, while pictures are cleared. Select menu C_BMP, "YES" displaying, press "SET" cursor will move to "YES", continuously press "SET" to run clear process, after clearing, "SUCC" displays on the screen. Note, after pictures are cleared, please copy the pictures again from SD card to controller.

I Note: controller support MicroSD with maximum size of 32G, under OSDC menu, if "SAVE"、"LOAD"、"REMC"、"FORM" functions run successfully, behind every menu, "SUCC" displays, then you can no longer run these functions, but you can exit this menu and reenter, then such functions can be reactivated.



		value to "0"
C		Reset RE2 operation time
RE2_T		value to "0"
C CV_1		Reset CV operation time
		value to "0"
C		Reset RE3 operation time
RE3_T		value to "0"
С		Reset RE1 operation time
RE1_T		value to "0"

Rst Parameter: With the reset function, all settings can be restored to factory settings

C OHQM: Cumulative Heat (dHQM) can be reset to 0

C PUMP-T: Accumulated solar pump operating hours

(P1time/P2time/RE2time/CVtime/RE3time/RE1time to be reset to "0"

(22) PASS Password setting

Menu structure diagram								
PASS (Main menu) 22								
PWDC PWDN PWDN PWDG								
Main	Subme	Subme	Factory	Adjustm	Adjustm	Description		
menu	nu1	nu2	default	ent	ent			
menu	nu1	nu2	default	ent range	ent amplitu			
menu	nu1	nu2	default	ent range	ent amplitu de			
menu PASS	nu1	nu2	default	ent range	ent amplitu de	Password setting		
menu PASS	nu1 PWDC	nu2	default 0000	ent range	ent amplitu de	Password setting Enter the current		
menu PASS	nu1 PWDC	nu2	default 0000	ent range	ent amplitu de	Password setting Enter the current password		
menu PASS	nu1 PWDC PWDN	nu2	default 0000	ent range	ent amplitu de	Password setting Enter the current password Enter a new password		
menu PASS	nu1 PWDC PWDN PWDG	nu2	default 0000	ent range	ent amplitu de	Password setting Enter the current password Enter a new password Enter the new password		

Select password set menu "PASS"

▶ Press "SET" button, "PWDC 0000" displays on the screen, current password is asked to be entered. (Factory default password: 0000)

▶ Press "SET" button, "PWDN 0000" displays on the screen, enter a new password

▶ Press "SET" button, "PWDG 0000" displays on the screen, reenter the new password, and confirm the new password.

▶ Press "ESC" button to exit the set, new password is set successfully.

- **Note:** If the password is forgot, it is impossible to recover, but you can recover the password to factory set, then you can reedit a password like above descript steps, doing like following to recover to factory set.
- ► Switch-off the power to controller
- ► Hold down "ESC" button

► Reconnect the power supply, and then release "ESC" button, Controller recovers to the factory set password (factory set possword is 0000),

6. Holiday function

The holiday function is used for operating the system when no water consumption is expected, e. g. during a holiday absence. This function cools down the system in order to reduce the thermal load.

2 cooling functions are available: tank cooling (OSTC) and tank heat transfer (OHDP).

Controller is designed to run tank heat transfer (OHDP) function priority, when tank heat transfer (OHDP) function is deactivated, then tank cooling function (OHTC) runs automatically in turn.

Activated / deactivate holiday function

- ▶ Press "Holiday" button for 3 seconds, "Holiday 7 Days" displays.
- ▶ Press "↑", "↓" button to adjust days of holiday, adjust range 0-99 days.
- ▶ Repress "Holiday" button for 3 seconds, adjust days of holiday is "0" day.
- ▶ Press "ESC" button to exit, holiday function is deactivated.



7. Software of controller upgrade

Revision history

Rev	Date	Author	Description
1.0	6-Jul-2015	Ji GenJun	Initial version
1.1	30-Jul-2015	Ji GenJun	Update for picture upgrade
1.2	9-Aug-2015	Ji GenJun	Update for new firmware SR1568

1) Please copy the files like SR1568.bin,*.dta to the root directory of Micro SD Card. See screen snap below.

剪贴板	组织	新建	打开	选择		
• 1 👝 🕨 这台	合电脑 → 可移动磁盘 (G:)					✓ Č ∄
Ξ ^	名称		修改日期	类型	大小	
台访问的位置	SR1568.bin		2015-07-2	3 23:19 BIN 文件		319 KB
	auxBlank.dta		2015-07-1	1 15:06 DTA 文件		8 KB
Drive	BmpList.txt		2015-07-29	9 21:28 文本文档		1 KB
cuments	circ3_yy.dta		2015-07-28	8 22:10 DTA 文件		8 KB
tures	circ4_yy.dta		2015-07-28	3 22:36 DTA 文件		8 KB
	📄 solidfl.dta		2015-03-3	1 2:56 DTA 文件		5 KB
8	📄 sys1.dta		2015-07-1	1 20:09 DTA 文件		140 KB
1110						

A. Switch-off the power and insert card to the controller, then hold down button "HOLIDAY", and reconnect power to controller. Then the screen will show "Upgrade Picture and Firmware?" there are four possible questions can be shown here, please check the FAQs.



2) Press "SET" button to confirm upgrade, If there are updated file in card, screen will show red words "Updating Picture", blue word "working" will flash at the top of screen.



3) When upgrading is finished (depending on the size and quantity of files, running time is different), "Updating Picture OK" will show.



- 4) Press "SET" button to continue to upgrade firmware. Press "ESC" to exit upgrading and return to control system.
- 5) When Pressed "SET", after 3 seconds, display appears "Update Success! Press SET to restart", it indicate the upgrading is successful. Press "SET" or "ESC", the controller will return to the control system.



6) After the controller return to the system, please check the new version.





7) If the screen shows "Update Failure! Please try again!", please check the files in TFCard, and do again following the step 1 above descript or call our technician for support.

String in screen	Reason				
Please Insert TFCard!	The card is not inserted or not correctly.				
No valid files in TFCard!	Please check the files in Card, update the files, and try again.				
	The the format of the card, make sure it is FAT.				
Update Picture?	Only have pictures to update in Micro SD card				
Update Firmware?	Only have firmware to upgrade in Micro SD card				
Update Failure! Please try	Upgrade firmware failure, copy files from PC to Micro SD				
again!	card again, and try upgrade firmware again. Or call our				
	technician for support.				

FAQs:

8. Protection function

8.1 Screen protection

When no any press on button for 6 minutes, screen protection is activated automatically, and then LED background lamp is switched-off. Through press any button to light LED lamp again.

8.2 Trouble protection

When there is a break or short circuit between the connection of temperature sensors, flow meter and pressure sensor, controller switches off the corresponding functions and no more output signals are given, at the same time error signal \bigwedge appears on the screen. And indicate lamp flashes.

▶ Press "↑""↓" button to view the error message (red indication)

Fault code:

Т	Sensor fault
VFS	VFS Grundfos flow meter fault
NOFL	No flow fault

8.3 Trouble checking

The built-in controller is a qualified product, which is conceived for years of continuous trouble-free operation. If a problem occurs, the most of causes is from the peripheral components but no relation with controller itself. The following description of some well-known problems should help the installer and operator to isolate the problem, so that the system can be put into operation as quickly as possible and to avoid unnecessary cost. Of

course, not all possible problems can be listed here. However, most of the normal problems encountered with the controller can be found in the list below, only return the controller to seller when you are absolutely sure that none of the problems listed below is responsible for the fault.



PT1000 resistance value

°C	0	10	20	30	40	50	60	70	80	90	100	110	120
Ω	1000	1039	1077	1116	1155	1194	1232	1270	1309	1347	1385	1422	1460

NTC 10K B=3950 resistance value

°C	0	10	20	30	40	50	60	70	80	90	100	110	120
Ω	33620	20174	12535	8037	5301	3588	2486	1759	1270	933	697	529	407











9. Quality Guarantee

Manufacturer provides following quality responsibilities to end-users: within the period of quality responsibilities, manufacturer will exclude the failure caused by production and material selection. A correct installation will not lead to failure. When a user takes incorrect handling way, incorrect installation, improper or crude handling, and wrong connection of Warm water outflow upwards?

The quality warranty expires within 24 months after the date of purchasing the controller.

Products name	Specification	Products picture
A01: High accurate Pt1000 sensor for collector	PT1000, Φ6*50mm,with 1.5m cable	
A02 High accurate sensor for tank and pipe	NTC10K, B=3950, Φ6*50mm,with 3m cable	
A05 304 stainless steel thermo well	304 stainless steel with thread 1/2' OT, Size: Φ8*200	
A13 Grundfos Direct Sensor VFS	1-12l/min; 2-40l/min	
SR802 Unit for high power electrical heater	Dimension:100mm*100mm*65mm Power supply: AC180V ~ 264V, 50/60Hz Suitable power: ≤ 4000W Available ambient temperature: -10 ~ 50°C Waterproof grade: IP43	Image: state of the state o

10. Accessories





Note: Switch-off power, and perform by profession installer.