Delta-T®
Solar Controls

Models DTT-84, DTT-94

INSTALLATION INSTRUCTIONS, OPERATIONAL TEST AND TROUBLESHOOTING GUIDE

DESCRIPTION

The DTT-84 AND DTT-94 Delta-T® solar controls are designed specifically to regulate solar systems with no freeze protection or systems employing: (a) closed loop heat exchanger for freeze protection; (b) drain-back freeze protection; or (c) recirculation freeze protection using the collector outlet thermistor sensor.

These controllers include as a standard feature (switch programmable) the capability of shutting off the output below 80°F collector temperature to minimize night time pump cycling due to thermosyphoning. High limit off is switchable between 160°F, 180°F or no high limit.

High limit off, freeze recirculation (at 42°F), off below 80°F and differential, all operate using collector and storage sensor. FS-5 sensors may be ordered for redundant freeze protection.

The following installation guide should be carefully followed for easy installation and trouble free performance.

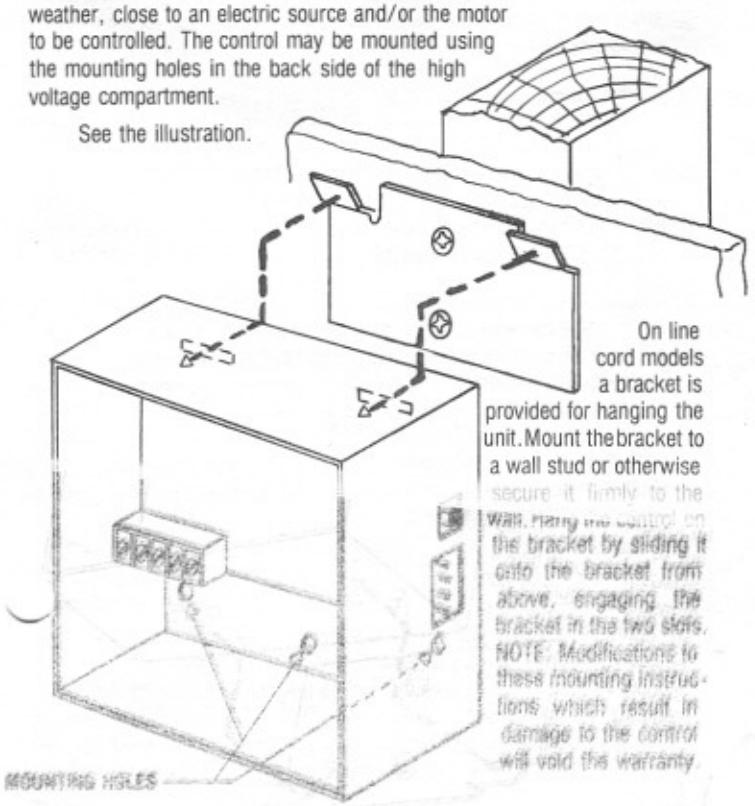
ONTROL INSTALLATION

This control should be installed by a qualified electrician and conform to the National Electric Code and prevailing local codes. CAUTION. TURN OFF ELECTRICITY AT MAIN FUSE BOX BEFORE PROCEEDING WITH INSTALLATION OF THE DTT-84. THIS IS NOT REQUIRED ON THE LINE CORD MODEL (DTT-94).

Mounting

Mount the control box on an inside wall, where it will not be exposed to weather, close to an electric source and/or the motor to be controlled. The control may be mounted using the mounting holes in the back side of the high voltage compartment.

See the illustration.

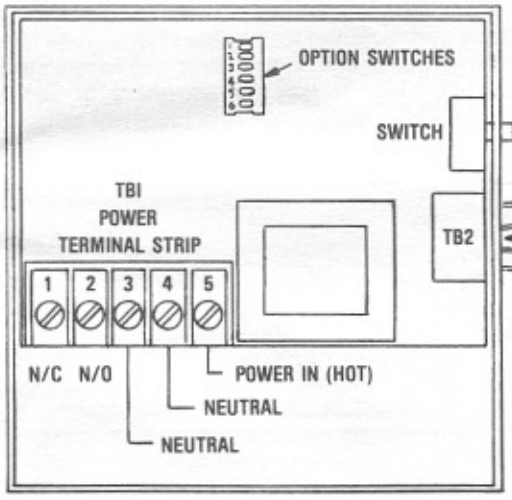


On line cord models a bracket is provided for hanging the unit. Mount the bracket to a wall stud or otherwise secure it firmly to the wall. Hang the control on the bracket by sliding it onto the bracket from above, engaging the bracket in the two slots. NOTE: Modifications to these mounting instructions which result in damage to the control will void the warranty.

Power Wiring for the DTT-84

After verifying correct voltage and disconnecting power make the following connections. The pressure washers may be used to clamp wires to the terminal strip (TBI):

1. Connect power in hot (120 VAC-black) to power terminal strip position 5.
2. Connect switched power out (120 VAC hot to pump) to position 2 (Normally open-N/O).
3. Neutral (white) wires in and out are connected to positions 3 and 4. (These two terminals are connected together on the circuit board.)
4. Connect protective ground wires (green or bare) to ground screw.
5. If desired to power a device "on" when the differential is "off," connect to N/C power out terminal position1.



Instructions correct with switch at right side. If control mounted otherwise, rotate instructions accordingly.

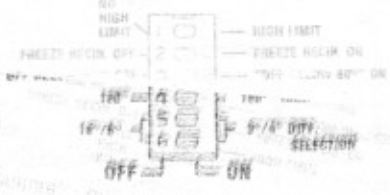
OPTION SWITCH SETTINGS

Switch 1 "On" selects high limit pump shut off overriding the differential but not freeze recirculation (if selected). "Off" prevents high limit shut off (factory set at "ON"). Use this switch in conjunction with switch 4.

Switch 2 "On" selects freeze recirculation using the collector outlet thermistor sensor for freeze detection (at 42°F). One or more FS-5 switching freeze sensors are recommended for redundant protection. "Off" disables this option (factory set at "OFF").

Switch 3 "On" selects pump off below 80°F. Use of this feature will prevent thermosyphon pump cycles for collector temperatures below 80°F. Freeze recirculation (if selected) will override this feature at the recirculation temperature. "Off" disables this option (factory set at "ON").

Switch 4 "On" selects 160°F high limit shut off. "Off" selects 180°F high limit shut off. Use this switch in conjunction with switch 1 (factory set at "ON").



Switch 5 and 6 Both "OFF" select 18°F on/5°F off differentials. Both "ON" select 9° on/4° off differentials (both are factory set at "ON").

OPERATION TEST

(This is an optional test which verifies that the previous procedures have been followed correctly and that the control itself functions correctly.)

With the control mounted and all high voltage connections complete the "control operation test" described in the trouble-shooting section of these instructions may be performed to verify correct operation of the control. Performing the "control operation test" before attaching the sensor leads to the control, insures the control is functioning properly and eliminates the need of disconnecting the sensor leads to check the control later.

SENSOR PLACEMENT

The sensor leads are 24 GA CLASS 2 wiring and carry 4 VDC. Use two conductor 18-24 GA zip or bell wire to run from sensor location to the control. Because of the unique circuit design it is not necessary to use shielded wire for the sensors.

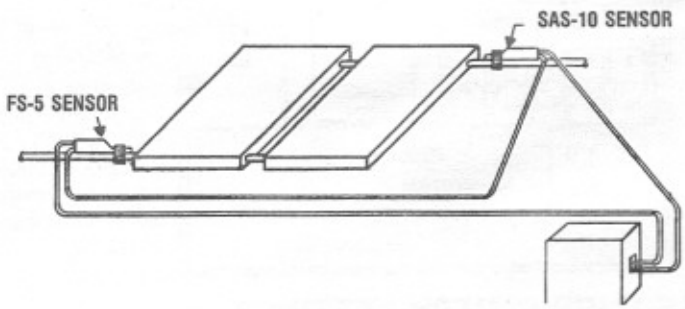
Collector Sensor

Attach SAS-10 sensor with hose clamp to outlet pipe of collector array as close to collector as possible. Insulate over the installed sensor. This sensor location detects the higher temperature for the Delta-T® function.

Storage Sensor

Attach SAS-10 sensor as close (thermally) as possible to storage tank bottom. The mounting can be achieved by a): Using a sensor mounting stud supplied on some solar hot water tanks; b) Taping sensor to wall of tank under tank insulation; or c) Clamping (hose clamp) the sensor to a supply pipe at the tank bottom and insulate. This sensor detects the temperature of the cold water in the tank for the Delta-T® function. This sensor also doubles as the high limit sensor.

CAUTION: This high limit function is not UL approved as a temperature limiting device. Water leaving the solar storage tank hotter than 180°F may cause unsafe pressures and temperature in the water storage tank. It may be necessary to add a temperature limit control in the system to prevent risk of water overheating.



Optional Function Sensors

The collector outlet sensor (SAS-10) also functions as a freeze sensor providing freeze recirculation at 42°F. In addition, 1 or more FS-5 switching freeze sensors must be wired in series with the collector outlet sensor to provide redundant protection. The freeze sensors should be located on the collector array(s) at the coldest points. In usual freezing situations this may be near the center of the panel in the lower ⅓ of the panel; fasten the freeze sensors to the absorber sheet or fin at this location on each panel. Contact the collector manufacturer for details on mounting the freeze sensor inside the panel.

If this location is not accessible other choices for freeze sensor location are: a) the stub end of the bottom collector manifold pipe opposite the end which is connected to the inlet piping; b) the inlet and outlet of each panel if panels are separated or; c) inlet and outlet of the array if panels are coupled together. Attach with a hose clamp one freeze sensor to the inlet and one freeze sensor to the outlet of each collector or array as close to the collector as possible, and insulate with pipe insulation. The thermistor sensor on the array outlet functions as one of these sensors. In arrays of more than three collectors it will be necessary to locate additional FS-5's on the array in locations such as on the couplings between the panels. Remember that locating freeze sensors outside the collector is, at best, a compromise, and this is not usually the coolest point in a collector array. This is an important consideration with large collectors where there may be a significant temperature gradient from the center of the panel (coldest point) to the freeze sensor location.

In systems where the inlet or outlet of the collector or array is kept artificially warm by close penetration into a warm attic or living space, freeze sensors located at inlet or outlet will provide very little protection.

Additional FS-5 sensors should be used on long exposed pipe runs or other locations where early freezing temperatures would occur. It is the installer's responsibility to provide for sufficient sensors, properly located. The freeze recirculation method must not be used in climatic regions where more than 3 freezes occur per year or temperatures below 30°F occur. Additionally, it is the installing contractor's responsibility for adequate alternate methods of freeze protection on systems with more than three collectors. Remember that the freeze recirculation method does not operate when the electricity is off. The freeze sensors detect the approach of freezing temperatures and any one of them will trigger the controller to turn on freeze recirculation.

Insulating Connections and Sensors

At the termination of all sensors weather insulating procedure should be exercised. If the wire-nuts are exposed to weather they should be sealed with silicone. When a sensor is installed on the outside of a pipe, the sensor must be covered with waterproof thermal insulation so that the sensors will pick up only the temperature of the surface, not the ambient air. This is absolutely necessary for accurate sensing.

Immersion Sensors

Should it be necessary to place the sensor into a liquid, it is recommended to utilize one of the standard pipe thread sensors designed for this such as the BP-50/10K, RBP-50/10K or IS-2.5/10K.

Protection of Sensors and Sensor Wiring

Sensor wiring can cause apparent control failure:

1. Use caution when stapling wires. The insulation can be broken and the wire may be shorted or open.
2. Check for wires not secured for protection against breakage or damage.
3. Use caution when pulling wires through metal flashing as wire may be easily stripped or shorted by sharp metal objects.
4. Protect buried wire from shovels, burrowing animals, etc. Use conduit.

Sensors require protection:

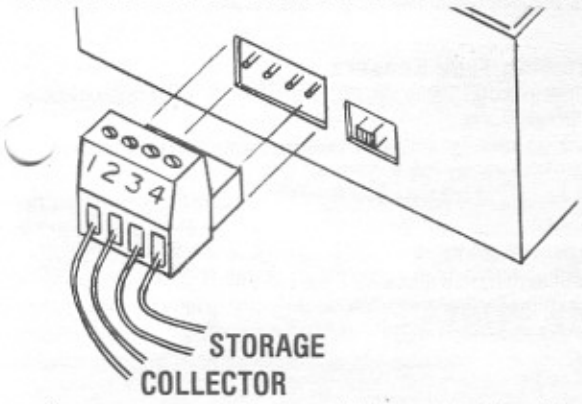
1. Attach sensors securely to pipe, collector, etc. and insulate from air contact to obtain a correct indication.
2. Waterproofing is important because moisture from rain, humidity, etc. can corrode the wire connections and cause sensor failure. Also, corrosion can cause breakage and inaccurate readings. To protect from this, seal wire nut connections with silicone and wrap with tape.
3. Check the physical location of the sensor in relation to external sources of heat or heat sinks, eg. vents blowing air on sensors. Sensor location plays a very important role in how accurately your control responds to system temperature changes.

Sensor Test

(This is an optional test which will alert the installer to any problems associated with the sensors or their wiring.)

Once the sensors are in place, but before they are connected to the control the sensor operational test described in the trouble-shooting section of these instructions should be performed to verify correct operation of the temperature sensors.

CONNECTING SENSORS TO CONTROL



Sensors are connected to the controller by using a 4 position, plug-in connector.

Unplug the connector from the unit and orient it with screws up and facing the wire connections. Connect the two lead-in wires from the collector sensor(s) (SAS-10 and one or more FS-5s if used) to positions 1 and 2 by sliding the wire into the retainer and tightening the screws. Connect the two lead-in wires from the storage sensor to positions 3 and 4. Reinsert the connector into its socket firmly.

Control Operation

Having followed the instructions to this point and performed the control and sensor tests your system is ready to be put into operation. The function switch on the control should be placed in the center position. If there is a temperature difference between the collector and the storage tank greater than the "ON" differential setting the indicator light will come on and the pump will start. If there is insufficient temperature difference the unit will not come on until there is.

If the function switch is in the "OFF" position the pump will not come on, regardless of the temperature difference. With the function switch in the "ON" position the pump will run constantly.

Should the control not seem to be functioning properly refer to the Trouble shooting section of these instructions.

TROUBLESHOOTING GUIDE

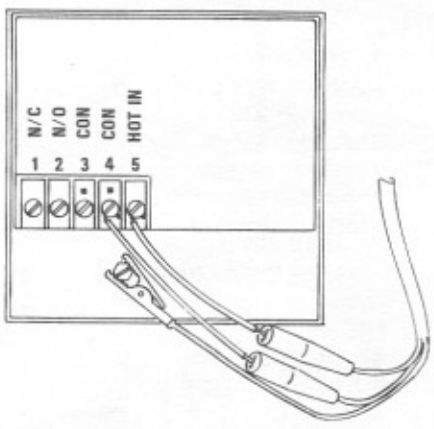
Delta-T® solar controls are relatively simple, trouble free and very reliable. All controls shipped by Heliotrope General have gone through a rigorous quality control process. Actual experience has shown Delta-T® controls to have a very low failure rate. Most failures can be identified by performing the following simple tests. If the control and sensors check out good but the system still isn't operating properly, suspect that there is something else wrong with the system.

CONTROL OPERATION TEST

The following "control operation test" will verify the correct operation of the control. These tests may be performed when the control is mounted and wired into the system but with the sensor wires disconnected or bench tested as described below.

Preparation for Testing

If bench testing a DTT-84, a test line cord must be connected to power terminal strip positions 5 and 4 (hot and neutral respectively). Connect protective ground to the ground screw. Plug the line cord into a 120 VAC receptacle. **CAUTION: HIGH VOLTAGE IS NOW PRESENT ON THE TERMINAL STRIP.**



The power on LED indicator (left) should come on when the cord is plugged in.

The control operation tests can now be conducted.

ON/OFF Test

This test verifies that the control will turn on and off. Switch the control "On," power is now applied to the Normally Open relay point, terminal 2. This may be verified with an AC voltmeter across terminals 2 and 3. If a pump is connected it should turn on.

With the switch in the "Off" position power is applied to the normally closed relay point, terminal 1. This may be verified with a voltmeter across terminals 1 and 3.

With the relay energized (120 VAC power present at terminal 2) the pump LED indicator should be on.

If the relay will not switch power as noted above it should be returned for repair.

Basic Function Test

Place the option switches in the following positions, 1 - ON, 2 - OFF, 3 - OFF, 4 - EITHER, 5-6 - EITHER. Switch the controller to "Auto." Unplug the 4 position sensor connector plug. If the collector input is shorted (connect pins 1 and 2 together at the controller socket) the control will turn on. If the storage input is shorted (connect pins 3 and 4 together at the controller socket) the unit will turn off. With **both** collector input and storage input open **or** with both inputs shorted, the controller may be on **or** off.

Function Test with ILT-10 Tester

Review ILT-10 instructions if you are unfamiliar with unit.

1. Plug the ILT-10 in series with the sensors. The sensors unplug from the controller and plug into the ILT-10, ILT-10 then plugs into controller.
2. Test the sensors by depressing the "Sensor Test" button. If open or shorted light illuminates check for a broken or shorted sensor wire and perform Sensor Operational Test.
3. Rotate the ILT-10 selector knob to the test you wish to perform and depress the "Control Function Test" button. The unit should change state i.e. from off to on or on to off. For example: Differential Test. Place knob in correct position. Control and load should be off until test button is depressed at which time control will turn on.

NOTE: Some tests may not work if internal option switches are not selected for that particular option. If option switches are all in "ON" position, to the right, then all options are selected and should test accordingly. If control fails any of the tests return unit to Heliotrope General for repair.

SENSOR OPERATIONAL TEST

Thermistor Sensors

The SAS-10 thermistor sensors should be checked before connecting them to the control and activating the system. This test requires the use of a volt-ohmmeter.

All SAS-10 sensors manufactured by Heliotrope General are tested to be within ± 0.6°F of a reference test sensor. This means that all SAS-10 sensors manufactured by Heliotrope Heneral are compatible with one another. If one sensor were to fail it would be necessary to replace that failed sensor only. The SAS-10 sensors have a negative temperature coefficient which means they exhibit a very high resistance at low temperatures and a very low resistance at high temperatures. The following Temperature versus Resistance chart shows this relationship and provides a few resistance readings and corresponding temperatures.

TEMPERATURE VS. RESISTANCE CHART
Thermistor @ 25°C

°F	°C	Ohms Resistance 10K
Open		**Infinite**
32	0	32,630
41	5	25,380
50	10	19,890
59	15	15,710
68	20	12,490
77	25	10,000
86	30	8,057
95	35	6,531
104	40	5,326
113	45	4,368
122	50	3,601
131	55	2,985
140	60	2,487
149	65	2,082
158	70	1,751
176	80	1,255
194	90	917
212	100	680
Short		**None**

To properly perform a sensor check you will need a volt-ohmmeter set to perform resistance (ohms) measurements. Be sure the volt-ohmmeter is in good working order and has a fresh battery before using it to test sensors.

Connect the volt-ohmmeter leads to the two wire leads coming from the sensor. If the volt-ohmmeter shows an infinite reading (e.g. a 1 in the display on a digital volt-ohmmeter or no deflection on a meter type volt-ohmmeter) this indicates an open circuit.

Check the following:

1. The sensor lead-in wire to the sensor for a break in the wire. This would usually be found around sharp metal corners or edges such as roof flashing.
2. The sensor lead-in wire where it connects to the sensor leads for possible disconnection.

If the volt-ohmmeter indicates a short (i.e. an 0 in the display on a digital volt-ohmmeter or full deflection on a meter type volt-ohmmeter).

Check the following:

1. A nail or staple through the sensor wire shorting both leads.
2. Insulation that has been scraped-off the sensor wires around sharp metal edges such as roof flashing.
3. At the sensor where it is connected to the sensor lead-in wire to determine if the sensor itself is shorted.

If the volt-ohmmeter indicates a large variation in the resistance reading relative to what you believe is the true temperature referencing the Temperature versus Resistance chart then a failure of the sensor may have occurred. However, this is not always the case. To further check the suspected faulty sensor you can compare it to another known good sensor placed in exactly the same spot with the same insulation, if any, around the sensors. If this is not possible you can disconnect the suspected faulty sensor from the system and compare it at room temperature with a good sensor. Be sure to leave both sensors in the room together for about 30 minutes so they can reach the same temperature. If the suspect sensor shows a large variation from the good sensor this would confirm a faulty sensor. If not, the sensor is good and the large temperature variation experienced in the system is probably a problem in the plumbing of the system.

FS-5 Switching Type Sensors

As the name indicates these sensors are switches which open/close at their preset temperatures.

—FS-5 Opens at 42°F ± 5°F with lowering temperatures and does close until temperature returns to 52°F ± 5°F.

Switching sensors may be checked with the volt-ohmmeter for closed circuit (zero resistance) or open circuit (infinite resistance) by subjecting the sensor to the temperatures indicated above. For example, testing an FS-5 sensor at room temperature above 52°F the volt-ohmmeter should indicate a closed circuit (0 reading on digital volt-ohmmeter or full needle deflection on a meter type volt-ohmmeter). Putting the FS-5 sensor in a cup of ice water at 42°F or below the volt-ohmmeter should indicate an open circuit (1 reading on a digital volt-ohmmeter or no deflection on a meter type volt-ohmmeter).

Defective Controls or Sensors

All Delta-T® controls carry a ten-year limited warranty. During the first year replacement of defective merchandise with a tested replacement will be made at no charge.

For years 2 through 5 replacement will be made for a service fee not to exceed 25% of the current list price and for years 6 through 10 the fee will not exceed 50% of the current list price. Ask for a copy of the warranty for full details.

Special Applications

For assistance with special applications or unusual installations please call or write Heliotrope General.

Manufacturer of Delta-T® the leading name in solar control circuitry.

HELIOTROPE GENERAL

3733 Kenora Drive, Spring Valley, California 91977 • Fax (619) 460-9211

Telephone (619) 460-3930 • TOLL FREE: (800) 552-8838