Delta-T®
Multi-Logic™
Models DML-106 and DML-108

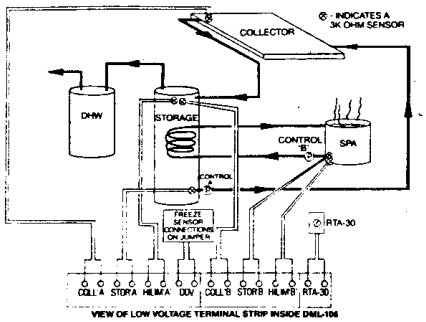
INSTALLATION INSTRUCTIONS, OPERATIONAL TEST AND TROUBLE-SHOOTING GUIDE

DESCRIPTION

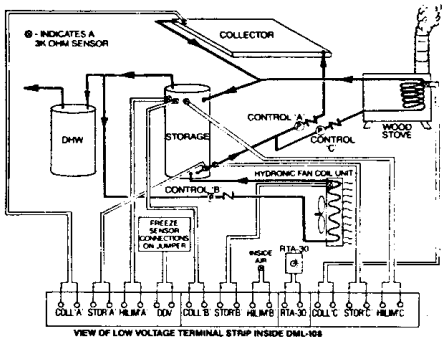
The Delta-T® Multi-Logic™ (DML) series of controls are hardwired units designed for systems requiring 2 or 3 differential control circuits to activate 2 or 3 pumps, fans, valves, etc.

For example, a DML-108 could be used in a control system for solar collection (with or without drain dump or freeze recirculation), woodstove or fireplace loop and spa heater with remote temperature adjustment capability.

Shown below are two typical systems using a DML-106 and a DML-108.



VIEW OF LOW VOLTAGE TERMINAL STRIP INSIDE DML-106



VIEW OF LOW VOLTAGE TERMINAL STRIP INSIDE DML-108

The optional features available with this unit are Remote temperature adjust (RTA-30) and Priority Switch (PS).

The remote temperature adjust feature allows temperature adjustment of a pool, spa or living space (in the range of approximately 60° to 110°F) at a location up to 100 feet from the control.

The priority switch option (between control circuits A & B) allows external switching so one control circuit may operate while disabling the other on a priority basis until conditions are no longer present for the first priority control to run. This is switchable between A and B, or "no priority".

CONTROL INSTALLATION

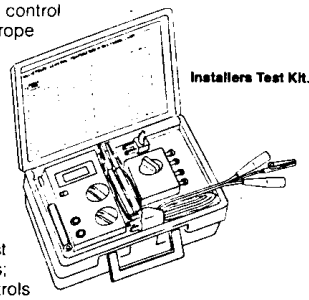
This control should be installed by a qualified electrician and conform to the National Electric Code and prevailing local codes. ***CAUTION! Turn off electricity at main fuse box before proceeding with installation.***

Tools and Equipment

Typical tools and equipment recommended for proper installation include:

- Electric Drill
- Drill bits
- Wire cutters, strippers
- Phillips screwdriver
- Blade screwdriver
- Appropriate screws for mounting
- Small blade screwdriver (⅛" or smaller)
- Wire Nuts
- Pliers
- Hose clamps (for SAS-3 sensor attachment to pipe
- Silicone sealant

To properly check out the control installation the use of Heliotrope General's Installers Test Kit is recommended. Included in the kit are: A digital volt-ohmmeter necessary to check sensors resistance and line voltage; a Thermostat Differential Tester (TDT-1) for checking the operation of the control; a line cord with insulated alligator clips for supplying test power to hardwired controls; glow plug for checking controls with receptacles; and Temperature versus Resistance chart for sensor checkout.


Installers Test Kit.

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 motors to be controlled. The control may be mounted using the two mounting holes in the back side of the control (See control illustration).

NOTE: Modifications to these mounting instructions which result in damage to the control will void the warranty.

Power

Before proceeding with wiring the control be sure the line voltage to the control matches the control — 120 volt control is standard, 240 volts is optional. Check the strip label on the side or back of the control you are installing to be sure of the correct voltage.

After disconnecting power, make the high voltage connections with standard wire nuts (not provided) as follows:

A. Connect the green ground wire inside the DML box to the power in ground.

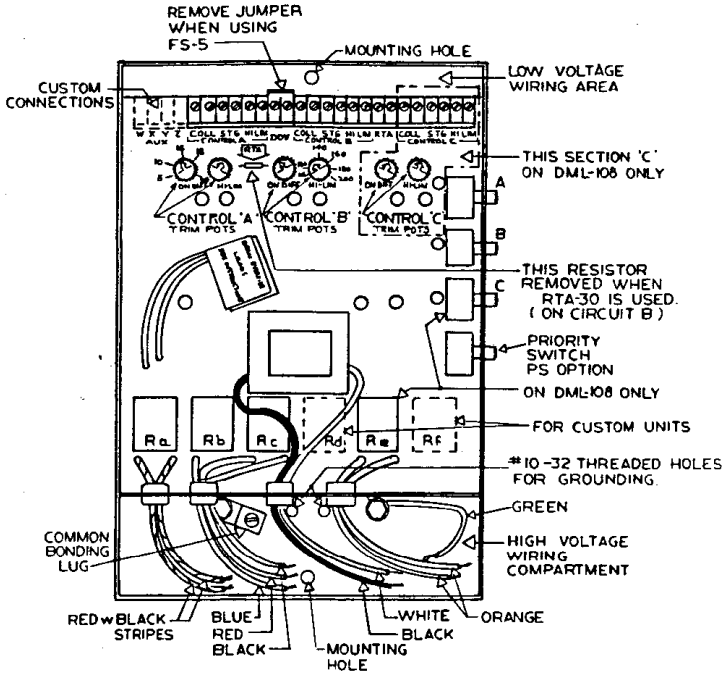
B. On pool/spa systems which have a #8 common bonding conductor, connect the common bonding conductor to the common bonding lug.

C. Connect the white (neutral) from the electrical source to the white from the transformer and to the neutral from each of the pumps, fans, valves or other loads which the DML controls.

D. Connect the black (hot) from the electrical source to the black from the transformer and to one wire from each relay as follows:
(Note: On relays where the wires are the same color connect only one wire, on relays with different colored wires connect the color specifically called for.)
   1. Red with black trace from Relay Ra
   2. Black from Relays Rb and Rc
   3. Orange from Relay Re (on DML-108)
   4. Black with white or yellow trace from optional 1 HP relays in position Re or Rf.

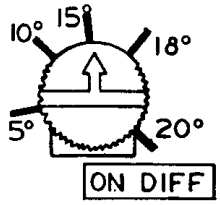
E. Connect the remaining relay wires as follows:
   1. Second red wire with black trace (from relay Ra) to the load which is controlled by *Circuit B.*
   2. Red wire (from relay Rc) to the drain pump valve if used. If not, cap the red wire.
   3. Blue wire (from relay Rb) to the pump or other load which is controlled by *Circuit A.*
   4. Second orange wire (from relay Re) to the load controlled by *Circuit C.*

The above power wiring is for standard DML-106 and DML-108 controls. For custom or non-standard controls, consult the custom wiring diagram provided with the control.



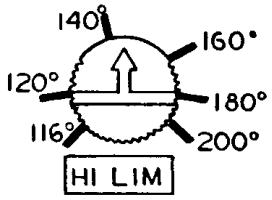
Differential Adjustment

Using a ⅛" blade screwdriver, gently adjust the "ON" differential adjustment (the left hand pot on each control circuit). The adjustment range is from 5° to 20°F. The "OFF" differential is fixed at 2.5°F.



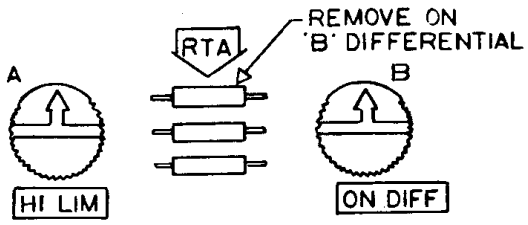
High Limit Adjustment

Using a ⅛" blade screwdriver, gently adjust the high limit off pot (the right hand pot on each control circuit). The adjustment range is from 116°F to 200°F.



Remote Adjustable "High-Limit" — (RTA-30)

On swimming pool, hot tub, spa and jacuzzi installations the RTA-30, Remote Temperature Control, is necessary to control the maximum temperature that the water will reach for the user's comfort. The RTA-30 may be mounted outdoors up to 100 feet away from the DML-106 control unit. The RTA-30 may be flush mounted onto a wall or mounted directly onto a weather resistant cast aluminum universal box such as a Slater No. B-23. Run a two conductor cable of 22 GA minimum size from the RTA-30 to the DML-106. The connection points for this two conductor cable are identified as RTA-30 on the terminal strip in the Low Voltage wiring area of the DML-106.



IMPORTANT: It is also necessary to remove one resistor from the printed circuit board when the RTA-30 is employed. This resistor is identified by an arrow and the designation "RTA Remove." Utilizing diagonal clippers, clip out this resistor from the circuit board and throw away. After doing this the "HI-LIM" trim pot has been disabled on CONTROL B and the maximum water temperature is controlled only by the RTA-30, in a range of approximately 60°-110°F.

Control Operation Test

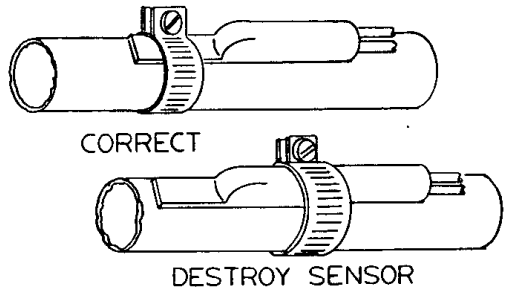
(This is an optional test which verifies that the previous procedures have been followed correctly and that the control itself functions correctly.)

With the control mounted and all high voltage connections complete the "control operation test" described in the troubleshooting 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 & Wiring

The sensor leads are 24 GA CLASS 2 wiring and carry 10 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.

Each control circuit will be connected to its own differential sensors and (optional) high limit sensor.



Collector Sensor

Attach with a hose clamp an SAS-3 sensor to the collector array outlet pipe as close to the collector as possible. Insulate over the sensor with pipe insulation.

On air systems the sensor may be mounted on the collector plate or on an insulating block in the air flow.

Storage Sensor (Heat Storage)

Attach with a hose clamp an SAS-3 to the pipe (which exits from the bottom of the tank) to the feed side of the pump (for collectors, fireplace loop, etc.). Alternative locations are the sensor mounting stud provided on many tanks or the side wall of the tank near the bottom. This sensor inputs tank temperature for lower of the two temperatures (heat sink) of the differential. Thermal insulation must be placed over the sensor for accurate sensing. The RBP-50 may be used to construct a "drop tube" for non-metallic tanks.

For rockbed storage the SAS-3 sensor may be used inside a protective pipe or tube.

Storage Sensor (Heat Source)

Attach an SAS-3 sensor to the pipe which supplies hot water out to the unit receiving heat (or heat sink).

Spa/Pool Sensor

On PVC plastic plumbing the DIS-2.5 sensor (2 sensors in one housing) is recommended for the differential and high limit sensor. Screw this sensor into a ½ inch FPT tee so that the sensing elements (end of the extension) is in the water flow. Insulate over the exposed sensor end to prevent erroneous readings due to direct sunlight or cold night air striking the exposed end. On copper plumbing (2) SAS-3 sensors may be strapped to the pipe with a hose clamp and insulated.

Fireplace grate or woodstove loop

Attach with a hose clamp an SAS-3 sensor to the outlet pipe far enough from the fire to prevent sensor damage. Insulate over the sensor with pipe insulation.

Storage High Limit (optional)

Attach SAS-3 sensor to the top or side wall near the top of the storage tank under the insulation or attach with a hose clamp to the hot water outlet pipe and insulate. This sensor location detects temperature for High Limit OFF.

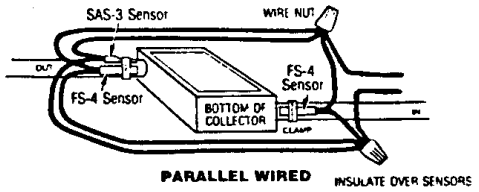
CAUTION: This high limit function is not UL approved as a temperature limiting device. Water leaving the solar storage tank hotter than 180°F may cause unsafe pressures and temperature in the water storage tank. It may be necessary to add a temperature limit control in the system to prevent risk of water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

Freeze Protection

The DML unit can be used with systems employing: a) Closed loop heat exchanger with anti-freeze solution; b) Drain back freeze protection; c) Recirculation freeze protection; or d) Drain dump freeze protection.

Recirculation and drain dump require the use of special freeze sensors as described below.

Freeze Recirculation



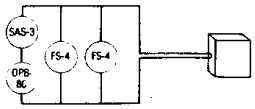
PARALLEL WIRED INSULATE OVER SENSORS

For freeze recirculation, two or more FS-4 sensors are wired in parallel with the collector thermistor sensor. The pump will recirculate warm storage tank water through collector array if any one of the FS-4's falls below 42°F ± 5°F. All of the control circuits may utilize this option.

The Freeze Recirculation method must not be used in climatic regions where more than 20 freezes occur per year or temperatures below 20°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 doesn't operate when the electricity is off.

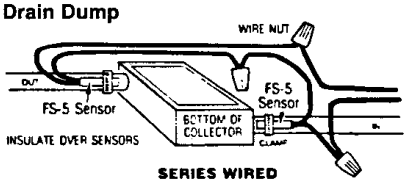
NOTE: In the event that the OPB-80 sensor is used in conjunction with the FS-4 sensors be certain to wire the SAS-3 and the OPB-80 sensor in series and the FS-4 sensors in parallel with the collector sensor. Failure to comply with this wiring diagram when using both OPB-80 and FS-4 sensors will disable the freeze protection function.



Leave the DDV jumper in place if freeze recirculation is used for control circuit A or if drain dump is not used. ***If freeze recirculation is used on a control with priority switch option, the recirculation control must have first priority or "no priority" to allow pump operation in freeze mode.***

Please read the section on freeze sensor placement.

Freeze Drain Dump



SERIES WIRED

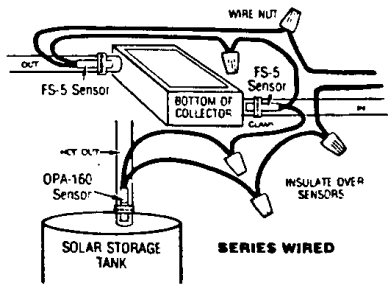
Only control circuit A can utilize freeze drain dump. If freeze drain dump is utilized, wire 2 or more FS-5 freeze sensors in a series loop and connnect to the "DDV" terminal strip position after removing the "DDV" jumper. When any one of the FS-5 sensors falls below 42°F ± 5° the control circuit (A) will cause the drain dump valve to drain and the circulator pump to shut off.

Drain Override Feature

These controls have a field selectable Drain Override capability. This feature allows the system to fill and collect heat if a temperature differential is present even if the FS-5 freeze sensors are below the drain temperature. The control is shipped from the factory without this feature activated. To activate the Drain Override, the two short Yellow leads tagged "Drain Override Leads" must be stripped and twisted together with a wire nut.

IMPORTANT NOTES about the Drain Override Feature:

1. Although this feature can increase system efficiency it also increases the risk of freezing collectors. This feature should only be used in areas where freezing conditions are infrequent and mild.
2. When the Drain Override feature is activated, placing the Control Circuit "A" switch in the "Manual ON" position will energize the Drain Down Valve and fill the system. Freeze damage could occur in cold atmospheric conditions.
3. When the Drain Override Feature is used the 160°F High Limit Drain function (OPA-160 Sensor) cannot be used.
4. If a DER-300W is installed with the DML, using the same sensors as the control, depressing the storage temperature button will energize the Drain Down Valve and fill the system. Freeze damage could occur in cold atmospheric conditions.



SERIES WIRED

Pump Off and Collector Dump Above 160°F

Attach OPA-160 sensor with hose clamp, tighten slightly, to the hot water service outlet pipe of the solar storage tank. (Optional mounting location is on side of tank near top.) Wire in series with the FS-5 freezer sensors. This sensor detects the solar storage temperature and turns off the pump and dumps the collector when the storage temperature is above 160°F. When the OPA-160 is utilized it is not necessary to use an SAS-3 for High Limit Control; leave the high limit unconnected. This feature cannot be used when the Drain Override Feature (see above) is activated. This feature does not apply to freeze recirculation.

Please read the following section on Freeze Sensor Placement

Freeze Sensor Placement

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 1/3 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 the next best choice for freeze sensor location is the inlet and outlet of each panel if panels are separated or inlet and outlet of the array if panels are coupled together. Attach with a hose clamp one FS-4 or FS-5 to the inlet and one to the outlet of each collector or array as close to the collector as possible, and insulate with pipe insulation. In arrays of more than three collectors it will be necessary to locate additional freeze sensors 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 the inlet or outlet will provide very little protection.

Additional freeze 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.

Insulating Connections and Sensors

At the termination of all sensors weather insulating procedure should be exercised. If the wire nuts are exposed to weather, hey should be sealed with silicone. When a sensor is installed on the outside of a pipe, the sensor must be covered with weatherproof 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.

Sensor Wiring and Protection

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 sensor 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 inaccuratge 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 source 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.

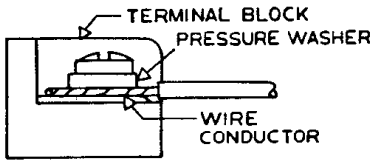
Sensor Test

(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 test described in the trouble-shooting section of these instructions should be performed to verify correct operation of the temperature sensors.

CONNECTING SENSORS TO THE CONTROL

The sensor leads are attached to the controller in the Low Voltage wiring area. Sensor wiring is fed into the control through side knockouts. The black terminal strip for the sensor lead connections is of a "pressure" type and the sensor wires do not need to be wrapped around the screw as is typically done with some terminal strips. To make a wire connection, strip the conductor back approximately 5/16" and insert conductor below the square "pressure" washer and tighten snugly.



For each control section (A, B and C - on DML-108) connect the sensor lead in wire pair to the appropriate terminals on the terminal strip.

On each section the higher temperature input for the differential is connected to "coll". This may be the lead in pair from the collector sensor, or woodstove sensor or the top of the storage tank — the heat source.

Connect the lower temperature input for the differential to the terminals marked "stg" on each section. This may be tank bottom, spa or pool, living space etc. — the heat sink.

The high limit sensor (optional) is connected to the "hi lim" terminals on each section. If the RTA-30 feature is used (with pool, spa or space heating) a high limit sensor must be used with control circuit B.

If high limit is not used, make no connections to the "hi lim" terminals. Not using the high limit will cause the high limit sensor fault indicator to light. Therefore it is necessary to place a piece of electrical tape on the underside of the cover under the "hi limit" sensor fault lens for each control circuit not using the high limit function.

If a freeze dump valve (controlled by relay Rc and Circuit A) is employed in the system, connect the FS-5 sensor loop to the DDV terminal strip position after removing the "DDV" jumper. If a freeze dump valve is not used, leave the "DDV" jumper in place.

Control Operation

Having followed the instructions to this point and performed the control and sensor test your system is ready to be put into operation. The function switch on each control section should be placed in the "Auto" position. If there is a temperature difference between the heat source and the heat sink greater than the "ON" differential adjustment setting the indicator light will come on and the output will energize. If there is insufficient temperature difference the unit will not come on until there is.

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

Special Applications

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

TROUBLE-SHOOTING GUIDE

DML 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 DML 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.

Before proceeding with the Operational Tests perform these basic trouble-shooting procedures:

A. Check all high voltage wiring to be sure it is wired according to the instructions.
B. Check for power to the control from the main circuit breaker with an AC Voltmeter.
C. Check the sensor connections at the control.

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 using a line cord for power as described below.

Preparing the control for bench testing.

CAUTION! HIGH VOLTAGE ***Follow these instructions and illustrations exactly.***

Connect line cord to the black and white transformer leads *only*, using insulated alligator clips as illustrated for "Differential Test." Also connect ground clip to ground. Connect alligator clips *before* plugging in the line cord to 120 VAC.

The "control operation test" can now be conducted.

ON/OFF Test — This test verifies that each control circuit will turn "ON" and "OFF". The function switch for each control circuit should be in the "manual ON" position. When power is applied to the control the "control ON" indicator lights should illuminate and the output relays should come on.

If no device is wired to the control relay then a Continuity Test of the two unconnected relay leads will verify that the output device would turn on. The two relay wires show continuity when checked by the ohm/resistance measurement of the volt-ohmmeter when the reading is zero ohms.

If the indicator lights do not illuminate and there is no power to the pump, fan, etc. (or relay wire continuity), the control is defective.

On/Off Function Test — A simple ON/OFF electrical function test of the DML control circuit can be performed in the field.

1. Remove all sensor leads from the terminal strip.
2. If a Drain Down Valve is used the two terminals identified "DDV" should have a jumper connecting them together, for test purposes only.
3. Connect any standard thermistor sensor (a resistor in the range of 500 ohms to 15K ohms can also be used) to CONTROL A terminals, identified "STG".
4. Place CONTROL A switch in the AUTO position.
5. By shorting together the two terminals identified CONTROL A "COLL" the pump will turn ON, when separated, the pump will turn OFF.
   Repeat for CONTROL B utilizing the CONTROL B "STG" terminals for the sensor connection (or resistor) and by shorting the CONTROL B "COLL" terminals to turn on the output.
   In a similar fashion, test control C (if present).

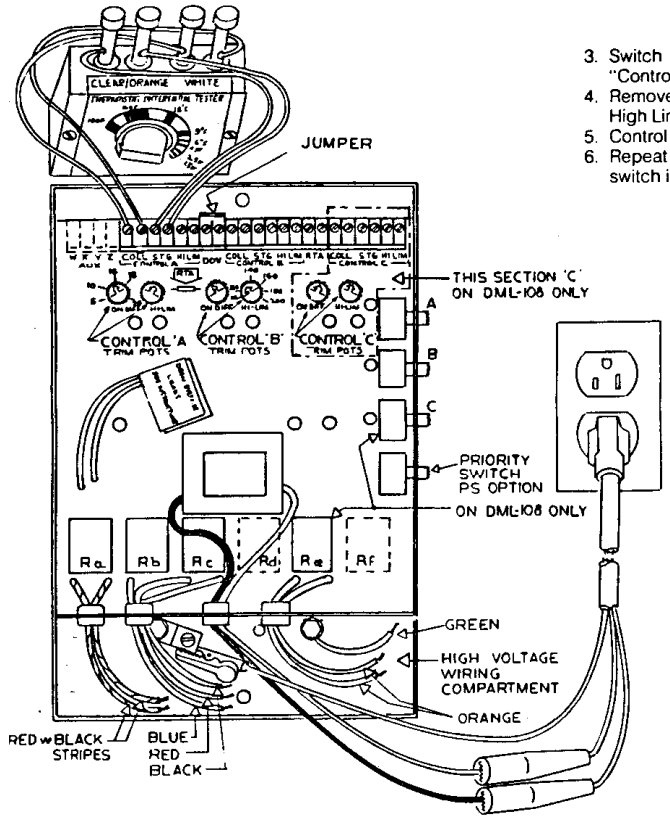
Differential Test (See illustration on next page) — The ON and OFF differential switch points may be verified using the TDT-1 tester. Test each control section in turn.

1. Connect jumpers from the "Coll" terminals on the circuit under test to the "White" terminals on the TDT-1 tester.
2. Connect jumpers from the "STG" terminals to the "Clear/Orange" terminals.
3. Rotate the knob on the TDT-1 Tester counterclockwise until the indicator light comes on. The knob on the tester should be pointing to the approximate setting of the "ON" differential.
4. To check the "OFF" differential, rotate the knob on the tester clockwise until the indicator light goes off. The knob on the tester should now be pointing to *approximately* 2.5°F. This is the fixed "OFF" differential setting.
5. The "ON" and "OFF" is accompanied by a click of the controller's relay. Hearing the click without an accompanying indicator light tells you that the indicator light has failed.

The temperature indicators on the TDT-1 Testers are for approximate readings and are not intended for precise calibration purposes. The adjustments on the control may vary slightly from the settings of the tester.

Priority Test (if P/S option present) —

1. Turn on controls A & B (in auto) using TDT-1 or ON/OFF function test. Priority switch in "No Priority". Note A & B "Control ON" lights should be lit.
2. Switch priority to A. Should have A priority light and A "Control ON" light but *not* B.



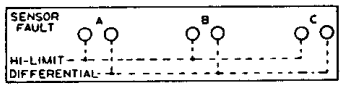
3. Switch priority to B. Should have B priority light and B "Control ON" light but *not* A.
4. Remove condition which turns on B control or present High Limit to B with a jumper on the "hi lim" terminals for B.
5. Control should switch to A.
6. Repeat with B turned on, removing turn on for A with switch in A priority. Should switch to B.

Sensor Fault — Sensor wiring faults are indicated when any of the sensor fault LED's are lit.

If a sensor fault LED lights, it is an indication that the wiring, sensor connections, or the sensor itself has shorted or open circuited. Trace down the cause and repair to restore the unit to full working condition.

A "Hi-Limit" sensor fault indicates the "Hi-Limit" sensor, wiring or connections are open or shorted. A "Differential" sensor fault can be caused by either the "Coll" or "STG" sensor, wiring or connections.

(NOTE: If the high limit is not being used on a given circuit, the "Hi Limit" sensor fault light should be blanked out by placing a piece of electrical tape on the underside of the cover over the lens opening. The LED will be lit but not seen from outside the control.)



CONTROL 'C' IS NOT APPLICABLE FOR MODEL DML-106

OPERATIONAL TEST FOR THERMISTOR SENSORS:

The 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 thermistor sensors manufactured by Heliotrope General are tested and trimmed to be with ± ½°F of a reference test sensor. This means that all thermistor sensors manufactured by Heliotrope General are compatible with one another. If one sensor were to fail it would be necessary to replace that failed sensor only. The 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 which correspond to temperatures.

TEMPERATURE VS. RESISTANCE CHART

3,000 Ohm Thermistor @ 25°C

°F	°C	Ohms Resistance
Open		Infinite
32	0	9,810
41	5	7,620
50	10	5,970
59	15	4,710
68	20	3,750
77	25	3,000
86	30	2,420
95	35	1,960
104	40	1,600
113	45	1,310
122	50	1,080
131	55	879
140	60	747
149	65	624
158	70	525
176	80	378
194	90	275
212	100	204
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 two volt-ohmmeter leads to the two wire leads coming from the sensor. If the volt-ohmmeter shows an infinite reading (i.e. 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 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.

Switching Type Sensors — As the name indicates these sensors are switches which open/close at their preset temperatures:

—FS-4 Closes at 42°F ± 5°F with lowering temperatures and does not open until temperature returns to 52°F ± 5°F.

—FS-5 Opens at 42°F ± 5°F with lowering temperatures and does not close until temperature returns to 52°F ± 5°F.

—OPB-80 Opens at 81°F ± 9°F with lowering temperatures and does not close again until temperature reaches 98°F ± 9°F.

—OPA-160 Opens at 167°F ± 9°F with rising temperature and does not close again until temperature reaches 163°F ± 9°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-4 sensor at room temperature above 52°F the volt-ohmmeter should indicate an open circuit (1 reading on digital volt-ohmmeter or no needle deflection on a meter type volt-ohmmeter). Putting the FS-4 sensor in a cup of ice water at 42°F or below the volt-ohmmeter should indicate a closed circuit (0 reading on a digital volt-ohmmeter or full deflection on a meter type volt-ohmmeter).

Defective Controls or Sensors

Any control or sensor that has been installed for one year or less and found to be defective after following the trouble-shooting procedures and performing the operational tests, should be returned to the distributor from whom it was purchased or returned directly to Heliotrope General for repair or replacement.

If the control has been in operation greater than one year but less than five, return the control, postage paid, and a $10.00 check or money order direct to Heliotrope General. The control will be repaired or replaced and returned to you within five working days.

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

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