Instruction Manual

TD320 Differential Temperature Controller For HVAC

Version 1.2 (Oct, 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 where the temperature needs to be regulated. The auxiliary sensor (Sensor2) should be placed to monitor the temperature of 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, and each channel has its own set temperature. There are two output sockets, one for cooling and one or heating. The controller also offers the flexibility of re-assign the heating or cooling output to one or both sockets per the user's setting.

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.

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 the sensor has a 12-feet (2 m) cable, which makes it easy to reach the external medium.

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 ~ 120°C) 0.1°F (between -9.9 ~ 99.9°F) 1°F (between -58 ~ 10°F, 100 ~ 248°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	-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 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 socket on the left.
(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 socket on the right.
(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

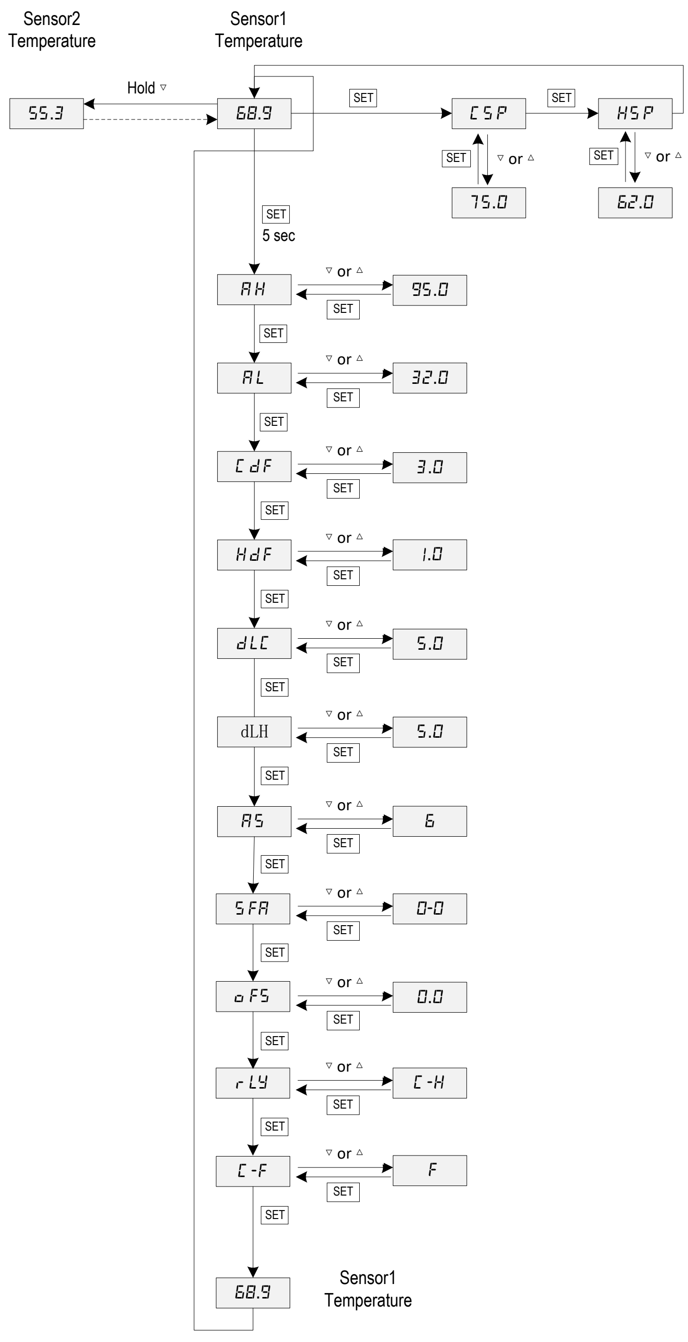


Figure 2. Flow chart of checking sensor readings and parameters.

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.

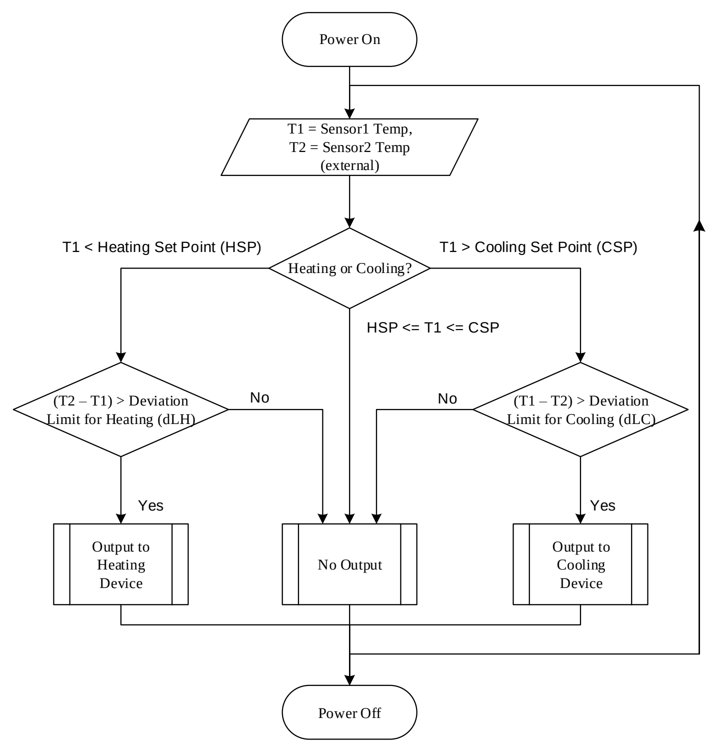


Figure 3. The main operating logic of controller TD320.

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	CSP	Cooling Set Point	-58 ~ 248°F, -50 ~ 125°C	75.0	1
HSP	HSP	Heating Set Point	-58 ~ CSP°F, -50 ~ CSP°C	62.0	1
AH	AH	High Limit Alarm	-58 ~ 248°F, -50 ~ 125°C	95.0	2
AL	AL	Low Limit Alarm	-58 ~ AH°F, -50 ~ AH°C	32.0	2
CdF	CdF	Cooling Hysteresis	0 ~ 50.0	3.0	1
HdF	HdF	Heating Hysteresis	0 ~ 50.0	1.0	1
dLC	dLC	Deviation Limit for Cooling (T1 – T2)	0.0 ~ 99.9	5.0	3
dLH	dLH	Deviation Limit for Heating (T2 – T1)	0.0 ~ 99.9	5.0	3
AS	AS	Cooling Anti-Short	0 ~ 12 min	6	4
SFA	SFA	Sensor Failure Operation	0-0, 0-1, 1-0	0-0	5
oFS	oFS	Offset of Sensor1	-10.0 ~ 10.0	0.0	6
rLY	rLY	Relay Output Mode	(see note 7)	C-H	7
C-F	C-F	Temperature Unit	C (Celsius), F(Fahrenheit)	ºF	

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 wants 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 = 67.0ºF and HSP = 62.0ºF. 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 ~ 248ºF (-50 ~ 125ºC). 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 = 95.0ºF, AL = 32.0ºF. 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 wants 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 ºF 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 degrees 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 imposes 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 37ºF when the actual temperature is 36ºF, setting the parameter oFS = -1 can correct the temperature reading to 36 ºF. This parameter does not affect the Sensor2 reading.

Note 7. The parameter RLY (r LY) defines how the output relays/sockets are configured. By default, the socket on the left side is for cooling devices, which is energized as the cooling condition is met; the socket on the right side is for heating devices, which is be energized as the heating condition is met. The user can change this configuration by changing the RLY setting. The table below lists all the possible values of RLY and the condition to energize each of the sockets.

RLY Option	Left socket triggered by	Right socket triggered by
C-H (default)	Cool	Heat
A-A	All conditions (cool & heat)	All conditions (cool & heat)
H-H	Heat	Heat
C-C	Cool	Cool
-CH	--	All conditions (cool & heat)
CH-	All conditions (cool & heat)	--

C-H: This is the default configuration. The output socket on the left is assigned to controller's cooling function, and the output socket on the right is assigned to controller's heating function.

A-A: In this configuration, all conditions, either heating or cooling, will trigger both the left and the right output sockets; i.e., when the controller calls for heating or cooling, both sockets will be energized.

H-H: Both output sockets are assigned to controller's heating function. When the controller calls for heating, both the left and the right sockets will be energized; when the controller calls for cooling, no output socket will be energized.

C-C: Both output sockets are assigned to controller's cooling function. When the controller calls for cooling, both the left and the right sockets will be energized; when the controller calls for heating, no output socket will be energized.

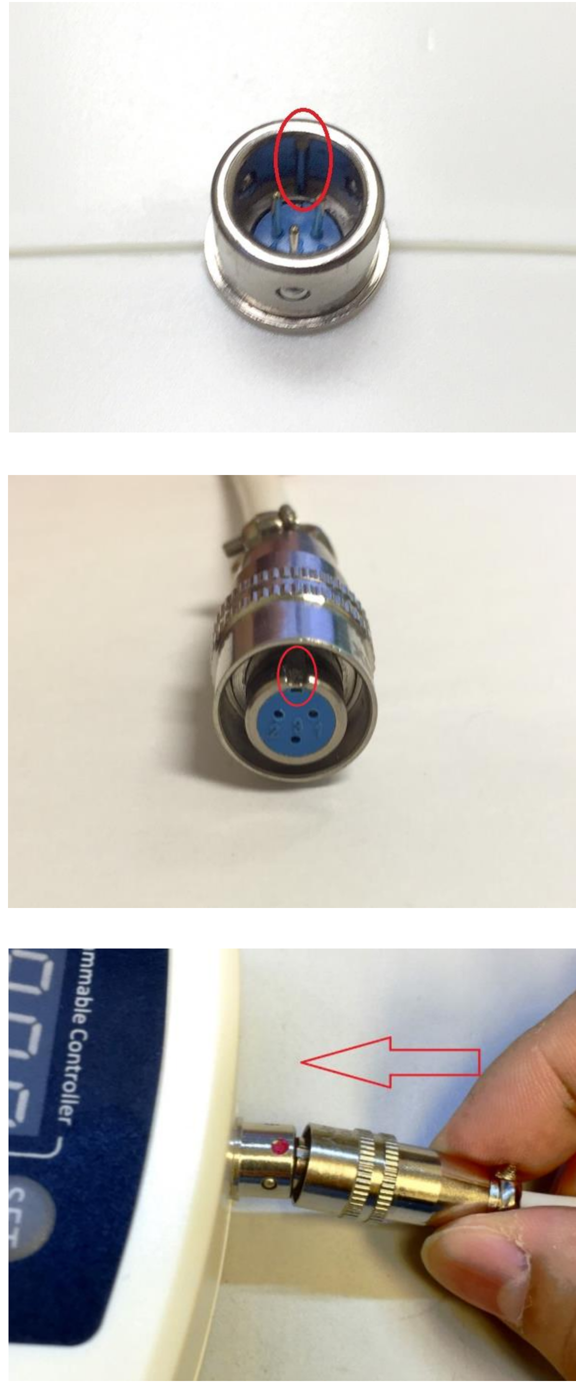
-CH: The output socket on the right is assigned to both cooling and heating. The socket on the left is disabled. When this controller calls for heating or cooling, it will only energize the socket on the right.

CH-: The output socket on the left is assigned to both cooling and heating. The socket on the right is disabled. When this controller calls for heating or cooling, it will only energize the socket on the left.

Please note that the LED indicator above each socket is synchronized with the socket. It is not an indicator of what condition triggers the socket.

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.

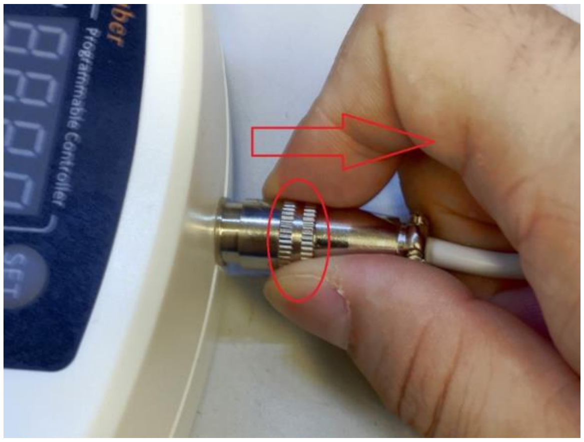


Figure 5. Remove the sensor.

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