Thank you for buying this product.
Read this manual carefully to get the best performance from this unit.
Please keep this manual carefully.

iSolar™ 4

Mounting
Connection
Application examples
Operation
Troubleshooting
General

Safety advice:
Please read the following information carefully before installing and operating the controller. In this way damage to the solar system caused by wrong installation will be avoided. Please make sure that the mounting is adapted to the characteristics of the building, that the local regulations are respected and is conform with the technical rules.
Please pay attention to the following safety advice in order to avoid danger and damage to people and property.

Subject to technical change. Errors excepted.

Description of symbols

| WARNING! | Warnings are indicated with a warning triangle! They contain information on how to avoid the danger described. |

Signal words describe the danger that may occur, when it is not avoided.

**Warning** means that injury, possibly life-threatening injury, can occur.

**Attention** means that damage to the appliance can occur.

**Note**
Notes are indicated with an information symbol.

→ Arrows indicate instruction steps that should be carried out.

Instructions:

Attention should be paid to
• Valid national and local standards and regulations
• Respective valid standards and directives

Equipment to be installed and used in accordance with the rules of the National Electrical Code (NEC) or with Canadian Electrical Code (CEC), Part I.

These instructions are exclusively addressed to authorized skilled personnel.

• Only qualified electricians should carry out installation and maintenance work.
• Initial installation should be carried out by qualified personnel.

Information about the product

Proper usage

The solar controller is designed for use in solar thermal and heating systems in compliance with the technical data specified in these instructions.
Improper use excludes all liability claims.

Note
Strong electromagnetic fields can impair the function of the controller.

→ Make sure the controller as well as the system are not exposed to strong electromagnetic fields.
Overview

• System-monitoring-display
• Up to 4 Pt1000 temperature sensors
• Semiconductor relay for pump speed control
• 3 basic system layouts to choose from
• Energy metering
• VBus®
• Function control
• Thermostat function (time controlled)
• Control of the system by ServiceCenter software possible
• User-friendly operation
• Housing with outstanding design
• Extra-low power consumption
• HE pump control via adaptor

Included with the iSolar 4:
1 × iSolar 4
1 × accessory bag
  1 × spare fuse T4A
  2 × screws and wall plugs
  4 × strain relief and screws
1 × manual

Additionally enclosed in the full kit:
1 × sensor FKP6
2 × sensor FRP6

Technical data

Housing: plastic, PC-ABS and PMMA
Protection type: IP 20 / EN 60529
Ambient temp.: 32 ... 104 °F
[0 ... 40 °C]
Size: 6.8” × 4.3” × 1.9”
172 × 110 × 47 mm
Mounting: wall mounting, mounting into patch-panels is possible
Display: System screen for system visualization, 16-segment display, 7-segment display, 8 symbols for system status and operating control lamp
Operation: by 3 push buttons at the front of the housing

Functions: Differential temperature controller with optional add-on system functions. Function control, operating hours counter for solar pump, evacuated tube collector function, pump speed control, thermostat function, drainback and booster option, and energy metering.

Inputs:
for 4 Pt1000 temperature sensors

Outputs: 2 semiconductor relays

Bus: VBus®

Power supply: 100 ... 240 V~

Standby power consumption: < 1 W

Switching capacities:
R1: 1 (1) A 100 ... 240 V~ (semiconductor relay)
R2: 1 (1) A 100 ... 240 V~ (semiconductor relay)
1. Installation

1.1 Mounting

The unit must only be installed
- in a dry interior location
- in a non-hazardous location
- away from electromagnetic fields

The controller must additionally be supplied from a double-pole switch with contact gap of at least 0.12” [3 mm].

Route sensor cables and power supply cables separately.

- Unscrew the cross-head screw from the cover and remove it along with the cover from the housing
- Mark the upper fastening point on the wall and drill
- Fasten the enclosed wall plug and screw leaving the head protruding
- Hang the housing from the upper fastening point and mark the lower fastening point through the hole in the terminal box (centers 5.1” [130 mm])
- Drill and insert the lower wall plug
- Fasten the housing to the wall with lower fastening screw and tighten
- Complete wiring connections in accordance with terminal allocations, see chap. 1.2 “Electrical connection”
- Place the cover back onto the housing
- Fasten the cover by means of the cross-head screw

1.2 Electrical connection

ATTENTION! ESD damage!
Electrostatic discharge can lead to damage to electronic components!
- Take care to discharge properly before touching the inside of the device. To do so, touch a grounded surface such as a radiator or tap!

Note:
The minimum pump speed must be set to 100 % when auxiliary relays or valves are connected.
1.3 Data communication/ Bus

Connecting the device to the power supply must always be the last step of the installation!

The power supply to the controller must be carried out via an external power switch (last step!). The supply voltage must be 100 ... 240 V~ (50 ... 60 Hz). Flexible cables must be attached to the housing with the enclosed strain relief and the corresponding screws.

The controller is equipped with 2 semiconductor relays, to which loads such as pumps, valves etc. can be connected:

- Relay 1
  - 18 = conductor R1
  - 17 = neutral conductor N
  - 13 = ground conductor
- Relay 2
  - 16 = conductor R2
  - 15 = neutral conductor N
  - 14 = ground conductor

The power supply is to be carried out at the terminals:

- 19 = neutral conductor N
- 20 = conductor L
- 12 = ground terminal

The temperature sensors (S1 up to S4) are to be connected to the following terminals with either polarity:

1 / 2 = Sensor 1 (e.g. Sensor collector)
3 / 4 = Sensor 2 (e.g. Sensor tank)
5 / 6 = Sensor 3 (e.g. Sensor tank top)
7 / 8 = Sensor 4 (e.g. Sensor return)

All Pt1000 temperature sensors are equipped with a platinum measuring element in their tip. The electrical resistance of the measuring element changes in relation to the temperature (see table in chap. 5).

The difference between FKP and FRP type sensors only lies in the cable insulation material. The insulation material of FKP type sensor cables resists a higher temperature, so that FKP type sensors should be used as collector sensors. FRP type sensors are best used as reference sensors in tanks or pipes.

The controller is equipped with a VBus® for data transfer with and energy supply to external modules. The connection is carried out at the terminals marked “VBus” (either polarity). One or more VBus® modules can be connected via this data bus, such as:

- GA3 large display, SD3 smart display
- DL2 datalogger
- VBus®/USB or VBus®/LAN interface adaptor
- VBus®/PWM interface adaptor
- AM1 alarm module
- WMZ calorimeter module

By means of a DL2 datalogger or an interface adaptor, the controller can be connected to a PC or a computer network. With the ServiceCenter Software (RSC) the controller measurements can be read out, processed and visualized. The software allows easy function control of the system. For the remote parametrisation of the controller, a special software tool will be available for download, soon.
1.4 Terminal allocation in the different system layouts

System layout 1

The controller calculates the temperature difference between collector sensor S1 and tank sensor S2. If the difference is larger than or identical to the adjusted switch-on temperature difference (DT O), the solar pump will be operated by relay 1, and the tank will be loaded until the switch-off temperature difference (DT F) or the maximum tank temperature (S MX) is reached.

Sensors S3 and S4 can optionally be connected for measurement purposes. S3 can optionally be used as reference sensor for the tank emergency shutdown option (OSEM). If heat quantity measurement (OHQM) is activated, sensor S4 has to be connected as return sensor. If the drainback option (ODB) is activated, relay 2 can be used to operate a booster pump by activating the booster function (OBST).

Display Channels

<table>
<thead>
<tr>
<th>Channel</th>
<th>Description</th>
<th>Terminal</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>INIT</td>
<td>x° ODB initialization active</td>
<td>-</td>
<td>18</td>
</tr>
<tr>
<td>FLL</td>
<td>x° ODB filling time active</td>
<td>-</td>
<td>18</td>
</tr>
<tr>
<td>STAB</td>
<td>x° ODB stabilization in progress</td>
<td>-</td>
<td>18</td>
</tr>
<tr>
<td>COL</td>
<td>x Temperature collector</td>
<td>S1</td>
<td>18</td>
</tr>
<tr>
<td>TST</td>
<td>x Temperature tank</td>
<td>S2</td>
<td>18</td>
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<tr>
<td>S3</td>
<td>x Temperature sensor 3</td>
<td>S3</td>
<td>18</td>
</tr>
<tr>
<td>TSTT</td>
<td>x° Temperature tank at the top</td>
<td>S3</td>
<td>18</td>
</tr>
<tr>
<td>S4</td>
<td>x Temperature sensor 4</td>
<td>S4</td>
<td>18</td>
</tr>
<tr>
<td>TR</td>
<td>x° Temperature return sensor</td>
<td>S4</td>
<td>18</td>
</tr>
<tr>
<td>n %</td>
<td>x Pump speed R1</td>
<td>R1</td>
<td>19</td>
</tr>
<tr>
<td>hP</td>
<td>x Operating hours R1</td>
<td>R1</td>
<td>19</td>
</tr>
<tr>
<td>hP1</td>
<td>x° Operating hours R1 (if OBST is activated)</td>
<td>R1</td>
<td>19</td>
</tr>
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<td>hP2</td>
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<td>19</td>
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<tr>
<td>MWh</td>
<td>x° Heat quantity MWh</td>
<td>-</td>
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</tr>
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<td>TIME</td>
<td>x Time</td>
<td>-</td>
<td>16</td>
</tr>
<tr>
<td>Channel</td>
<td>Description</td>
<td>Factory setting</td>
<td>Page</td>
</tr>
<tr>
<td>---------</td>
<td>-------------</td>
<td>-----------------</td>
<td>------</td>
</tr>
<tr>
<td>Arr</td>
<td>System</td>
<td>1</td>
<td>20</td>
</tr>
<tr>
<td>DT O</td>
<td>Switch-on temperature difference</td>
<td>12.0 °Ra [6.0 K]</td>
<td>20</td>
</tr>
<tr>
<td>DT F</td>
<td>Switch-off temperature difference</td>
<td>8.0 °Ra [4.0 K]</td>
<td>20</td>
</tr>
<tr>
<td>DT S</td>
<td>Nominal temperature difference</td>
<td>20.0 °Ra [10.0 K]</td>
<td>20</td>
</tr>
<tr>
<td>RIS</td>
<td>Rise control R1</td>
<td>4 °Ra [2 K]</td>
<td>20</td>
</tr>
<tr>
<td>nMN</td>
<td>Minimum pump speed</td>
<td>30 %</td>
<td>20</td>
</tr>
<tr>
<td>S MX</td>
<td>Maximum tank temperature</td>
<td>140 °F [60 °C]</td>
<td>21</td>
</tr>
<tr>
<td>OSEM</td>
<td>Option tank emergency shutdown</td>
<td>OFF</td>
<td>21</td>
</tr>
<tr>
<td>EM</td>
<td>Emergency temperature temperature collector</td>
<td>270 °F [130 °C]</td>
<td>21</td>
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<tr>
<td>OCC</td>
<td>Option collector cooling</td>
<td>OFF</td>
<td>22</td>
</tr>
<tr>
<td>CMX</td>
<td>Maximum collector temperature</td>
<td>230 °F [110 °C]</td>
<td>22</td>
</tr>
<tr>
<td>OSYC</td>
<td>Option system cooling</td>
<td>OFF</td>
<td>22</td>
</tr>
<tr>
<td>DTCO</td>
<td>Cooling switch-on temperature difference</td>
<td>40.0 °Ra [20.0 K]</td>
<td>22</td>
</tr>
<tr>
<td>DTCF</td>
<td>Cooling switch-off temperature difference</td>
<td>30.0 °Ra [15.0 K]</td>
<td>22</td>
</tr>
<tr>
<td>OSTC</td>
<td>Option tank cooling</td>
<td>OFF</td>
<td>23</td>
</tr>
<tr>
<td>OHOL</td>
<td>Option holiday cooling</td>
<td>OFF</td>
<td>23</td>
</tr>
<tr>
<td>THOL</td>
<td>Holiday cooling temperature</td>
<td>110 °F [40 °C]</td>
<td>23</td>
</tr>
<tr>
<td>OCN</td>
<td>Option minimum limitation</td>
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<td>23</td>
</tr>
<tr>
<td>CMN</td>
<td>Minimum collector temperature</td>
<td>50 °F [10 °C]</td>
<td>23</td>
</tr>
<tr>
<td>OCF</td>
<td>Option antifreeze</td>
<td>OFF</td>
<td>23</td>
</tr>
<tr>
<td>CFR</td>
<td>Antifreeze temperature</td>
<td>40.0 °F [4.0 °C]</td>
<td>23</td>
</tr>
<tr>
<td>OTC</td>
<td>Option tube collector</td>
<td>OFF</td>
<td>24</td>
</tr>
<tr>
<td>TCST</td>
<td>OTC starting time</td>
<td>07:00</td>
<td>24</td>
</tr>
<tr>
<td>TCEN</td>
<td>OTC ending time</td>
<td>19:00</td>
<td>24</td>
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<tr>
<td>TCRU</td>
<td>OTC runtime</td>
<td>30 s</td>
<td>24</td>
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<tr>
<td>TCIN</td>
<td>OTC standstill interval</td>
<td>30 min</td>
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<td>OHQM</td>
<td>Option energy metering</td>
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<tr>
<td>FMAX</td>
<td>Maximum flow</td>
<td>6.0 l</td>
<td>24</td>
</tr>
<tr>
<td>MEDT</td>
<td>Antifreeze type</td>
<td>1</td>
<td>24</td>
</tr>
<tr>
<td>MED%</td>
<td>Antifreeze concentration (only if MEDT = propylene or ethylene)</td>
<td>45 %</td>
<td>24</td>
</tr>
<tr>
<td>ODB</td>
<td>Drainback option</td>
<td>OFF</td>
<td>25</td>
</tr>
<tr>
<td>tDTO</td>
<td>ODB switch-on condition - time period</td>
<td>60 s</td>
<td>25</td>
</tr>
<tr>
<td>tFLL</td>
<td>ODB filling time</td>
<td>5.0 min</td>
<td>25</td>
</tr>
<tr>
<td>tSTB</td>
<td>ODB stabilization time</td>
<td>2.0 min</td>
<td>25</td>
</tr>
<tr>
<td>OBST</td>
<td>Option booster function</td>
<td>OFF</td>
<td>25</td>
</tr>
<tr>
<td>MAN1</td>
<td>Manual operation R1</td>
<td>Auto</td>
<td>26</td>
</tr>
<tr>
<td>MAN2</td>
<td>Manual operation R2</td>
<td>Auto</td>
<td>26</td>
</tr>
<tr>
<td>ADA1</td>
<td>HE pump control</td>
<td>OFF</td>
<td>26</td>
</tr>
<tr>
<td>LANG</td>
<td>Language</td>
<td>En</td>
<td>26</td>
</tr>
<tr>
<td>UNIT</td>
<td>Temperature unit</td>
<td>°C</td>
<td>26</td>
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<tr>
<td>RESE</td>
<td>Reset - back to factory defaults</td>
<td></td>
<td>26</td>
</tr>
<tr>
<td>W0040100</td>
<td>Version number</td>
<td></td>
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Legend:

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>x</td>
<td>Channel is available</td>
</tr>
<tr>
<td>x*</td>
<td>Channel is available if the corresponding option is activated.</td>
</tr>
<tr>
<td>s*</td>
<td>System-specific channel, only available if the corresponding option is activated</td>
</tr>
</tbody>
</table>
System layout 2

The controller calculates the temperature difference between collector sensor S1 and tank sensor S2. If the difference is larger than or identical to the adjusted switch-on temperature difference (DT O), the solar pump will be operated by relay 1, and the tank will be loaded until the switch-off temperature difference (DT F) or the maximum tank temperature (S MX) is reached. Sensor S3 is used for a thermostatic function, which operates relay 2 for afterheating or heat dump purposes, when the adjusted thermostat switch-on temperature (AH O) is reached. This function can optionally be combined with up to three adjustable time frames. Sensor S3 can also be optionally used as a reference sensor for the thermal disinfection function OTD or the tank emergency shutdown option (OSEM). Sensor S4 can optionally be connected for measurement purposes. If heat quantity measurement (OHQM) is activated, sensor S4 has to be connected as return sensor.

Display Channels

<table>
<thead>
<tr>
<th>Channel</th>
<th>Description</th>
<th>Terminal</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>INIT</td>
<td>x* ODB initialization active</td>
<td>-</td>
<td>18</td>
</tr>
<tr>
<td>FLL</td>
<td>x* ODB filling time active</td>
<td>-</td>
<td>18</td>
</tr>
<tr>
<td>STAB</td>
<td>x* ODB stabilization in progress</td>
<td>-</td>
<td>18</td>
</tr>
<tr>
<td>COL</td>
<td>x Temperature collector</td>
<td>S1</td>
<td>18</td>
</tr>
<tr>
<td>TSTB</td>
<td>x Temperature tank 1 bottom</td>
<td>S2</td>
<td>18</td>
</tr>
<tr>
<td>TSTT</td>
<td>x Temperature tank 1 at the top</td>
<td>S3</td>
<td>18</td>
</tr>
<tr>
<td>TDIS</td>
<td>s* Thermal disinfection temperature</td>
<td>S3</td>
<td>18</td>
</tr>
<tr>
<td>S4</td>
<td>x Temperature sensor 4</td>
<td>S4</td>
<td>18</td>
</tr>
<tr>
<td>TR</td>
<td>x* Temperature return sensor</td>
<td>S4</td>
<td>18</td>
</tr>
<tr>
<td>n1 %</td>
<td>x Pump speed R1</td>
<td>R1</td>
<td>19</td>
</tr>
<tr>
<td>h P1</td>
<td>x Operating hours R1</td>
<td>R1</td>
<td>19</td>
</tr>
<tr>
<td>h P2</td>
<td>x Operating hours R2</td>
<td>R2</td>
<td>19</td>
</tr>
<tr>
<td>kWh</td>
<td>x* Heat quantity kWh</td>
<td>-</td>
<td>19</td>
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<tr>
<td>MWh</td>
<td>x* Heat quantity MWh</td>
<td>-</td>
<td>19</td>
</tr>
<tr>
<td>CDIS</td>
<td>s* Countdown of monitoring period</td>
<td>-</td>
<td>19</td>
</tr>
<tr>
<td>SDIS</td>
<td>s* Starting time display</td>
<td>-</td>
<td>19</td>
</tr>
<tr>
<td>DDIS</td>
<td>s* Heating period display</td>
<td>-</td>
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<td>TIME</td>
<td>x Time</td>
<td>-</td>
<td>16</td>
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### Adjustment Channels

<table>
<thead>
<tr>
<th>Channel</th>
<th>Description</th>
<th>Factory setting</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arr</td>
<td>x System</td>
<td>2</td>
<td>20</td>
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<tr>
<td>DT O</td>
<td>x Switch-on temperature difference</td>
<td>12.0 °Ra [6.0 K]</td>
<td>20</td>
</tr>
<tr>
<td>DT F</td>
<td>x Switch-off temperature difference</td>
<td>8.0 °Ra [4.0 K]</td>
<td>20</td>
</tr>
<tr>
<td>DT S</td>
<td>x Nominal temperature difference</td>
<td>20.0 °Ra [10.0 K]</td>
<td>20</td>
</tr>
<tr>
<td>RIS</td>
<td>x Rise control R1</td>
<td>4 °Ra [2 K]</td>
<td>20</td>
</tr>
<tr>
<td>n1MN</td>
<td>x Minimum pump speed R1</td>
<td>30 %</td>
<td>20</td>
</tr>
<tr>
<td>S MX</td>
<td>x Maximum tank temperature</td>
<td>140 °F [60 °C]</td>
<td>21</td>
</tr>
<tr>
<td>OSEM</td>
<td>x Option tank emergency shutdown</td>
<td>OFF</td>
<td>21</td>
</tr>
<tr>
<td>EM</td>
<td>x Emergency temperature collector</td>
<td>270 °F [130 °C]</td>
<td>21</td>
</tr>
<tr>
<td>OCC</td>
<td>x Option collector cooling</td>
<td>OFF</td>
<td>22</td>
</tr>
<tr>
<td>CMX</td>
<td>x* Maximum collector temperature</td>
<td>230 °F [110 °C]</td>
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</tr>
<tr>
<td>OSEMC</td>
<td>x Option system cooling</td>
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<td>22</td>
</tr>
<tr>
<td>DTCO</td>
<td>x* Cooling switch-on temperature difference</td>
<td>40.0 °Ra [20.0 K]</td>
<td>22</td>
</tr>
<tr>
<td>DTCF</td>
<td>x* Cooling switch-off temperature difference</td>
<td>30.0 °Ra [15.0 K]</td>
<td>22</td>
</tr>
<tr>
<td>OSTC</td>
<td>x Option tank cooling</td>
<td>OFF</td>
<td>23</td>
</tr>
<tr>
<td>OHOM</td>
<td>x* Option holiday cooling</td>
<td>OFF</td>
<td>23</td>
</tr>
<tr>
<td>THOL</td>
<td>x* Holiday cooling temperature</td>
<td>110 °F [40 °C]</td>
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</tr>
<tr>
<td>OCN</td>
<td>x Option minimum limitation</td>
<td>OFF</td>
<td>23</td>
</tr>
<tr>
<td>CMN</td>
<td>x* Minimum collector temperature</td>
<td>50 °F [10 °C]</td>
<td>23</td>
</tr>
<tr>
<td>OCF</td>
<td>x Option antifreeze</td>
<td>OFF</td>
<td>23</td>
</tr>
<tr>
<td>CFR</td>
<td>x* Antifreeze temperature</td>
<td>40.0 °F [4.0 °C]</td>
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</tr>
<tr>
<td>OTC</td>
<td>x Option tube collector</td>
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</tr>
<tr>
<td>TCST</td>
<td>x* OTC starting time</td>
<td>07:00</td>
<td>24</td>
</tr>
<tr>
<td>TCEN</td>
<td>x* OTC ending time</td>
<td>19:00</td>
<td>24</td>
</tr>
<tr>
<td>TCRU</td>
<td>x* OTC runtime</td>
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<tr>
<td>TCIN</td>
<td>x* OTC standstill interval</td>
<td>30 min</td>
<td>24</td>
</tr>
<tr>
<td>OHQM</td>
<td>x Option energy metering</td>
<td>OFF</td>
<td>24</td>
</tr>
<tr>
<td>FMAX</td>
<td>x* Maximum flow</td>
<td>6.0 l</td>
<td>24</td>
</tr>
<tr>
<td>MEDI</td>
<td>x* Antifreeze type</td>
<td>1</td>
<td>24</td>
</tr>
<tr>
<td>MED%</td>
<td>x* Antifreeze concentration</td>
<td>45 %</td>
<td>24</td>
</tr>
<tr>
<td>AH O</td>
<td>s Switch-on temp. for thermostat 1</td>
<td>110 °F [40 °C]</td>
<td>10</td>
</tr>
<tr>
<td>AH F</td>
<td>s Switch-off temp. for thermostat 1</td>
<td>120 °F [45 °C]</td>
<td>10</td>
</tr>
<tr>
<td>t1 O</td>
<td>s Switch-on time 1</td>
<td>00:00</td>
<td>10</td>
</tr>
<tr>
<td>t1 F</td>
<td>s Switch-off time 1</td>
<td>00:00</td>
<td>10</td>
</tr>
<tr>
<td>t2 O</td>
<td>s Switch-on time 2</td>
<td>00:00</td>
<td>10</td>
</tr>
<tr>
<td>t2 F</td>
<td>s Switch-off time 2</td>
<td>00:00</td>
<td>10</td>
</tr>
<tr>
<td>t3 O</td>
<td>s Switch-on time 3</td>
<td>00:00</td>
<td>10</td>
</tr>
<tr>
<td>t3 F</td>
<td>s Switch-off time 3</td>
<td>00:00</td>
<td>10</td>
</tr>
<tr>
<td>ODB</td>
<td>x Drainback option</td>
<td>OFF</td>
<td>25</td>
</tr>
<tr>
<td>tDTO</td>
<td>x* ODB switch-on condition - time period</td>
<td>60 s</td>
<td>25</td>
</tr>
<tr>
<td>tFLL</td>
<td>x* ODB filling time</td>
<td>5.0 min</td>
<td>25</td>
</tr>
<tr>
<td>tSTB</td>
<td>x* ODB stabilization time</td>
<td>2.0 min</td>
<td>25</td>
</tr>
<tr>
<td>OTD</td>
<td>s Option thermal disinfection</td>
<td>OFF</td>
<td>11</td>
</tr>
<tr>
<td>PDIS</td>
<td>s* Monitoring period</td>
<td>01:00</td>
<td>11</td>
</tr>
<tr>
<td>DDIS</td>
<td>s* Heating period</td>
<td>01:00</td>
<td>11</td>
</tr>
<tr>
<td>TDIS</td>
<td>s* Disinfection temperature</td>
<td>140 °F [60 °C]</td>
<td>11</td>
</tr>
<tr>
<td>SDIS</td>
<td>s* Starting time</td>
<td>00:00</td>
<td>11</td>
</tr>
<tr>
<td>MAN1</td>
<td>x Manual operation R1</td>
<td>Auto</td>
<td>26</td>
</tr>
<tr>
<td>MAN2</td>
<td>x Manual operation R2</td>
<td>Auto</td>
<td>26</td>
</tr>
<tr>
<td>ADA1</td>
<td>x HE pump control</td>
<td>OFF</td>
<td>26</td>
</tr>
<tr>
<td>LANG</td>
<td>x Language</td>
<td>En</td>
<td>26</td>
</tr>
<tr>
<td>UNIT</td>
<td>x Temperature unit</td>
<td>°C</td>
<td>26</td>
</tr>
<tr>
<td>RESE</td>
<td>x Reset - back to factory defaults</td>
<td></td>
<td>26</td>
</tr>
<tr>
<td>W0040100</td>
<td>Version number</td>
<td></td>
<td>26</td>
</tr>
</tbody>
</table>

**Legend:**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>x</td>
<td>Channel is available</td>
</tr>
<tr>
<td>x*</td>
<td>Channel is available if the corresponding option is activated.</td>
</tr>
<tr>
<td>s</td>
<td>Channel is specifically available in this system layout</td>
</tr>
<tr>
<td>s*</td>
<td>System-specific channel, only available if the corresponding option is activated</td>
</tr>
</tbody>
</table>
The thermostat function works independently from the solar operation and can be used for using surplus energy or for backup heating.

- **AH O < AH F**
  thermostat function for backup heating
- **AH O > AH F**
  thermostat function for using surplus energy

The symbol ① will be shown on the display if the second relay output is activated.

**Reference sensor for the thermostat function is S3!**

### AH O:
Thermostat switch-on temp.
Adjustment range:
30.0... 200.0 °F
[0.0 ... 95.0 °C]
in steps of 1.0 °F [0.5 °C]
Factory setting:
110.0°F [40.0 °C]

### AH F:
Thermostat switch-off temp.
Adjustment range:
30.0... 200.0 °F
[0.0 ... 95.0 °C]
in steps of 1.0 °F [0.5 °C]
Factory setting:
120.0 °F [45.0 °C]

### t1 O, t2 O, t3 O:
Thermostat switch-on time
Adjustment range:
00:00 ... 23:45
Factory setting: 00:00

### t1 F, t2 F, t3 F:
Thermostat switch-off time
Adjustment range:
00:00 ... 23:45
Factory setting: 00:00

In order to block the thermostat function for a certain period, there are three time frames t1 ... t3. If the function should be active between 6:00 and 9:00, set t1 O to 6:00 and t1 F to 9:00.

If all time frames are set to 00:00 o'clock, the thermostat function is continuously activated (factory setting).
When a starting time for thermal disinfection with starting delay is adjusted in SDIS, the thermal disinfection will be delayed until that time, even after the CDIS has counted down to 00:00. If CDIS ends, for example, at 12:00 o’clock, and SDIS has been set to 18:30, relay 2 will be operated with a delay of 6.5 hours at 18:30 instead of 12:00. During the waiting time, SDIS is displayed with the adjusted starting time (flashing).

If, during the waiting time, the temperature at S3 exceeds TDIS for the adjusted heating period DDIS, thermal disinfection is considered complete and a new monitoring period begins.

If the starting time is adjusted to 00:00 (factory setting), the delay function is inactive.

Upon delivery, OTD is deactivated. The adjustment values PDIS, TDIS, DDIS and SDIS are displayed after the option has been activated. After the thermal disinfection function has been completed, the values will be “hidden” and the monitoring period will be displayed.

**Option: Thermal disinfection of the upper DHW zone (OTD)**

**OTD:**
Thermal disinfection function
Adjustment range: ON / OFF
Factory setting: OFF

**PDIS:**
Monitoring period
Adjustment range: 0 ... 30:00 ... 24 h (dd:hh)
Factory setting: 01:00

**DDIS**
Heating period
Adjustment range: 00:00 ... 23:59 (hh:mm)
Factory setting: 01:00

**TDIS**
Disinfection temperature
Adjustment range: 30 ... 200 °F [0 ... 95 °C]
in steps of 2 °F [1 °C]
Factory setting: 140 °F [60 °C]

**SDIS**
Starting time
Adjustment range: 00:00 ... 24:00 (o’clock)
in steps of: 00:01
Factory setting: 00:00

This function is used for protecting the upper tank zone against Legionella by activating the backup heating.

**Reference sensor for the thermal disinfection is S3!**

To activate the function, select “On” in the OTD channel.

For thermal disinfection, the temperature in the upper DHW tank zone has to be monitored. This protection is ensured when, during the monitoring period (PDIS), the disinfection temperature (TDIS) is continuously exceeded for the entire heating period (DDIS). S3 is used as the reference sensor and displayed as TSTT.

If OTD is activated, PDIS will start as soon as the temperature at S3 falls below TDIS. In the display channel CDIS, the remaining time of PDIS is counted backwards. If, during the monitoring period, the temperature at S3 exceeds TDIS continuously for the duration of DDIS, thermal disinfection is considered complete and a new monitoring period begins.

If CDIS counts down to 00:00, relay 2 will be operated in order to use the backup heating for thermal disinfection. CDIS will then be replaced with a display channel DDIS showing the adjusted heating period. DDIS will start counting down the heating period as soon as TDIS is exceeded at S3. As long as DDIS is active, the temperature at S3 will be displayed as TDIS instead of TSTT.

If, during DDIS, the temperature at S3 exceeds TDIS by more than 10 °Ra [5 K], relay 2 is switched off until the temperature falls below TDIS + 4 °Ra [2 K].

If, during DDIS, the temperature at S3 falls below TDIS, the heating period will restart. DDIS can only be completed when TDIS is exceeded without interruption.

Due to the flexible control logic, the exact time of thermal disinfection is not predictable. In order to set a fixed time for the disinfection to be run, the starting delay SDIS must be employed:

When a starting time for thermal disinfection with starting delay is adjusted in SDIS, the thermal disinfection will be delayed until that time, even after the CDIS has counted down to 00:00. If CDIS ends, for example, at 12:00 o’clock, and SDIS has been set to 18:30, relay 2 will be operated with a delay of 6.5 hours at 18:30 instead of 12:00.

During the waiting time, SDIS is displayed with the adjusted starting time (flashing).

If, during the waiting time, the temperature at S3 exceeds TDIS for the adjusted heating period DDIS, thermal disinfection is considered complete and a new monitoring period begins.

If the starting time is adjusted to 00:00 (factory setting), the delay function is inactive.

Upon delivery, OTD is deactivated. The adjustment values PDIS, TDIS, DDIS and SDIS are displayed after the option has been activated. After the thermal disinfection function has been completed, the values will be “hidden” and the monitoring period will be displayed.
System layout 3

The controller calculates the temperature difference between collector sensor S1 and tank sensor S2. If the difference is larger than or identical to the adjusted switch-on temperature difference (DT O), the solar pump will be operated by relay 1, and the tank will be loaded until the switch-off temperature difference (DT F) or the maximum tank temperature (S MX) is reached.

If the maximum collector temperature (CMX) is reached, the solar pump will be operated by relay 1 and the 3-way-valve will be operated by relay 2 in order to direct the surplus energy to a heat dump. For security purpose this will be carried out only if the tank temperature is below the non-adjustable emergency shutdown of 200 °F.

Sensors S3 and S4 can optionally be connected for measurement purposes. S3 can optionally be used as reference sensor for the tank emergency shutdown option (OSEM). If heat quantity measurement (OHQM) is activated, sensor S4 has to be connected as return sensor.

| Display Channels |
|------------------|------------------|------------------|
| Channel | Description | Terminal | Page |
| COL | Temperature collector | S1 | 18 |
| TST | Temperature tank | S2 | 18 |
| S3 | Temperature sensor 3 | S3 | 18 |
| TSTT | Temperature tank at the top | S3 | 18 |
| S4 | Temperature sensor 4 | S4 | 18 |
| TR | Temperature return sensor | S4 | 18 |
| n % | Pump speed relay | R1 | 18 |
| h P1 | Operating hours R1 | R1 | 19 |
| h P2 | Operating hours R2 | R2 | 19 |
| kWh | Heat quantity kWh | - | 19 |
| MWh | Heat quantity MWh | - | 19 |
| TIME | Time | - | 16 |
### Adjustment Channels

<table>
<thead>
<tr>
<th>Channel</th>
<th>Description</th>
<th>Factory setting</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arr</td>
<td>x System</td>
<td>3</td>
<td>20</td>
</tr>
<tr>
<td>DT O</td>
<td>x Switch-on temperature difference</td>
<td>12.0 °Ra [6.0 K]</td>
<td>20</td>
</tr>
<tr>
<td>DT F</td>
<td>x Switch-off temperature difference</td>
<td>8.0 °Ra [4.0 K]</td>
<td>20</td>
</tr>
<tr>
<td>DT S</td>
<td>x Nominal temperature difference</td>
<td>20.0 °Ra [10.0 K]</td>
<td>20</td>
</tr>
<tr>
<td>RIS</td>
<td>x Rise control R1</td>
<td>4 °Ra [2 K]</td>
<td>20</td>
</tr>
<tr>
<td>nMN</td>
<td>x Minimum pump speed</td>
<td>30 %</td>
<td>20</td>
</tr>
<tr>
<td>S MX</td>
<td>x Maximum tank temperature</td>
<td>140 °F [60 °C]</td>
<td>21</td>
</tr>
<tr>
<td>OSEM</td>
<td>x Option tank emergency shutdown</td>
<td>OFF</td>
<td>21</td>
</tr>
<tr>
<td>EM</td>
<td>x Emergency temperature collector</td>
<td>270 °F [130 °C]</td>
<td>21</td>
</tr>
<tr>
<td>CMX</td>
<td>s Maximum collector temperature</td>
<td>230 °F [110 °C]</td>
<td>22</td>
</tr>
<tr>
<td>OCN</td>
<td>x Option minimum limitation</td>
<td>OFF</td>
<td>23</td>
</tr>
<tr>
<td>CMN</td>
<td>x* Minimum collector temperature</td>
<td>50 °F [10 °C]</td>
<td>23</td>
</tr>
<tr>
<td>OCF</td>
<td>x Option antifreeze</td>
<td>OFF</td>
<td>23</td>
</tr>
<tr>
<td>CFR</td>
<td>x* Antifreeze temperature</td>
<td>40.0 °F [4.0 °C]</td>
<td>23</td>
</tr>
<tr>
<td>OTC</td>
<td>x Option tube collector</td>
<td>OFF</td>
<td>24</td>
</tr>
<tr>
<td>TCST</td>
<td>x* OTC starting time</td>
<td>07:00</td>
<td>24</td>
</tr>
<tr>
<td>TCEN</td>
<td>x* OTC ending time</td>
<td>19:00</td>
<td>24</td>
</tr>
<tr>
<td>TCRU</td>
<td>x* OTC runtime</td>
<td>30 s</td>
<td>24</td>
</tr>
<tr>
<td>TCIN</td>
<td>x* OTC standstill interval</td>
<td>30 min</td>
<td>24</td>
</tr>
<tr>
<td>OHQM</td>
<td>x Option energy metering</td>
<td>OFF</td>
<td>24</td>
</tr>
<tr>
<td>FMAX</td>
<td>x* Maximum flow</td>
<td>6.0 l</td>
<td>24</td>
</tr>
<tr>
<td>MEDT</td>
<td>x* Antifreeze type</td>
<td>1</td>
<td>24</td>
</tr>
<tr>
<td>MED%</td>
<td>x* Antifreeze concentration (only if MEDT = propylene or ethylene)</td>
<td>45 %</td>
<td>24</td>
</tr>
<tr>
<td>MAN1</td>
<td>x Manual operation R1</td>
<td>Auto</td>
<td>26</td>
</tr>
<tr>
<td>MAN2</td>
<td>x Manual operation R2</td>
<td>Auto</td>
<td>26</td>
</tr>
<tr>
<td>ADA1</td>
<td>x HE pump control</td>
<td>OFF</td>
<td>26</td>
</tr>
<tr>
<td>LANG</td>
<td>x Language</td>
<td>En</td>
<td>26</td>
</tr>
<tr>
<td>UNIT</td>
<td>x Temperature unit</td>
<td>°C</td>
<td>26</td>
</tr>
<tr>
<td>RESE</td>
<td>x Reset - back to factory defaults</td>
<td></td>
<td>26</td>
</tr>
<tr>
<td>W0040100</td>
<td>Version number</td>
<td></td>
<td></td>
</tr>
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</table>

### Legend:

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>x</td>
<td>Channel is available</td>
</tr>
<tr>
<td>x*</td>
<td>Channel is available if the corresponding option is activated.</td>
</tr>
<tr>
<td>s</td>
<td>Channel is specifically available in this system layout</td>
</tr>
</tbody>
</table>
2. Operation and function

2.1 Push buttons

The controller is operated via three push buttons below the display.

**Button 1** is used for scrolling forward through the indication menu or to increase the adjustment values. **Button 2** is used for scrolling backward and reducing values. **Button 3** is used for selecting channels and confirming adjustments.

During normal operation, only the display channels are shown.

- Scroll through the display channels by pressing buttons 1 and 2

**Accessing the adjustment channels:**

- Scroll down in the display menu and press button 1 for approx. 2 seconds after you have reached the last display item.

When an **adjustment value** is shown on the display, **SET** is indicated to the right of the channel name.

- Press button 3 in order to access the adjustment mode. **SET** starts flashing.
- Adjust the value using buttons 1 and 2
- Briefly press button 3, **SET** permanently appears, the adjusted value will be saved.

2.2 System monitoring display

The system monitoring display consists of three blocks: **channel display, tool bar** and **system screen** (active system layout).

The **channel display** consists of 2 lines. The upper line is an alpha-numeric 16-segment display (text display) for displaying channel names and menu items. In the lower 7-segment display, the channel values and the adjustment parameters are displayed.

Temperatures are either indicated in °F or °C, whereas temperature differences are indicated in K or °Ra respectively.

The additional symbols of the **tool bar** indicate the current system status.

<table>
<thead>
<tr>
<th>Status</th>
<th>standard</th>
<th>flashing</th>
</tr>
</thead>
<tbody>
<tr>
<td>relay 1 active</td>
<td></td>
<td></td>
</tr>
<tr>
<td>relay 2 active</td>
<td></td>
<td></td>
</tr>
<tr>
<td>maximum tank temperature exceeded</td>
<td></td>
<td></td>
</tr>
<tr>
<td>tank emergency shutdown active</td>
<td></td>
<td></td>
</tr>
<tr>
<td>collector emergency shutdown active</td>
<td></td>
<td></td>
</tr>
<tr>
<td>collector cooling active</td>
<td></td>
<td></td>
</tr>
<tr>
<td>system cooling active</td>
<td></td>
<td></td>
</tr>
<tr>
<td>tank cooling active</td>
<td></td>
<td></td>
</tr>
<tr>
<td>holiday cooling function activated</td>
<td></td>
<td></td>
</tr>
<tr>
<td>holiday cooling function active</td>
<td></td>
<td></td>
</tr>
<tr>
<td>collector minimum limitation active</td>
<td></td>
<td></td>
</tr>
<tr>
<td>antifreeze function activated</td>
<td></td>
<td></td>
</tr>
<tr>
<td>antifreeze function active</td>
<td></td>
<td></td>
</tr>
<tr>
<td>manual operation relay 1 ON</td>
<td></td>
<td></td>
</tr>
<tr>
<td>manual operation relay 2 ON</td>
<td></td>
<td></td>
</tr>
<tr>
<td>manual operation relay 1 / 2 OFF</td>
<td></td>
<td></td>
</tr>
<tr>
<td>sensor defective</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The system screen (active system layout) shows the system selected on the controller. It consists of several system component symbols, which are – depending on the current status of the system – either flashing, permanently shown or hidden.

**System screen**

- **Collector** with collector sensor
- **Tank** with heat exchanger
- **3-way valve** The flow direction or the actual switching position is shown
- **Backup heating** with burner symbol
- **Temperature sensor**
- **Pump**

### 2.3 Flashing codes

#### System screen flashing codes
- Pumps are flashing when the corresponding relay is switched on
- Sensor symbols are flashing if the corresponding sensor display channel is selected
- Sensors are flashing quickly in the case of a sensor fault
- Burner symbol is flashing if the backup heating is active

#### LED flashing codes
- green: everything OK
- red/green flashing: initialization phase
- red flashing: manual operation
- sensor fault
  (sensor symbol is flashing quickly)
3. Commissioning

➢ Establish the power supply
During a short initialization phase, the operating control lamp flashes red and green.

When the controller is commissioned for the first time or after a reset, it will run a commissioning menu. The commissioning menu leads the user through the most important adjustment channels needed for operating the system.

Operating the commissioning menu:
➢ Enter the channel by pressing button 3
The SET symbol flashes.
➢ Adjust the value by pressing buttons 1 and 2
➢ Save the adjustment by pressing button 3 again
The SET symbol stops flashing.
➢ Press button 1 or 2 to switch to the next or previous channel

The commissioning menu consists of the following 6 channels:

LANG:
Language selection
Selection: dE, En, Fr
Factory setting: En

UNIT:
Temperature unit selection
Selection: °F, °C
Factory setting: °F

TIME:
Real time adjustment

The three pushbuttons of the BS/4 controller

1. Language
➢ Adjust the desired menu language in this channel
• dE : German
• En : English
• Fr : French

2. Unit
➢ Adjust the unit in which temperatures and temperature differences shall be displayed

3. Time
➢ Adjust the current time for the real time clock
The hours and minutes have to be adjusted separately, first the hours, then the minutes.
4. System layout

- Adjust the desired system layout of your solar thermal system.

For a detailed description of the different system layouts selectable, see chapter 1.4.

Overview of system layouts:

Arr 1: standard solar system layout
Arr 2: solar system layout with backup heating
Arr 3: standard solar system layout with heat dump

If the system layout selection is changed later on, any previous adjustments which have been made in the other channels will be lost. Therefore, changing the system layout is always followed by a security enquiry.

Only confirm the security enquiry if you are sure that you wish to change the system layout selection!

Security enquiry:

To confirm the security enquiry, press button 3

5. Maximum tank temperature

- Adjust the desired maximum tank temperature

S MX:

Maximum tank temp.

Adjustment range:
40 ... 200 °F [4 ... 95 °C]
Arr 3:
40 ... 190 °F [4 ... 90 °C]
in steps of 2 °F [1 °C]
Factory setting: 140 °F [60 °C]

Note:
The controller is also equipped with a non-adjustable emergency shutdown function, which will shut the system down if the tank reaches 200 °F [95 °C].

6. Minimum pump speed

- Adjust a minimum speed for the pump

nMN:
Pump speed control

Adjustment range:
30 ... 100 %
in steps of 5 %
Factory setting: 30 %

Note:
If a load which is not speed-controlled is used, the value must be set to 100 %.

Completing the commissioning menu

After the last channel of the commissioning menu has been adjusted and confirmed, the controller asks for confirmation of the adjustments.

- To confirm the adjustments made in the commissioning menu, press button 3

Now the controller is ready for operation with typical settings to suit the selected system layout.

The settings made in the commissioning menu can be changed later on in the corresponding adjustment channels. Additional functions and options can of course be individually adjusted as well (see chap. 4.2).
# 4. Channel overview

## 4.1 Display channels

### Indication of collector temperature

**COL:**

Collector temperature

Display range: 

-40...+500 °F  
[-40...+260 °C]

Indicates the current collector temperature.

### Indication of tank temperatures

**TST, TSTB, TSTT, TDIS:**

Tank temperatures

Display range: 

-40...+500 °F  
[-40...+260 °C]

Indicates the current tank temperature.

- **TST:** tank temperature  
- **TSTB:** tank temperature bottom  
- **TSTT:** tank temperature top  
- **TDIS:** thermal disinfection temperature  
  (replaces TSTT if, during thermal disinfection, the heating period DDIS is active)

**TSTB** and **TDIS** are available in Arr = 2 only

### Indication of sensors 3 and 4

**S3, S4:**

Sensor temperatures

Display range: 

-40...+500 °F  
[-40...+260 °C]

Indicates the current temperature of the corresponding additional sensor (without control function).

- **S3:** temperature sensor 3 (Arr = 1 and 3 only)  
- **S4:** temperature sensor 4

### Indication of return temperature

**TR:**

Return temperature

Display range: 

-40...+500 °F  
[-40...+260 °C]

If energy metering is active, the temperature at sensor 4 is indicated as TR.

### Note:

The displayed values and adjustment channels depend on which system layout, which options and functions have been selected. Only values and adjustment channels available for the individual settings selected will appear in the menu.

- **INIT:** ODB initialization active

Indicates the time adjusted in tDTO, running backwards.

- **FLL:** ODB filling time active

Indicates the time adjusted in tFLL, running backwards.

- **STAB:** Stabilization

Indicates the time adjusted in tSTB, running backwards.

### Note:

S3 and S4 will only be indicated if the temperature sensors are connected.
Indication of current pump speed

\[ n \%: \]
Current pump speed
Display range: 30 ... 100 \%

\[ kWh/MWh: \]
Heat quantity
in kWh / MWh
Display channel

Indicates the current pump speed of the solar pump.

Indicates the energy gained in heat quantity – only available if energy metering (OHQM) is activated.

The flow rate as well as the reference sensors S1 (flow) and S4 (return) are used for calculating the heat quantity supplied. It is shown in kWh in the channel kWh and in MWh in the channel MWh. The overall heat quantity results from the sum of both values.

The accumulated heat quantity can be set back to 0. As soon as one of the display channels of the heat quantity is selected, the SET symbol is permanently shown on the display.

- Press button 3 for about 2 seconds in order to access the RESET mode of the counter.
- The display symbol SET will flash and the heat quantity value will be set to 0.
- Confirm the reset with button 3 in order to finish the reset.

In order to interrupt the RESET-process, do not press a button for about five seconds. The display returns to the display mode.

CDIS
Countdown of monitoring period
Display range:
0 ... 30:0 ... 24 (dd:hh)

SDIS
Starting time display
Display range:
00:00 ... 24:00 (hh:mm)

DDIS
Heating period display
Display range:
00:00 ... 24:00 (hh:mm)

TIME
Indicates the current time.

- Press button 3 for two seconds to adjust the hours
- Set the hours by pressing buttons 1 and 2
- Press button 3 again to adjust the minutes
- Set the minutes by pressing buttons 1 and 2
- Press button 3 in order to save the adjustments

If the thermal disinfection option (OTD) is activated and the monitoring period is in progress, the remaining monitoring time will be displayed as CDIS (in days and hours) and counted backwards.

If the thermal disinfection option (OTD) is activated and a starting delay time has been adjusted, the adjusted delay time is displayed (flashing) in this channel.

If the thermal disinfection option (OTD) is activated and the heating period is in progress, the remaining time of the heating period is displayed (in hours and minutes) in this channel, counting backwards.

The operating hours counter accumulates the solar operating hours of the respective relay (h P / h P1 / h P2). Full hours are displayed.

The accumulated operating hours can be set back to 0. As soon as one operating hours channel is selected, the symbol SET is displayed.

- In order to access the RESET-mode of the counter, press button 3 for approx. 2 seconds.
- The display symbol SET will flash and the operating hours will be set to 0.
- Confirm the reset with button 3 in order to finish the reset.

In order to interrupt the RESET-process, do not press a button for about five seconds. The display returns to the display mode.
4.2 Adjustment channels

System layout selection

Arr:
System layout selection.
Adjustment range: 1 ... 3
Factory setting: 1

Security enquiry:

ΔT-regulation

DT O:
Switch-on temperature diff.
Adjustment range: 2.0 ... 40.0 °Ra
[1.0 ... 20.0 K]
in steps of 1 °Ra [0.5 K]
Factory setting: 12.0 °Ra [6.0 K]

DT F:
Switch-off temperature diff.
Adjustment range: 1.0 ... 39.0 °Ra
[0.5 ... 19.5 K]
in steps of 1 °Ra [0.5 K]
Factory setting: 8.0 °Ra [4.0 K]

Pump speed control

DT S:
Nominal temperature difference
Adjustment range: 3.0 ... 60.0 °Ra
[1.5 ... 30.0 K]
in steps of 1 °Ra [0.5 K]
Factory setting: 20.0 °Ra [10.0 K]

RIS:
Rise
Adjustment range: 2 ... 40 °Ra [1 ... 20 K]
in steps of 2 °Ra [1 K]
Factory setting: 4 °Ra [2 K]

Minimum pump speed

nMN:
Pump speed control
Adjustment range: 30 ... 100 %
in steps of 5 %
Factory setting: 30 %
if ODB is activated: 50 %

In this channel, a pre-defined system layout can be selected. Each system layout has a set of pre-programmed settings that can be individually changed. If the system layout selection is changed later on, all adjustments made in the other channels will be lost. Therefore, changing the system layout is always followed by a security enquiry.

Only confirm the security enquiry if you are sure that you wish to change the system layout selection!

→ To confirm the security enquiry, press button 3

The controller works as a standard differential controller. If the switch-on difference is reached, the pump is activated. When the temperature difference falls below the adjusted switch-off temperature difference, the relay switches off.

Note:
The switch-on temperature difference must be at least 1 °Ra [0.5 K] higher than the switch-off temperature difference.

Note:
When the drainback option ODB is activated, the temperature differences DT O, DT F and DT S are set to a fixed adjustment:

DT O = 20 °Ra [10 K]
DT F = 8 °Ra [4 K]
DT S = 30 °Ra [15 K]

Previous adjustments made in these channels will be overridden and may have to be entered again if ODB is deactivated later on.

Note:
For pump speed control, the operation mode of relay 1 must be set to Auto (adjustment channel MAN1).

When the switch-on temperature difference is reached, the pump is activated at full speed for 10 seconds. Then, the speed is reduced to the minimum pump speed value (factory setting = 30%).

If the temperature difference reaches the adjusted nominal temperature difference, the pump speed increases by one step (10%). If the difference increases by the adjustable rise value, the pump speed increases by 10% respectively until the maximum pump speed of 100% is reached. The response of the controller can be adapted via the parameter “Rise”.

Note:
The nominal temperature difference must be at least 1 °Ra [0.5 K] higher than the switch-on temperature difference.

A relative minimum pump speed can be allocated to the output R1 via the adjustment channel nMN.

Note:
When a load which is not speed-controlled is used, the value must be set to 100% in order to deactivate pump speed control.
Maximum tank temperature

S MX:
Maximum tank temp.
Adjustment range:
40 ... 200 °F [4 ... 95 °C]
Arr 3:
40 ... 190 °F [4 ... 90 °C]
in steps of 2 °F [1 °C]
Factory setting: 140 °F [60 °C]

Once the adjusted maximum temperature is exceeded, the solar pump is switched off and further loading of the tank is prevented to reduce scald risk or system damage. A fixed hysteresis of 4 °Ra [2 K] is set for the maximum tank temperature.

When the temperature at sensor 2 exceeds the adjusted maximum tank temperature, the symbol is shown on the display.

Note:
If the collector cooling or the system cooling function is activated, the adjusted tank temperature may be overridden. In order to prevent system damage, the controller is also equipped with a non-adjustable emergency shutdown if the tank reaches 200 °F [95 °C].

Tank emergency shutdown option

OSEM:
Tank emergency shutdown option
Adjustment range: ON/OFF
Factory setting: OFF

This option is used for activating the integrated tank emergency shutdown for an upper tank sensor. If the temperature at the reference sensor (S3) exceeds 200 °F [95 °C], the tank will be blocked and loading will be stopped until the temperature falls below 190 °F [90 °C].

Collector temperature limitation

Emergency shutdown of the collector

EM:
Collector temperature limitation
Adjustment range:
170 ... 390 °F [80 ... 200 °C]
in steps of 2 °F [1 °C]
Factory setting: 270 °F [130 °C]

If the adjusted collector emergency shutdown temperature EM is exceeded, the controller switches off the solar pump (R1) in order to protect the system against overheating (collector emergency shutdown). A hysteresis of 20 °Ra [10 K] is set for the collector temperature limitation. While the collector is in emergency shutdown, (flashing) is shown on the display.

Note:
If the drainback option ODB is activated, the adjustment range of EM is changed to 170 ... 250 °F [80 ... 120 °C]. The factory setting in that case is 200 °F [95 °C].

WARNING!
Danger of injury and system damage through pressure surges!
If water is used as a heat transfer medium in a pressure-less system, the water will start boiling at 212 °F [100 °C].

➔ If a pressure-less drainback system is used with water as a heat transfer medium, do not adjust the collector temperature limitation EM to more than 200 °F [95 °C]!
Cooling functions

In the following the three cooling functions – collector cooling, system cooling and tank cooling – are described in detail. The following notes are valid for all three cooling functions:

Note:
The cooling functions will not become active as long as solar loading is possible.

Collector cooling function

OCC:
Option collector cooling
Adjustment range: OFF/ON
Factory setting: OFF

CMX:
Maximum collector temp.
Adjustment range:
150...320 °F
[70 ... 160 °C]
in steps of 1 °F [1 °C]
Factory setting:
230 °F [110 °C]

When the collector cooling function is activated, the controller aims to keep the collector at an operational temperature. When the adjusted maximum tank temperature is reached, solar loading stops. If the collector temperature increases to the adjusted maximum collector temperature, the solar pump is activated until the collector temperature falls at least 10 °R [5 K] below the maximum collector temperature. The tank temperature may increase (subordinate active maximum tank temperature), but only up to 200 °F [95 °C] (emergency shutdown of the tank).

If the collector cooling function is active, † and ✻ (flashing) is shown on the display.

Note:
This function will only be available if the system cooling function (OSYC) is deactivated.

Note:
In system layout 3, the parameter CMX is available without the OCC function. In system layout 3, CMX is used to set the activation temperature for the heat dump function. No other switch-on condition is needed in that case.

System cooling function

OSYC:
Option system cooling
Adjustment range: OFF/ON
Factory setting: OFF

DTCO:
Switch-on temperature diff.
Adjustment range:
2.0 ... 60.0 °Ra
[1.0 ... 30.0 K]
in steps of 1 °Ra [0.5 K]
Factory setting:
40.0 °Ra [20.0 K]

When the system cooling function is activated, the controller 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 maximum tank temperature SMX and the switch-on temperature difference DTCO is reached, the solar system remains activated. Solar loading is continued until either the tank temperature reaches 200 °F [95 °C] (emergency shutdown of the tank), the temperature difference falls below the adjusted value DTCF or the collector emergency shutdown temperature EM is reached.

If the system cooling function is active, † and ✻ (flashing) is shown on the display.

Note:
This function will only be available if the collector cooling function (OCC) is deactivated.

DTCF:
Switch-off temperature diff.
Adjustment range:
1.0 ... 59.0 °Ra
[0.5 ... 29.5 K]
in steps of 1 °Ra [0.5 K]
Factory setting:
30.0 °Ra [15.0 K]

Note:
This function will only be available if the system cooling function (OSYC) is deactivated.
Tank cooling function

**OSTC:**
Tank cooling option
Adjustment range: OFF / ON
Factory setting: OFF

**CMN:**
Collector minimum temp.
Adjustment range: 50.0 ... 190.0 °F
[10.0 ... 90.0 °C]
in steps of 1.0 °F [0.5 °C]
Factory setting: 50.0 °F [10.0 °C]

Collector minimum limitation option

**OCN:**
Collector minimum limitation
Adjustment range: OFF / ON
Factory setting: OFF

**CMN:**
Collector minimum temp.
Adjustment range: 50.0 ... 190.0 °F
[10.0 ... 90.0 °C]
in steps of 1.0 °F [0.5 °C]
Factory setting: 50.0 °F [10.0 °C]

Antifreeze option

**OCF:**
Antifreeze function
Adjustment range: OFF / ON
Factory setting: OFF

**CFR:**
Antifreeze temperature
Adjustment range: -40.0 ... +50.0 °F
[-40.0 ... +10.0 °C]
in steps of 1 °F [0.5 °C]
Factory setting: 40.0 °F [4.0 °C]

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 $S_{MX}$ is exceeded and the collector temperature falls below the tank temperature, the system will be reactivated in order to cool down the tank. Cooling will continue until the tank temperature has fallen below the adjusted maximum tank temperature $S_{MX}$ again. A fixed hysteresis of 4 °R [2 K] is set for this function.

Reference threshold temperature differences for the tank cooling function are $DT_{O}$ and $DT_{F}$.

If no DHW consumption is expected for a longer period of time, the additional holiday cooling option $OHOL$ can be activated in order to extend the tank cooling function. The adjustable temperature $THOL$ then replaces the maximum tank temperature $S_{MX}$ as a switch-off temperature for the tank cooling function.

When the holiday cooling function is activated, $\odot$ and $\Delta$ (flashing) are shown on the display.

While the holiday cooling function is active, $\odot$, $\odot$ and $\Delta$ (flashing) are shown on the display.

**Note:**
If $OSTC$ or $OCF$ is active, the collector minimum function will be overridden. In that case, the collector temperature may fall below $CMN$.

The antifreeze function activates the loading circuit between the collector and the tank when the temperature falls below the adjusted antifreeze temperature. This will protect the fluid against freezing or coagulating. If the adjusted antifreeze temperature is exceeded by 2 °R [1 K], the loading circuit will be deactivated.

When the antifreeze function is activated, $\odot$ is shown on the display. If the antifreeze function is active, $\odot$ and $\odot$ (flashing) are shown on the display.

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

The antifreeze function will be suppressed if the tank temperature falls below 40 °F [5 °C] in order to protect the tank from frost damage.
Evacuated tube collector function

**OTC:**
Evacuated tube collector function  
Adjustment range: OFF/ON  
Factory setting: OFF

**TCST:**
Tube collector function starting time  
Adjustment range: 00:00...23:45  
in steps of 00:15  
Factory setting: 07:00

**TCEN:**
Tube collector function ending time  
Adjustment range: 00:00...23:45  
in steps of 00:15  
Factory setting: 19:00

**TCRU:**
Tube collector function runtime  
Adjustment range: 5 ... 500 s  
in steps of 5 s  
Factory setting: 30 s

**TCIN:**
Tube collector function standstill interval  
Adjustment range: 1 ... 60 min  
in steps of 1 min  
Factory setting: 30 min

**Energy metering**

**OHQM:** Energy metering  
Adjustment range: OFF/ON  
Factory setting: OFF

**FMAX:** Flow rate in l/min  
Adjustment range: 0.5 ... 100.0  
in steps of 0.5  
Factory setting: 6.0

**MEDT:** Heat transfer fluid  
Adjustment range: 0...3  
Factory setting: 1

**MED%:** Antifreeze ratio in Vol-% (MED% is hidden when MEDT 0 or 3 is used.)  
Adjustment range: 20...70 %  
in steps of 1 %  
Factory setting: 45 %

This function helps overcome the disadvantages caused by the non-ideal sensor position with some tube collectors. This function operates within an adjusted time frame (beginning at TCST and ending at TCEN). It activates the collector circuit pump for an adjustable runtime (TCRU) between adjustable standstill intervals (TCIN) in order to compensate for the delayed temperature measurement.

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

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

Note:
If the drainback option ODB is activated, TCRU will not be available. In that case, the runtime is determined by the parameters tFLL and tSTB.

**WARNING!**  
Danger of injury and system damage through pressure surges!  
If a drainback system is filled due to the tube collector function and the heat transfer medium enters very hot collectors, pressure surges can occur.  
⇒ If a pressure-less drainback system is used, TCST and TCEN must be adjusted such that the system will not be filled during times of potentially strong irradiation!

If OHQM is activated, the heat quantity gained can be calculated and displayed. Energy metering is possible if a flowmeter is used. To enable energy metering, proceed as follows:

⇒ Read the flow rate (l/min) from the flowmeter at maximum pump speed and adjust it in the FMAX channel

⇒ Adjust the heat transfer fluid and the concentration of the antifreeze in the channels MEDT and MED%.

**Heat transfer fluid:**

0 : Water  
1 : Propylene glycol  
2 : Ethylene glycol  
3 : Tyfocor® LS / G-LS

Note:
If the system layout 3 has been selected and OHQM is activated, energy metering will be interrupted when the 3-way-valve switches to the heat dump.
### Drainback option

**Note:**
A drainback system layout requires additional components such as a holding tank. The drainback option should only be activated if all components required are properly installed.

**Note:**
The drainback option is only available in system layouts 1 and 2.

### ODB:
**Drainback option**
Adjustment range: OFF / ON
Factory setting: OFF

**Note:**
When the drainback option ODB is activated, the cooling functions OCC, OSYC and OSTC as well as the antifreeze function OCF are not available.
If OCC, OSYC, OSTC or OCF have already been activated before, they will be deactivated again as soon as ODB is activated. They will remain deactivated, even if ODB is deactivated later on.

### Time period - switch-on conditions

**tDTO:**
Time period - switch-on conditions
Adjustment range: 1 ... 100 s in steps of 1 s
Factory setting: 60 s

**Filling time**
**tFLL:**
Filling time
Adjustment range: 1.0 ... 30.0 min in steps of 0.5 min
Factory setting: 5.0 min

**Stabilization**
**tSTB:**
Stabilization
Adjustment range: 1.0 ... 15.0 min in steps of 0.5 min
Factory setting: 2.0 min

### Booster function option

**OBST:**
Booster function
Adjustment range: ON / OFF
Factory setting: OFF

A drainback system permits the heat transfer fluid to drain back into the holding tank when solar energy is not collected. The drainback option will initiate the filling of the system when solar loading begins.

If the drainback option ODB is activated, the pump will operate at 100 % speed for the adjusted filling time tFLL in order to fill the system with fluid from the holding tank. After tFLL, pump speed will go down to the adjusted minimum pump speed nMn. The switch-off conditions will then be ignored for the stabilization time tSTB in order to avoid the system from shutting down prematurely.

If the function is activated, the menu items described in the following (tDTO, tFLL and tSTB) have to be adjusted:

**Note:**
When the drainback option ODB is activated, the temperature differences DT O, DT F and DT S as well as the minimum speed value nMN are set to a fixed adjustment. Additionally, the adjustment range and the factory setting of the collector emergency shutdown temperature EM changes (see the corresponding channel descriptions for further information).

Previous adjustments made in these channels will be overridden and have to be entered again if ODB is deactivated later on.

The parameter tDTO is used for adjusting the time period during which the switch-on condition DT O must be permanently fulfilled.

The filling time can be adjusted using the parameter tFLL. During this period, the pump runs at 100 % speed.

The parameter tSTB is used for adjusting the time period during which the switch-off condition DT F will be ignored after the filling time has ended.

This function is used for switching on a second pump when filling the solar system. When solar loading starts, R2 is energized in parallel to R1. After the filling time (tFLL) has ended, R2 is switched off.

**Note:**
The booster function is available in system layout 1 (Arr = 1) only. The booster function will only be available if the drainback option has been activated.
Operating mode
MAN1 / MAN2:
Operating mode
Adjustment range: OFF, Auto, ON
Factory setting: Auto

For control and service work, the operating mode of the controller can be manually adjusted. For this purpose, select the adjustment value MAN1, MAN2 in which the following adjustments can be made:

- **MAN1 / MAN2**
  Operating mode
  OFF: relay off (flashing) +
  Auto: relay in automatic operation
  ON: relay on (flashing) + /

**Note:**
Always adjust the operating mode back to “Auto” when the control and service work is completed. Normal operation is not possible in manual mode.

HE pump control
ADA1:
HE pump control
Adjustment range: ON / OFF
Factory setting: OFF

This option is used for controlling a high-efficiency pump via a VBus®/PWM adaptor. The power supply of the pump takes place via the semiconductor relay (R1). For pump speed control with activated ADA1 option, the relay is switched on or off (no pulse packets). Temperature dependent speed information is transmitted via the VBus®. The relay will remain deactivated for 1 hour after its switch-off conditions have been fulfilled (pump protection).

Language
LANG:
Language selection
Selection: dE, En, Fr
Factory setting: En

The menu language can be adjusted in this channel.
- dE: German
- En: English
- Fr: French

Unit
UNIT:
Temperature unit selection
Selection: °F, °C
Factory setting: °F

In this adjustment channel, the display unit for temperatures and temperature differences can be chosen. The unit can be switched between °C / K and °F / °Ra during operation. Temperatures and temperature differences in °F and °Ra are displayed without units. If the indication is set to °C, the units are displayed with the values.

Reset
RESE
Reset function

By using the reset function, all adjustments will be set back to the factory settings.
- To initiate a reset, press button 3
Any previous adjustments will be lost. Therefore, initiating the reset function is always followed by a security enquiry.

**Only confirm the security enquiry if you are sure that you wish to reset all adjustments to the factory settings!**

**Security enquiry:**

- To confirm the security enquiry, press button 3

**Note:**
Whenever a reset has been completed, the controller runs the commissioning menu again (see chap. 3).
5. Troubleshooting

Operating control lamp flashes red. On the display the symbols \(\ast\) and \(\Delta\) appear.

Sensor defect. An error code instead of a temperature is displayed in the sensor display channel.

- 88.8

Cable broken. Check cable.

Short circuit. Check cable.

Disconnected Pt1000 temperature sensors can be checked with an ohmmeter. In the following table, the resistance values with the corresponding temperatures are shown.

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<th>°C</th>
<th>°F</th>
<th>Ω</th>
<th>°C</th>
<th>°F</th>
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<td>1194</td>
<td>115</td>
<td>239</td>
<td>1442</td>
</tr>
</tbody>
</table>

Resistance values of the Pt1000-sensors

In the case of an error, a message is shown on the display of the controller:

Operating control lamp off.

Check the power supply. Is it disconnected?

- no

The fuse of the controller could be blown. It can be replaced after the front cover has been removed (spare fuse is enclosed in the accessory bag).

- yes

Check the supply line and reconnect it.
5.1 Various

Pump starts for a short moment, switches off, switches on again, etc.

Temperature difference at the controller too small?

- No
- Yes

Wrong position of collector sensors?

- No
- Yes

Mount the collector sensor at solar flow (warmest collector output); use sensor well of the respective collector.

Plausibility control of the option tube collector special function

Activate tube collector function if necessary.

Pump starts up very late

Switch-on temperature difference Ton too large?

- No
- Yes

Change ΔTon and ΔToff correspondingly.

Non-ideal position of the collector sensor (e.g. flatscrew sensor instead of sensor in sensor wells)?

- Yes

Clean the dirt trap

- No

Air in the system?

- Yes

Is the collector circuit blocked at the dirt trap?

- Yes

Clean the dirt trap

- No

Air in the system; increase the system pressure to at least static primary pressure plus 7.25 psi (0.5 bar); if necessary continue to increase pressure; switch the pump off and on for a short time.

The temperature difference between tank and collector increases enormously during operation; the collector circuit cannot dissipate the heat.

Collector circuit pump defective?

- No
- Yes

Check / replace it

Heat exchanger calcified?

- No
- Yes

Decalcify it

Heat exchanger blocked?

- No
- Yes

Clean it

Heat exchanger too small?

- Yes

Replace with correctly sized one.

- No

Activate tube collector function if necessary.
Tanks cool down at night

Collector circuit pump runs during the night?
- no
- yes

Collector temperature is at night higher than the outdoor temperature
- no
- yes

Sufficient tank insulation?
- yes
- no

Insulation close enough to the tank?
- yes
- no

Are the tank connections insulated?
- yes
- no

Warm water outflow upwards?
- no
- yes

Does the warm water circulation run for a very long time?
- no
- yes

Circulation pump and blocking valve should be switched off for one night; less tank losses?
- yes
- no

Check controller:
- Manual operation active?
- Tube collector function active? Tank cooling or antifreeze function active?

Check the check valve in the flow and the return pipe with regard to the functional efficiency.

Sufficient tank insulation?
- yes
- no

Insulate the connections.

Change connection and let the water flow horizontally or through a siphon (downwards); less tank losses now?
- no
- yes

Use the circulation pump with timer and switch-off thermostat (energy efficient circulation).

Check whether the pumps of the backup heating circuit run at night; check whether the non-return valve is defective; problem solved?
- no
- yes

Are the controller fuses o.k.?
- no
- yes

Replace fuses.

The solar circuit pump does not work, although the collector is considerably warmer than the tank.

Is the control lamp (LED) illuminated?
- yes
- no

Does the pump start up in manual operation?
- no
- yes

Is the pump current enabled by the controller?
- no
- yes

Check the non-return valve in warm water circulation - o.k.
- yes
- no

The thermosiphoning in the circulation line is too strong; insert a stronger valve in the non-return valve or an electrical 2-port valve behind the circulation pump; the 2-port valve is open when the pump is activated, otherwise it is closed; connect pump and 2-port valve electrically in parallel; activate the circulation again.

Clean or replace it

Further pumps which are connected to the solar tank must also be checked.

There is no current; check fuses / replace them and check power supply.

The adjusted temperature difference for starting the pump is too high; choose a value which makes more sense.

Is the pump stuck?
- yes

Turn the pump shaft using a screwdriver; now passable?
- no

Pump is defective - replace it

Controller might be defective - replace it or contact the distributor.
6. Accessories

Sensors
Our product range includes high-precision platinum temperature sensors, flatscrew sensors, outdoor temperature sensors, indoor temperature sensors, cylindrical clip-on sensors, also as complete sensors with immersion sleeve.

For more information, see our catalogue and price list.

Overvoltage protection device
In order to avoid overvoltage damage at collector sensors (e.g. caused by local lightning storms), we recommend the overvoltage protection SP10.

Smart Display SD3
The Smart Display is designed for simple connection to controllers with VBus®. It is used for visualizing data issued by the controller: collector temperature, storage temperature and energy yield of the solar thermal system. The use of high-efficient LEDs and filter glass assures a high optical brilliance and good readability even in poor visibility conditions and from a larger distance. An additional power supply is not required.

Large Display GA3
The Large Display GA3 is designed for simple connection to controllers via the VBus®. It is used for visualizing the data issued by the controller: collector and tank temperature as well as heat quantity produced in the solar system.

The use of high-efficient LEDs and antireflective filter glass assures a high optical brilliance and good readability - even in poor lighting conditions and at a larger distance.
**DL2 Datalogger**

This additional module enables the acquisition and storage of large amounts of data (such as measuring and balance values of the solar system) over a long period of time. The DL2 can be configured and read-out with a standard internet browser via its integrated web interface. For transmission of the data stored in the internal memory of the DL2 to a PC, an SD card can be used. The DL2 is appropriate for all controllers with VBus®. It can be connected directly to a PC or router for remote access and thus enables comfortable system monitoring for yield monitoring or for diagnostics of faults.

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**VBus® / USB interface adaptor**

The new VBus® / USB interface adaptor is the interface between the controller and a personal computer. With its standard mini-USB port it enables a fast transmission of system data via the VBus® for processing, visualizing and archiving. A full version of the ServiceCenter software is included.

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**VBus® / LAN interface adaptor**

The VBus® / LAN interface adaptor is designed for the direct connection of the controller to a PC network or router. It enables easy access to the controller via the local network of the owner. Thus, controller access and data charting can be effected from every workstation of the network. A full version of the ServiceCenter software is included.

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**VBus® / PWM interface adaptor**

The VBus® / PWM interface adaptor is used for the speed control of a pump via a PWM or 0-10 V signal. Via the VBus®, the adaptor receives information from the controller about the necessary pump speed. The speed is converted into a PWM or direct voltage signal and put out to the corresponding terminals.

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**AM1 Alarm module**

The AM1 alarm module is designed to signal system failures. It is to be connected to the VBus® of the controller and issues an optical signal via a red LED if a failure has occurred. The AM1 also has a dry contact relay output, which can e.g. be connected to a building management system (BMS). Thus, a collective error message can be issued in the case of a system failure.
Important notice:
The texts and drawings in this manual are correct to the best of our knowledge. As faults can never be excluded, please note: Your own calculations and plans, under consideration of the current standards should only be basis for your projects. We do not offer a guarantee for the completeness of the drawings and texts of this manual - they only represent some examples. They can only be used at your own risk. No liability is assumed for incorrect, incomplete or false information and/or any resulting damages.

Please note:
The design and the specifications can be changed without prior notice.
The illustrations may differ from the original product.