Instruction Manual

TD220 Differential Temperature Controller

Version 1.1 (Oct, 2017)

1. Overview

This controller can be used for solar water heater control and drying oven control. It has two sensor inputs. The temperature difference between the two sensors (DT) is used for output control. The controller has two independent outputs also. One of the output is to controller a cooling device so that DT is limited to a specified range. The other output is for a heating device so that DT is maintained to be not less than a specified range.

This controller is a plug and play controller. No wiring is needed for the heater or cooler. Both the heating and cooling control modes are simple on/off control, similar to a mechanical thermostat but with much higher precision due to adjustable hysteresis band, precise sensor and digital read out. Anti-short function is provided for cooling to protect the compressor from being turned on with high pressure Freon.

Different operation temperature ranges of the two outputs can be set separately. Once the cooling range is set, the controller program will automatically limit the heating range to prevent both heating and cooling from being turned on at the same time.

Two digital silicon band gap sensors are used. The advantage is being much more reliable in moisture environment than thermistor sensor. They can be immersed over extended period of time. They also have a more uniform accuracy over an entire specified temperature range.

2. Specifications

Temperature Control Range	-50 ~ 105°C, -58 ~ 221°F
Temperature Resolution	0.1 °C (between -9.9 ~ 99 °C) 1 °C (between -50 ~ 10 °C, 100 ~ 170°C) 0.1 °F (between -9.9 ~ 99.9 °F) 1 °F (between -58 ~ 10 °F, 100 ~ 306 °F)
Temperature Accuracy	0.5 °C or 0.9 °F
Temperature Control Mode	On/off Control. Heating and Cooling
Temperature Control Output	10A, 120V or 240V AC *
Audio Alarm	High and Low Limit
Sensor Type	Silicon Band Gap Sensor
Sensor Size	0.25" O.D. (6.35 mm) x 1" (25 mm) long
Sensor1 Cable Length	6 ft (2 m)
Sensor2 Cable Length	12 ft (4 m)
Operating Temperature	-20 ~ 50°C (0°F ~ 120°F)
Power Cable Length	3 ft (1 m)
Dimension	3.6" x 5.5" x 1.8" (91 x 140 x 46 mm)
Input Power	85 ~ 240 VAC, 50 Hz / 60 Hz
Warranty	One (1) year.

* Either the heating or the cooling device is limited to 10 Amps. The output voltage is the same as the input voltage. When the controller is plugged into 120V AC, the output will be 120VAC. If the controller is connected to 240 VAC, the output will be 240VAC also.

3. Front Panel

Figure 1. Front panel of TD220.

3.1 Descriptions

(a) Display Window. Shows temperature readings and parameters.
(b) Set Key. Press set key to display parameters and save changed values.
(c) Up Key/Mute Alarm. Increase value; mute the alarm buzzer.
(d) Down Key. Decrease value.
(e) Cooling Device Indicator. Synchronized with the power output in the Cooling Device Socket.
(f) Cooling Device Socket. Supply power to the cooling device. The voltage is the same as the input power to the controller.
(g) Heating Device Indicator. Synchronized with the power output in the Heating Device Socket.
(h) Heating Device Socket. Supply power to the heating device. The voltage is the same as the input power to the controller.
(i) Sensor 1 socket. For the primary sensor which measures the temperature of the subject to be controlled.
(j) Sensor 2 socket. For the auxiliary sensor which measures the temperature of the external medium that helps to control the temperature.

4. Setup Flow Chart

During the normal operation, the controller offers three different displaying modes: temperature reading of Sensor 1, T1; temperature reading of sensor 2, T2; or, the temperature difference between the two sensors, DT.

Following chart shows how to change the display from one reading to the other.

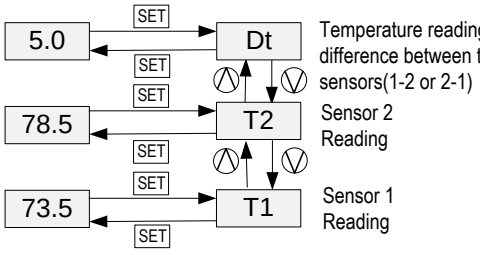


Figure 2. Probe reading Flow Chart

Press SET key momentarily. the controller will show Dt. Press Down key will show T2. Press down key again, the controller will show T1. Press SET when T1 is displayed will set the controller to display the sensor 1 temperature. Press SET when DT is displayed will set the controller to display the differential temperature. Press SET when T2 is displayed will set the controller to display the Sensor 2 temperature.

If T1 is selected before the controller was powered off, it will display the T1 next time when powered up. If either of the temperature sensors fails, the controller will display "Err".

5. Parameter Settings

To change the target temperature and system parameters, press SET key for 5 seconds, the controller will enter the parameter set up mode. The first parameter CSP will show on the display. Press SET key again to see the initial setting. Use Up or Down key to modify the parameter value. Then press SET key to confirm the change. The display will show the parameter again. Press down key to show the next parameter. The instrument will automatically exit if no key is pressed for 10 seconds. Please see the following flow chart on parameter settings and table 1 for the parameter definitions.

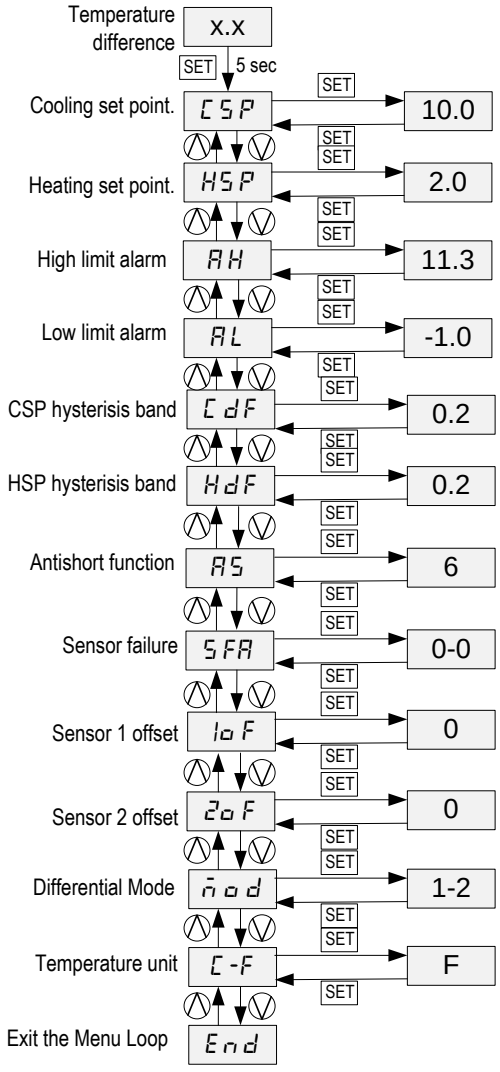


Figure 3 Parameter setting flow chart

Table 1. Parameters Description

Code		Description	Setting Range	Initial	Note
CSP	CSP	Cooling Set Point	-58~306 °F, -50~170 °C	10.0	1
HSP	HSP	Heating Set Point	-58~CSP °F, -50~CSP °C	2.0	1
AH	AH	Alarm High Limit	-58~306 °F, -50~170 °C	11.3	2
AL	AL	Alarm Low Limit	-58~AH °F, -50~AH °C	-1.0	2
CdF	CdF	Cooling Differential	0 ~ 50.0	0.2	1
HdF	HdF	Heating Differential	0 ~ 50.0	0.2	1
AS	AS	Cooling Antishort	0~12 min	6	3
SFA	SFA	Sensor Failure Operation	0-0, 0-1, 1-0	0-0	4
1of	1oF	Sensor 1 Offset	-10 ~ 10	0	5
2of	2oF	Sensor 2 Offset	-10 ~ 10	0	5
Mod	Mod	Differential Mode	1-2 or 2-1	1-2	6
C-F	C-F	Temperature Unit	C (Celsius), F(Fahrenheit)	°F	

Note 1. CSP is the set point for the cooling control channel. HSP is the set point for the heating control channel. The value of the setting is the temperature reading difference between the two probes. The unit is degree (Celsius or Fahrenheit, depends on the setting). The relay for the cooling channel control output will be on when the temperature difference is larger than the CSP. The relay for the heating channel will be on when the temperature difference is smaller than the HSP. For example, HSP = 5 means the controller will try to keep the sensor 1 temperature reading 5 degrees different from the sensor 2 temperature reading, regardless the actual temperature reading of sensor 1 or sensor 2 (as long as the both sensor are within their working temperature range). The cooling channel can be used for controlling the solar water heater pump. The heating channel can be used for controlling a dryer.

When DT is larger than CSP, C channel turns on. When DT is smaller than HSP, H channel turns on. Please note, HSP has to be smaller than CSP so that two channels do not work against each other. For example, when CSP = 20.0ºF, HSP can be set to any value between -58.0 and 20.0 (ºF). For CSP, it can be set to any value between -58 and 306 (ºF). If you set CSP to 55.0, the HSP will be changed to 55.0 automatically.

CDF is the differential band (hysteresis band) between cooling set point and on/off temperature. The controller will turn on when DT > CSP + CDF and turn off when DT < CSP - CDF. For example, if CSP = 20.0ºF, CDF = 0.2, the controller will turn on when DT > 20.2ºF and turn off when DT < 19.8ºF. Similarly, HDF is the differential band (hysteresis band) between heating set point and on/off temperature.

The controller will turn off at when DT > HSP + HDF and turn on again when DT < HSP - HDF. For example, if HSP = 18ºF, HDF = 0.2, the controller will turn off when DT > 18.2 ºF and turn on when DT < 17.8ºF.

Small differential band gives tight control; large differential band reduces the frequency of cycle on and off. It will extend the life of relay and compressor.

Note 2. The value of the alarm setting, AH and AL are for the maximum and minimum **temperature difference** between the two probes, not the actual temperature reading of the probes. If the actual temperature reading of either probe is out of its working temperature range, the controller will display error and trigger the alarm buzzer also. When DT is larger than AH, alarm buzzer will be on and display will flash AH and normal display. When DT is smaller than AL, alarm buzzer will be on. And display will flash between AL and the normal display.

Alarm can be cancelled by press V key. The alarm will not turn on until DT re-enter the alarm zone after it returned to the normal range once. To disable the alarm, set AH = AL.

The maximum value of the AL can be set is the current value of AH. But AH can be set to the value between -58 ~ 306ºF or -50 ~ 170ºC. When AH is set to a value lower than current AL, the AL will be adjusted to the AH value automatically. For example, when AH = 95.0ºF, AL can be set to any value between -58 and 95.0. For AH, it can be set to any value between -58 and 306. If you set The AH to 25.0, the AL will be changed to 25.0 automatically.

Note 3. The Cooling Antishort is the delay the time to turn the cooling load on. when the controller is used for cooling and load is a compressor, it should not turn on the compressor when it is at high pressure (just after turned off). Otherwise, It may shorten the life of compressor. The Anti-Short cycle delay function can be used to prevent the rapid cycling of the compressor. It establishes the minimum time that the NO contact remains open (after reaching cutout) before closing again. The delay overrides any Load Demand and does not allow the NO contacts to close until the set time-delay value has elapsed. It gives time to release the refrigerant pressure through evaporator. It is typically set to 4 - 6 (minutes). By default, AS is set to 6 minutes.

Note 4. The SFA defines how the output would be if the sensor fails. It can be set to 0-0, 0-1 or 1-0. Please refer to table 2 for details.

Table 2. Output of the controller when sensor fails.

SFA	Controller output when sensor fails
0-0	Cooling device off, heating device off
1-0	Cooling device on, heating device off
0-1	Cooling device off, heating device on

For example, when the unit controls a refrigerator for food, you may want to set SFA to 1-0 if the sensor fails to keep the food cold. When it controls a heater, you may want to set SFA to 0-0 for safety purpose.

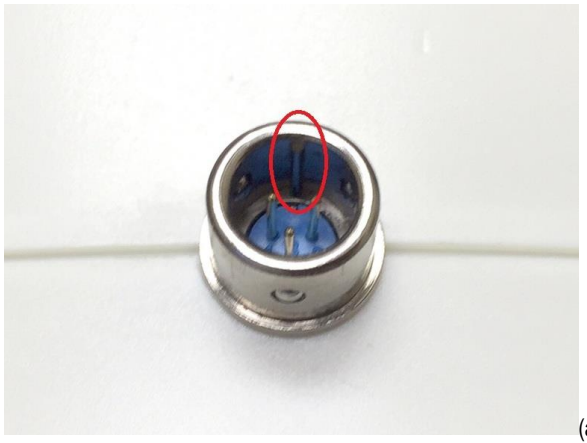
Note 5. The offset is used to set an input offset to compensate the error produced by the sensor or input signal itself. For example, if sensor 1 displays 37ºF when the actual temperature is 32ºF, setting parameter 1oF = -5 will make the controller display 32ºF.

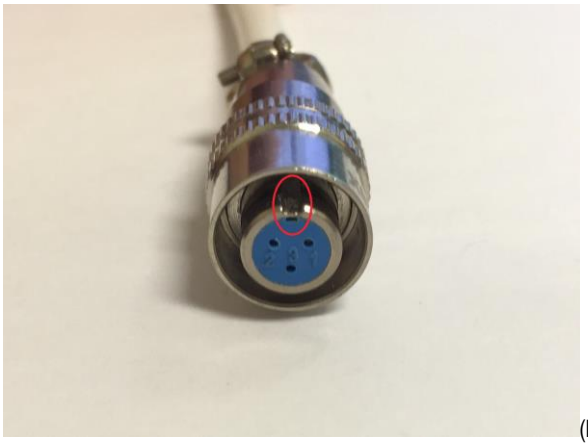
Note 6. The differential mode can be set to 1-2 or 2-1. It defines the how the value of DT is calculated. For example, 1-2 means DT is equal to the reading of sensor 1 minus reading of sensor 2.

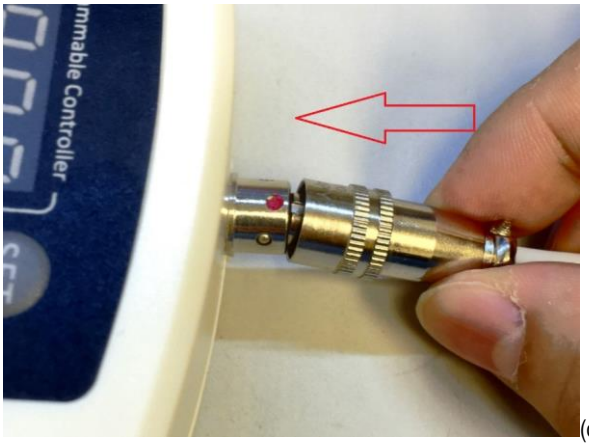
6. How to install the sensor to the unit.

The connector of sensor contains a slot for fitting pin connection. It also has a spring lock to prevent disconnections from accidental pulling on the cable.

To install the sensor to the controller: 1) identify the key on the male connector (Figure 4, a) and the notch on the female connector (Figure 4, b); 2) hold the tail of the female connector, align the notch and the key, and push the female connector forward (Figure 4, c). To remove the connector, hold the spring-loaded collar on the female connector and pull it back. Please see Figure 5.


(a)


(b)



(c)

Figure 4. Install the sensor.

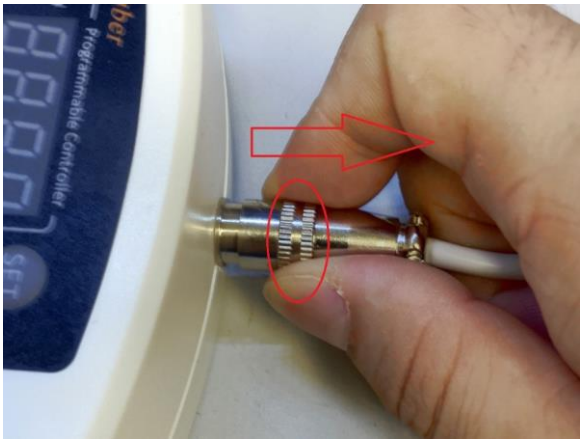


Figure 5. Remove the sensor.

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