Revision

1

THERMO TECHNOLOGIES

USDT 3000 Advanced Differential Controller

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The control unit has the following functions:

- 3 inputs for temperature sensors
- Suitable for type PT1000 sensors
- Auxiliary relay for overheating protection and supplement heating system
- Adjustable (2^{o}C to 19^{o}C) temperature difference (delta T)
- Manual override of pump for system testing
- Symbolic display of all parameters
- Concurrent display of two temperatures
- Indications of current state of pump
- System status and diagnostic displays

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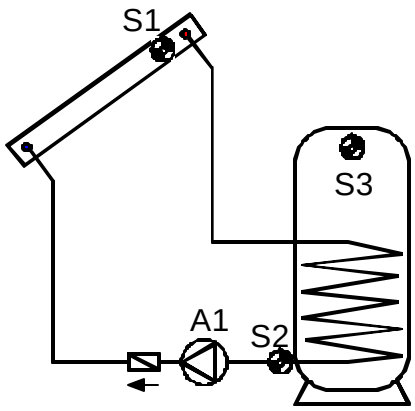
Installation and User's Guide

Introduction

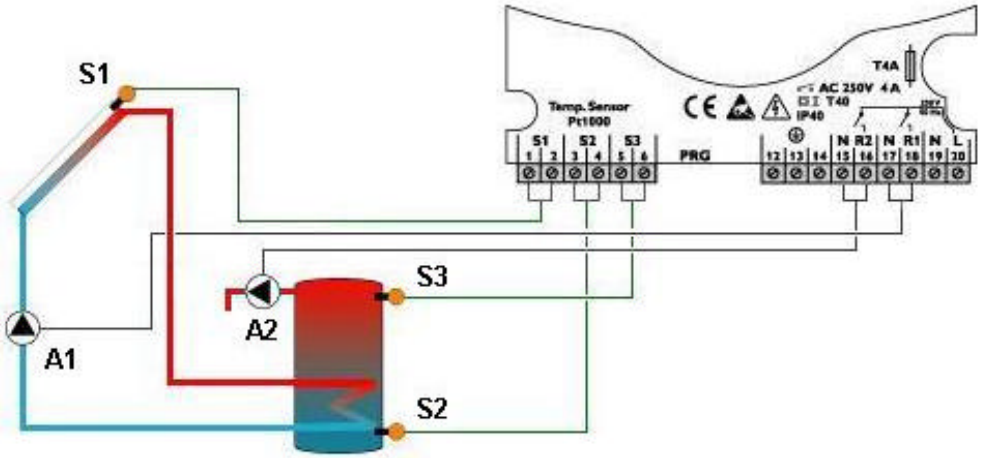
The USDT 3000 unit is a multifunctional temperature differential controller. It can be used in a wide range of applications. At the factory, it is set to control a standard solar water heating system with an auxiliary relay to divert surplus heat. The auxiliary relay can be used to maintain the tank temperature. It can protect the system from overheating or using another heat source to heat the storage tank. The controller has inputs for three PT1000-sensors. A 3-key-panel below a large LCD serves as the user interface. Simple icons give information about the function and operational mode of the controller and the system performance.

Principle of Operation – In the simplest form the solar system needs two sensors. One is positioned at the collector, **S1**, to monitor the collector temperature (T_C). The second is positioned at the location **S2** such that it measures the temperature of the heat transfer fluid inflowing into the collector. (T_S, bottom of the storage tank after the storage tank extracts the heat from the collector.) As the sun shines on the collector, the collector sensor picks up the temperature rise while the return sensor (T_S) remains at the existing temperature. The difference between these two temperatures is referred to as delta T. The solar pump **A1** runs while delta T exceeds the adjustable temperature difference. To avoid overheating, the Auxiliary relay (R2) can be used to divert the surplus energy if the tank sensor **S3** reaches its set point.



The pump **A1** runs only when the temperature at the collector sensor location **S1** is higher than the return temperature at location **S2** by at least delta T. The pump stops if delta T is less than the preset value:

A1 (ON) only for S1 > (S2 + Delta T)



The third sensor can be used for temperature monitoring of the tank and activation of R2 relay as the above example shows. Its function is totally independent from controller operation condition.

INSTALLATION

Note: This installation procedure is for guidance only, and the installer should verify its suitability. Make sure that the solar/boiler system is physically installed, manually tested, and is ready for controlled operation.

The following safety precautions are strongly recommended:

1. Before attempting to install and operate the unit read this instruction manual carefully.

2. Only suitably qualified personnel should carry out installation and any maintenance required.

3. It is recommended that the unit be connected to the power supply via a suitably 6 amps isolating switch.

4. The unit is designed for indoor use only. It is not suitable for installation in hazardous locations and should be protected from electromagnetic field.

5. ***WARNING: When the unit is connected to the 115-volt power supply and the cover is opened, high voltage circuits will be exposed.*** Therefore, when installing the unit ensure all required connections are made and the cover is attached to the controller box before turning the power on. Ensure that all the connections are secure. If any maintenance work is required ensure that the unit is isolated from the power supply before removing the cover. ***Never leave the unit unattended if the cover has been removed and the power supply is connected.***

6. Do not exceed unit ratings of 2.15 amps (1/6 HP or 245 Watts pump).

7. It is advisable to route power cables away from sensor cables.

Sensor installation: Temperature sensors may be installed in fluid lines by inserting it into a sensor pocket or strapping it directly to the pipe. For the system to function correctly, it is very important that the sensors are located and installed properly. The collector sensor should be installed at the upper part (collector outlet) of the collector. If you are using a sensor pocket, make absolutely sure that the sensors are pushed completely into the sensor pockets. (Sensor pockets are not supplied.) Sensors must be well insulated in order to prevent them from being influenced by the surrounding temperature.

When sensors are used outdoors, no water should be allowed to get into the immersion sleeves (lasting impedance change). Generally, sensors should not be exposed to moisture (e.g.

condensation) as this can diffuse through the cast resin and damage the sensor. If exposed to moisture, heating at approx. 195 °F for one hour may possibly save the sensor.

When sensors are used in open loops or swimming pools, make absolutely sure that immersion sleeves (sensor pockets) are corrosion-resistant.

- **Collector sensor FKP6 (Black Cable, Five Feet):** The cable of the collector sensor is silicone coated and is temperature and weather resistant. Insert the sensor sleeve into a thermo-well (sensor pocket), or strap it to the collector outlet pipe that projects from the collector housing. The best practice to house the collector sensor is to install a suitable sensor pocket into a T-piece on the collector outlet pipe. It is good practice to shield the sensor cable and its extension from UV rays and moisture.

- **Hot water return sensor FRP6 (Gray Cable, Nine Feet):** The return (collector inlet) sensor should be installed with an immersion thermo-well in the return leg (cold side) of the heat exchanger. If there is no provision for a tank sensor, it is advisable to push the sensor sleeve beneath the insulation – keeping it close to the inner tank wall at the desired tank location. The sensor required for the solar loop "cold" leg is installed usually in the lowest part of the storage tank.

- **Clip-on installation:** The Sensor is best secured to the appropriate line with pipe clamps, clips, etc. whereby you must make sure that the material is suitable (non-corrosive, heat-proof, etc.). It is advisable to insulate the sensor in order to measure the pipe temperature accurately and to prevent any influence from surrounding temperature.

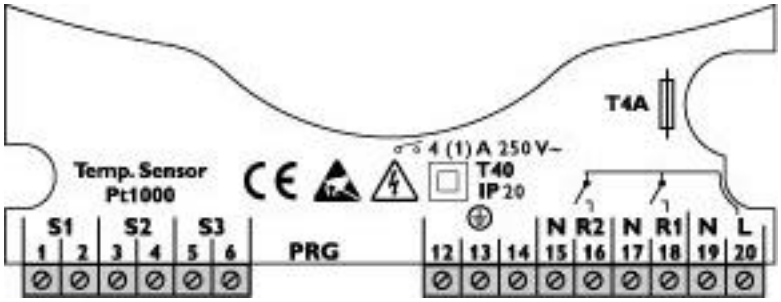
- **Pool sensor installation:** Place a heat conductive T-piece on the suction line directly at the pool outlet and screw in the sensor with an immersion sleeve (check corrosion resistance of the material used). Another possibility would be to attach the sensor at the same place with clips or adhesive tape, using appropriate thermal insulation against environmental influences.

- **Sensor cable extension:** Sensor cables (22/4 AWG telephone cable) can be extended up to 150 ft.

Controller unit installation: For viewing comfort, the controller unit should be positioned at eye level. It is always good practice to keep electronic equipment away from cold and heat, as extremes of temperature may reduce the lifetime of these devices. It is also good practice to keep electronic equipment away from heavy electrical loads, switches or contactors as these may cause electrical and electromagnetic interference when switched on or off.

1. Unscrew the cross-recessed screw off the cover and remove it from the housing.
2. Mark the upper fastening point on the wall and install the enclosed dowel and screw it in.
3. Hang up the housing at the upper fastening point and secure the base unit using the lower fastening hole.

Wire Connection: A small blade screwdriver may be used to fasten miniaturized terminal block screws while the corresponding wire is inserted.



Caution: Controller wiring should only be done when the unit is not energized. It is possible to damage the control unit if it is assembled under voltage. Miniaturized terminal blocks are used for making wiring connections. The wire is held in place within the terminal with a screw that provides excellent contact without damage to the wire.

Use up to an 18 AWG stranded wire to connect the sensor cables to the unit.

- **S1** collector sensor (higher temperature) 1 & 2
- **S2** return sensor (lower temperature) 3 & 4
- **S3** tank sensor (additional measure point) 5 & 6
- Ground terminals 12, 13, 14
- **Relay R2**, auxiliary relay for heat extraction
  R2 live line (Black) 16
  N neutral conductor (White) 15
  Ground clamp (Green) 14
- **Relay R1**, solar loop pump
  R1 live line (Black) 18
  N neutral conductor (White) 17
  Ground clamp (Green) 13
- Power Supply, **120 V AC**
  L live line (Black) 20
  N neutral conductor (White) 19
  Ground clamp (Green) 12

Power Connections: A small blade screwdriver may be used to fasten miniaturized terminal block screws while the corresponding wire is inserted.

NOTE 1: ***Always disconnect the controller from power supply before opening the housing.***

NOTE 2: The controller should be properly grounded. ***Flexible wires, 18/3 AWG (gauge/conductor), simplify connection to the terminals.*** *The power terminal block will accommodate wire sizes to 14 AWG. All other connections should be secured and adequately tightened, as loose power connections will over-heat, and may cause fire.*

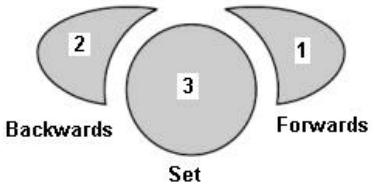
NOTE 3: It is important that the specified output loads (245 Watts) are not exceeded. Where these loads expect to exceed, external relays must be used. Always keep power cables away from sensor cables and other low voltage signal cables.

NOTE 4: To protect against lightning damage, the system must be grounded according to local regulations. Sensor failures due to the weather or electrostatic are mostly due to poor grounding.

OPERATION

Adjustment keys: The USDT 3000 user interface is accessible via the three pushbuttons. The forward key (1) is used for scrolling forward through the indication menu or to increase the adjustment values. The backwards key (2) is accordingly used for the reverse function.

To enter the parameter adjustment mode hold the forward key for 2 sec while **HO** is displayed. The "SEt" icon will be displayed on upper corner of LCD once you are in the adjustment mode. Now, you can select the parameter you wish to adjust by using the forward and backwards keys. Press the key "SEt" (3) in order to change the selected parameter:



- Select a parameter by keys 1 and 2
- Shortly press key 3, so that "SEt" flashes
- Adjust the value by keys 1 and 2
- Press key 3, so that "SEt" permanently appears, the adjusted value is now saved

Please note: The circulation pump (A1) stops at tank temperature of 90 °C to avoid tank overheating.

Parameter List

TC	Collector temperature
TS	Tank (return) temperature
TT	Thermostat temperature (control temperature for R2 relay)
HO	Solar operating hours (to be used for energy calculation)
DO	Pump starting temperature difference
DF	Pump switch off temperature difference
SX	Maximum tank temperature
CL	Collector limiting temperature
CX	Maximum collector temperature
CN	Minimum collector temperature
TO	Thermostat (R2) switch on temperature
TF	Thermostat (R2) switch off temperature
FN	Function: 0 : Maximum tank temperature disable 1 : Maximum tank temperature enable 2 : Maximum tank temperature disable, cooling function enable 3 : Maximum tank temperature enable, cooling function enable
MM	Manual operation mode: 0 : relays R1 and R2 are deactivated 1 : relay R1 is activated, relay R2 is deactivated 2 : relay R1 is deactivated, relay R2 is activated 3 : relays R1 and R2 are activated 4 : automatic operation
PG	Program number
VN	Version number

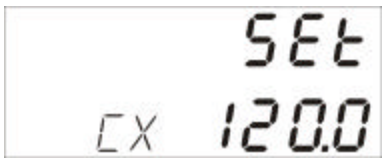
Examples

Delta T Adjustment -The controller monitors temperatures at S1 and S2 locations and compares the resulting temperature difference with delta T. The solar loop circulation pump (A1) runs, when the measured temperature difference delta T is higher than or identical to the set value (DO). The pump stops at the shut off temperature (DF). The Following parameters are factory defaults:

DO 6 °C and DF 4 °C

Maximum Tank Temperature (SX) - The solar pump A1 stops (R1) to avoid tank overheating (safety shutdown of the tank) at this (SX) set point. The overheating symbol flashes if the maximum tank temperature is exceeded. The factory setting is (see FN =3) 60 °C. To disable this protective feature of the unit, change FN to 0.

Solar Loop Limiting Temperature - If the temperature of the solar loop exceeds the set point temperature (CL), the solar pump A1 stops (R1) in order to protect the solar components from overheating (collector safety shutdown). The factory limit temperature is set to 140 °C but it can be changed within the adjustment range of 110-200 °C. The operating control lamp flashes red if the temperature limit is exceeded.



Maximum Collector Temperature (CX) – The pump A1 stops when the tank temperature reaches its set point (SX). The system will stagnate. When the collector exceeds its maximum design temperature (CX), the operating control lamp flashes green and the solar pump A1 (R1) comes on to “cool” the system. The tank temperature might increase above (SX), but only up to 90 °C (safety shutdown of the tank). This function guarantees a longer operating time for very hot summer days and ensures a thermal relief for the collectors and the system. The factory setting is 120 °C (shown in display), but it can be changed within the adjustment range of 100 -190 °C.

Minimum Collector Temperature (CN) - The minimum collector temperature is a minimum switching temperature. It must be exceeded to turn the solar pump A1 (R1) on. The minimum temperature reduces pump cycling at low solar radiation times such as early morning.

The factory setting is 10 °C that disables this feature. User can change this set point from –10 to + 90:

- Use –10.0 to 9.9 for frost protection in sunbelt regions
- Use 10.1 to 90 to permit start-up operation

Heat Extraction (FN 2) – While the tank temperature is higher than (SX), the solar pump runs until the tank temperature drops below the maximum tank temperature (SX). This feature avoids overheating and pre-mature temperature safety valve operation. It can happen only if hot water consumption is below the system capacity such as holidays or low hot water usage.

Collector Cooling Function (FN 3) - When the maximum tank temperature (SX) is reached, the solar pump A1 (R1) stops. The collector temperature now rises to the maximum collector temperature (CX). At this temperature the solar pump starts again to extract heat from the collector. The tank temperature may increase (SX) - but only up to 90 °C (system overheating safety shutdown). The solar pump stops if the tank temperature approaches 90 °C. It runs again to reduce the tank temperature if the collector temperature is at least 5K below the tank temperature.

Thermostat Function (TT) – The USDT 3000 is equipped with a 2nd relay (R2) and a 3rd temperature sensor input (S3, e.g. TT measures the upper tank temperature). It can be used for the tank temperature monitoring and safeguarding. It works independently from the solar operation. The relay (R2) operations are programmed by switch-on temperature (TO) and switch-off temperature (TF). They must be programmed in the corresponding windows. For example, it can be used to divert the collected energy to another user after reaching the desired tank temperature. TO and TF are disabled by setting them to 40 °C at the factory:

- TO = TF (R2) relay is energized only if the maximum tank temperature is reached
- TO > TF to be used to divert the surplus heat
- TO < TF to be used with an auxiliary heating system

TROUBLESHOOTING

Problem: Nothing happens when unit is powered-up.
Cause/Remedy: The fuse could be blown – check and replace if necessary. If the fuse blows again, then the pump draws more current than the unit is design to supply. Use an auxiliary relay or contact your product supplier.

Problem: Operating control red lamp is flashing.
Cause/Remedy: This indicates a system alarm warning, which may be caused by a sensor fault:

- Error code –888.8 is displayed ➔ (TC, TS or TT) sensor cable is short circuited
- Error code 888.8 is displayed ➔ (TC, TS or TT) sensor cable is open

Following table shows the impedance characteristics of PT 1000 sensors:

^{o}C	- 10	0	10	20	30	40	50	60	70	80	90	100	110
^{o}F	14	32	50	68	86	104	122	140	158	176	194	212	230
OHM	961	1000	1039	1078	1117	1155	1194	1232	1271	1309	1347	1385	1423

SPECIFICATION

Supply Voltage	120 V AC
Fuse	4 A
Phantom Load	max. 2 W
Hysteresis	6 degrees
Delta T	4 – 24 ^{o}F
Overheating Range	100 – 200 ^{o}F