

Instruction Manual

TD320 Differential Temperature Controller For HVAC

Version 1.0 (Sep, 2017)

1. Overview

TD320 is a temperature controller for heating, ventilating, and air-conditioning (HVAC) controls using the external medium such as air or water. The controller comes with two sensors. The primary sensor (Sensor1) should be placed in the room or close to the object whose temperature needs to be regulated. The auxiliary sensor (Sensor2) should be placed to monitor the external medium. The temperature difference between two sensors can be used as an additional criterion for controlling the power output. Two independent channels are available, one for cooling and one for heating.

This is a plug-n-play controller. No additional wiring is needed. Both the heating and cooling controls are on/off control. It is similar to a mechanical thermostat but has much higher precision due to adjustable hysteresis band, high precision sensor, and digital read out. Anti-Short (AS) function is available for the cooling channel to protect the compressor from being turned on/off frequently.

The two output channels are independent. Each channel has its own set temperature. But the change in the Cooling Set Point may affect the Heating Set Point in order to avoid energizing the heating and cooling devices at the same time.

Two digital silicon band gap sensors are used. This type of sensor is much more reliable in moist environment comparing to thermistor sensors. It can be immersed in water over an extended period of time. It also has high uniform accuracy over an entire specified temperature range. Two sensors are interchangeable. One of them has a 12 feet (2 m) cable, which makes it easy to reach the external medium.

2. Specifications

Temperature Control Range	-50 ~ 170 °C, -58 ~ 306 °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	10 A, 120 V or 240 VAC *
Audio Alarm	High and low limit
Sensor Type	Silicon Band Gap Sensor (digital)
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	-55 ~ 125 °C (-67 °F ~ 257 °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.

* **Please note:** although both the cooling and the heating channels can handle up to 15A, the combined power consumption of these two channels should not exceed 1500 Watts due to the limitation of the controller's power cord.

3. Front Panel



Figure 1. Front panel of TD320.

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. Connecting the Controller

Here are the basic operating procedures to use this controller. To fully understand the functions on this controller, please read the entire manual.

- 1) Connect the temperature sensors to the sensor socket that is located on the top of the controller. Please check the alignment of the slot on the plug with the key on the socket.
- 2) Plug the controller's power cord to a wall outlet. When the controller is powered on, it will display temperature reading from Sensor1. Press and hold the Down key to display the temperature reading from Sensor2. If either one of the sensor is not connected or shorted, the digital display will show "Err". Once powered up, the controller will start running according to the saved settings.

- 3) Set up the program and system parameters. Please read the rest of this manual for details. See the flow chart in Figure 2 for how to check temperature and change parameter settings.
- 4) Connect the cooling device and/or heating device to the output sockets on this controller. When an output socket is energized, its LED indicator will lit.

5. Basic Operations

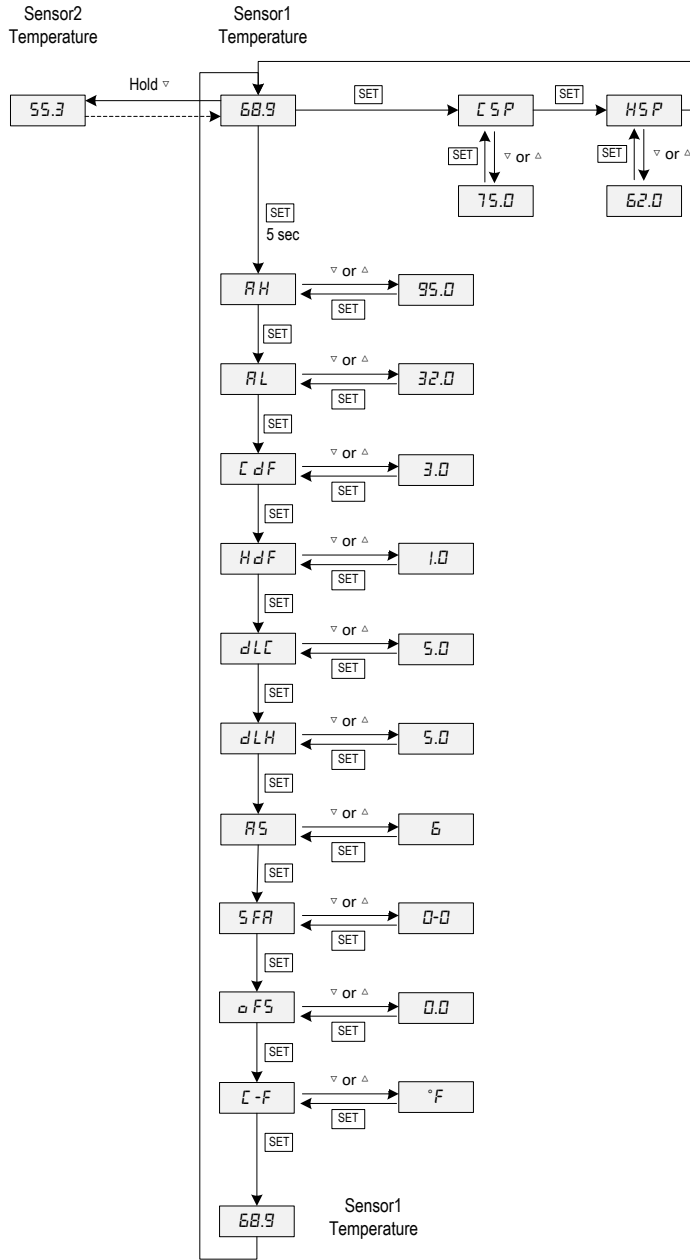


Figure 2. Flow chart of checking sensor readings and parameters.

Please see Figure 2 for a flow chart of how to access the parameters on this controller. To check the temperature reading from Sensor2, press and hold DOWN key. When you release the DOWN key, the controller will show temperature from Sensor1 again.

To change the set temperatures, press SET key momentarily. The controller will show CSP (Cooling Set Point), press SET again will show HSP (Heating Set Point). When the controller shows "CSP" or "HSP", press UP or DOWN key to

reveal the value. Then you can edit the value by pressing the UP or DOWN key. When finished editing, press SET key again to confirm the change.

To access the system parameters, press and hold the SET key for 5 seconds, the controller will enter the Parameter Setting Mode. The first parameter "AH" will be shown in the display window. Use UP or DOWN key to reveal and modify the value. Use SET key to confirm the change or go to the next parameter. The instrument will automatically exit if no key is pressed for 10 seconds.

6. Basic Operating Logic

The primary application of this controller is to use external medium (air or water) to help regulate the temperature of a particular object (e.g. a room or a tank) within a specified temperature range whose upper boundary is set by CSP and the lower boundary is set by HSP. The temperature of the object is monitored by the Primary Sensor (Sensor1), while the temperature of the external medium is monitored by the Auxiliary Sensor (Sensor2). Whether the controller will send power to the heating/cooling devices mainly depends on two criteria: 1) if the Sensor1 temperature is greater/less than the set points, Cooling Set Point (CSP) or Heating Set Point (HSP); and 2) if the temperature difference between Sensor1 and Sensor2 is greater than the deviation limits dLH (i.e., Deviation Limit for Heating) or dLC (i.e., Deviation Limits for Cooling). Please see the flow chart in Figure 3 for an illustration of the controller's operating logic.

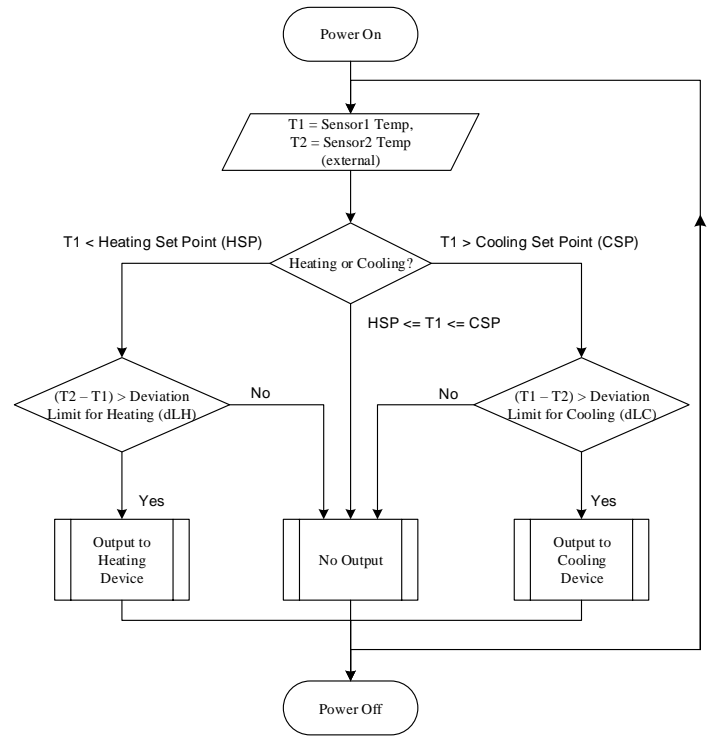


Figure 3. The main operating logic of controller TD320.

7. Parameter Settings

Please see a list of a system parameters in Table 1. See the notes below for detailed explanations.

Table 1. Parameters Description

Code	Description	Setting Range	Initial	Note
CSP	<i>CSP</i>	Cooling Set Point	-58~248 °F, -50~125 °C	75.0 1
HSP	<i>HSP</i>	Heating Set Point	-58~CSP °F, -50~CSP °C	62.0 1
AH	<i>AH</i>	High Limit Alarm	-58~248 °F, -50~125 °C	95.0 2
AL	<i>AL</i>	Low Limit Alarm	-58~AH °F, -50~AH °C	32.0 2
CdF	<i>CdF</i>	Cooling Hysteresis	0 ~ 50.0	3.0 1
HdF	<i>HdF</i>	Heating Hysteresis	0 ~ 50.0	1.0 1
dLC	<i>dLC</i>	Deviation Limit for Cooling (T1 – T2)	0.0~99.9	5.0 3
dLH	<i>dLH</i>	Deviation Limit for Heating (T2 – T1)	0.0~99.9	5.0 3
AS	<i>AS</i>	Cooling Anti-Short	0~12 min	6 4
SFA	<i>SFA</i>	Sensor Failure Operation	0-0, 0-1, 1-0	0-0 5
oFS	<i>oFS</i>	Offset of Sensor1	-10.0 ~ 10.0	0.0 6
C-F	<i>C-F</i>	Temperature Unit	C (Celsius), F(Fahrenheit)	°F

Note 1. For cooling, the output will be off when the T1 (Sensor1 temperature) is lower than the CSP; it will be on again when the temperature rises above (CSP + CdF). For heating, the output will be off when T1 (Sensor1 temperature) higher than HSP; it will be on again when T1 drops below (HSP - HdF).

The HSP should always be less than or equal to CSP. When the user want to change the CSP to a new value that violates this condition, the current HSP value will be automatically overwritten to meet this condition, i.e., set HSP = CSP. But if the user wants to change HSP to a new value that violates this condition, the operation is not allowed. For example, a controller has CSP = 67.0 °F and HSP = 62.0 °F. Now the user can only change HSP to any value between -58 and 67.0. But for CSP, it can be set to any value between -58 and 248. If the user set CSP = 55.0, then the controller will automatically change HSP to 55.0.

CdF and HdF are the hysteresis band for cooling and heating. Small hysteresis band gives tight temperature control. Large hysteresis band reduces the frequency of a device being cycled on and off, which will extend the life of the mechanical relay and/or the compressor if the cooling device was a refrigerator.

Note 2. If Sensor1 temperature (T1) is higher than AH, the High Limit Alarm will be activated and the internal buzzer will go off. If T1 is lower than AL, the Low Limit Alarm will be activated and the buzzer will go off. If the T1 falls between AL and AH, the alarm will be deactivated and the buzzer will stop. Sensor2 temperature will NOT trigger the alarm.

When the alarm is triggered, the display window will flash between the measured temperature and the alarm type (AH or AL). To mute the buzzer, press the UP key momentarily. If the T1 re-enters the alarm zone, the alarm buzzer will go off again. The alarm can be disabled by setting AH = AL.

The AL value must be less and equal to AH. The AH value can be set to any value between -58 ~ 248 °F (-50 ~ 125 °C). If AH is set to a value lower than the current AL value, controller will automatically set AL = AH. For example, on a controller, AH = 95.0 °F, AL = 32.0 °F. Now user can only change AL to a value between -58 and 95.0. But for AH, user can set it to any value between -58 and 248. If user sets it to 25.0, AL will be changed to 25.0 automatically.

Note 3. When external air or water is employed as a medium for cooling or heating, user can use the temperature difference between Sensor1 and Sensor2 as an additional criterion for cooling or heating. Two parameters, the Deviation Limit for Cooling (dLC) and the Deviation Limit for Heating (dLH) are made available for this purpose. For example, when the user want to blow the cool air from outside to an attic to control the inside temperature, but don't want to waste electricity if the outside temperature (T2, read by Sensor2) is not lower than the inside temperature (T1, read by Sensor1) by 10 °F degrees, the user can set dLC = 10.

The dLC is defined as (T1 -T2), where T1 is the temperature of Sensor1, T2 is the temperature of Sensor2. It only applies to cooling mode, and it is valid only when dLC value is greater than or equal to zero. Unless the T2 is lower than T1 and the difference is greater than dLC, the controller won't supply power to the Cooling Device Socket.

The dLH is defined as (T2-T1). It only applies to heating mode, and it is valid only when dLH value is greater than or equal to zero. Unless the T2 is higher than T1 and the difference is greater than dLH, the controller won't supply power to the Heating Device Socket. For example, set dLH =5 means that the minimum temperature difference for heating output to be turned on is T2 (Sensor2) is 5 degree higher than T1 (Sensor1).

Both dLC and dLH are non-negative numbers in the range between 0 and 99.9. Default values of dLC and dLH are 5.0.

Note 4. The Cooling Anti-Short is the delay time (the unit is minute) to turn the cooling load on. When the controller is used to control a compressor, it should not switch the compressor on/off too frequently. Activating the compressor when it is still at high pressure (just after it was turned off) may shorten the life of a compressor. The Anti-Short cycle delay function should be used to prevent the rapid cycling of the compressor. It impose a minimum time interval during which the Normally Open (N.O.) contacts which controls the cooling channel should remain open. The delay overrides any load demand on the cooling channel. It does not allow the N.O. contacts to close until the delay time has elapsed. This delay allows the pressure inside the compressor to release through its evaporator. The Cooling Anti-Short (AS) is typically set to 4 ~ 6 minutes. By default, AS is set to 6 minutes.

Note 5. The SFA defines whether the controller should be sending power to its loads when any of the temperature 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

Note 6. The parameter oFS is used to set an input offset to compensate the deviation of temperature reading from true temperature on Sensor 1. For example, if the unit displays 37 °F when the actual temperature is 36 °F, setting the parameter oFS = -1 can correct the temperature reading to 36 °F. This parameter does not affect the Sensor2 reading.

8. Connect Sensor to the Controller

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.



(a)



(b)



(c)

Figure 4. Install the sensor.

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.

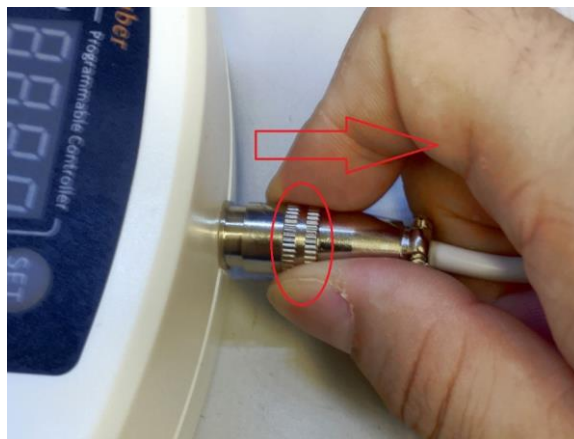


Figure 5. Remove the sensor.

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