

## Instruction Manual

# TD420P Programmable Temperature Controller

Version 1.0 (Dec, 2018)

## 1. Overview

This is a dual-output temperature controller with 8 programmable steps. It contains one temperature probe and two independent outputs. One output is for cooling device such as refrigerator and the other one is for heating device. The temperature control can be programmed to vary with different time step setting. Up to 8 temperature-time steps covering 33 days can be programmed. It can be used for applications such as beer fermentation or convert a refrigerator to kegerator. By using both cooling and heating devices, the refrigerator can be controlled at specific temperature regardless in hot summer or cold winter.

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 readout. Anti-short function is provided for cooling to protect the compressor from short cycling (turning on and off frequently) 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.

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

## 2. Specifications

Table 1. 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	10A, 120 V or 240 VAC *
Timer Range	Each step: 0.1 to 99.9 Hours or 1 to 999 Minutes
Timer Resolution	0.1 Hours or 1 Minute
Max Programmable Time	799.2 hours or 33.3 days (for total 8 steps)
Audio Alarm	High and low limit
Sensor Type	Silicon Band Gap Sensor
Sensor Size	0.25" OD (6.35 mm) x 2" (50mm) long
Ambient Temperature	-20 ~ 50°C (0 ~ 120°F)
Dimension	91 x 140 x 46mm
Input Power	85 ~ 242V AC, 50/60 Hz
Sensor Cable Length	6 ft (2 m)
Power Cable Length	3 ft (1 m)

Warranty: One (1) year for the controller

\*: Either heating or cooling device is limited to 10 Amps. The output voltage is same as 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, Part 1



Figure 2. Front Panel, Part 2

**Display window:** display temperature reading and parameters.

**START key:** start executing the program.

**PAUSE/STOP key:** short press it to pause the program; long press it for 4 seconds to stop the program (only when the program is already been paused).

**MUTE key:** silent the alarm buzzer.

**STEP key:** jump to different step; check the running step.

**SET key:** access the program settings and parameter settings.

**UP key:** increase the value.

**DOWN key:** decrease the value.

**Cooling device output socket:** supply power to cooling device.

**Cooling device output indicator:** green LED indicator; it is on when the cooling device socket is energized.

**Heating device output socket:** supply power to the heating device.

**Heating device output indicator:** red LED indicator lit; it is on when the heating device socket is energized.

#### 4. Basic Operation

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 sensor to the sensor socket that is located on the bottom of the controller. Please check the alignment of the slot on the plug with the key on the socket. (See section 12 for details.)
- 2) Plug the controller's power cord to a wall outlet.
- 3) Set up the program and system parameters. Please read the rest of this manual for details.
- 4) Connect the cooling device and/or heating devices to the output sockets on this controller.
- 5) Press START key to start running the program.

#### 5. Mode Selection

This controller has 5 different modes: program run, program hold, program stop, parameter setting, and programming mode. Before powering on the controller, please connect the sensor cable to it. If no sensor is connected, the controller will show error code "Err", indicating no sensor is detected. When the controller is powered on, it enters the **Program Run** mode. It will show measured reading temperature value. By default setting, this controller will run the temperature profile from the step 1. It is controlled by power outage parameter A-M (see note 7).

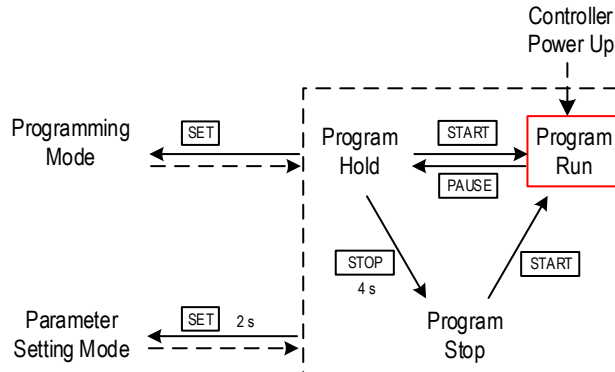


Figure 2. Switching between different modes.

**Program Running:** The controller executes the saved program. The display window should show the current temperature reading. The controller will send power to its heating/cooling sockets to regulate temperature. When the program is running, press PAUSE key momentarily will put the controller to Program Hold mode.

**Program Holding:** Controller pauses the time but it still regulates the temperature at the current set value. The display window flashes between the reading temperature and "Hold". To resume the program, press START key momentarily. To completely stop the program, hold the STOP key for 4 seconds.

**Program Stop:** The execution of the program is terminated. Controller outputs are deactivated and timer is also stopped. The display window flashes between the reading temperature and "Stop". To start the program, press the START key momentarily. The controller will start regulating the program from the first step.

**Programming Mode:** Review and edit temperature set value and set time for each steps. When the controller is in Program Run, Hold, or Stop mode, press SET key to enter the Programming mode. Please see Figure 4 for details.

**Parameter Setting Mode:** Review and edit system parameters. When the controller is in Program Run, Hold, or Stop mode, hold the SET key for 2 seconds to enter the Parameter Setting mode. Please see Figure 3 for details.

#### 6. Parameter Setup

Please see Table 2 for a list of parameters and see Figure 2 for the flow chart of how to set the parameters. Please note that parameters will remain unchanged unless you press set key to confirm the change.

Table 2. Parameters Description.

Code		Description	Setting Range	Initial	Note
AH	<i>RH</i>	Deviation high alarm	0.5~999.9	20.0	1
AL	<i>RL</i>	Deviation low alarm	0.5~999.9	20.0	1
Hy	<i>HY</i>	Temp. Control Hysteresis Band	0.5~99.9	1.0	2
CdF	<i>CD F</i>	Cooling Differential	0.5~99.9	5.0	3
HdF	<i>HD F</i>	Heating Differential	0.5~99.9	5.0	4
oFS	<i>oFS</i>	Temp. Offset	-99.9~99.9	0	5
AS	<i>RS</i>	Anti-short Cycle Delay (only for cooling socket)	M 0~ M99 (0~99 min)	M 0	6
A-M	<i>R-n</i>	Power Outage/Startup Modes	S,M,C	S	7
PrG	<i>Pr G</i>	Program Modes	on, off	ON	8
SFA	<i>SFA</i>	Sensor Failure Operation	0-0, 0-1, 1-0	0-0	9
Time	<i>Time</i>	Time unit	H, M	H	10
C-F	<i>C-F</i>	Temperature unit	°F, °C	°F	11

**Note 1.** AH, deviation high alarm; AL, deviation low alarm:

Assuming measured temperature is PV and set temperature is C. When PV - C is above AH, the built-in buzzer will turn on (deviation high alarm); when H - PV is above AL, the built-in buzzer will turn on (deviation low alarm). User can mute the alarm by momentarily pressing the Mute key. The alarm will remain inactive until the process value moves out of the alarm zone. Both alarms are deviation alarms, i.e., if AH = 20, AL = 30, and the Set Temperature (C) is 50F, the alarm will be activated if the temperature is above 70F or below 20F. The alarm function is suppressed at powering up or when the program is jumped from one step to another step. It will be activated automatically once the measured temperature enters the none-alarm zone (between C - AL and C + AH).

**Note 2.** Hy, Temperature Control Hysteresis Band, or Temperature Control Dead Band:

This parameter set up a dead band (between C - Hy and C + Hy) within which either the heating device or cooling device will not work. The minimum value for Hy is 0.5. The Hy value should not be too small if the system has sluggish response. Otherwise, it may result in the heating device and the cooling device working against each other, wasting energy and causing oscillation.

**Note 3.** CdF, Cooling Differential:

This is the differential band between turn on and turn off the cooling device. It is set to the higher side of the temperature set point (C + Hy). The cooling device will turn on when temperature is above (C + Hy + CdF), and turn off when temperature is below (C + Hy). For compressor based cooling device, the CdF value should not be set too small to prevent frequent cycling.

**Note 4.** HdF, Heating Differential:

This is the differential band between turn on and turn off the heating device. It is set to the lower side of the temperature set point (C - Hy). The heating device will turn on when temperature is below (C - Hy - HdF), and turn off when temperature is above (C - Hy).

For example, if Set Temperature C = 50, Hy = 5, CdF = 3, HdF = 2, then the heating device will turn on when process temperature is lower than 43 (C - Hy - HdF) and turn off when process temperature rises above 45 (C - Hy). The cooling device will turn on when process temperature is above 58 (C + Hy + CdF) and turn off when process temperature drops below 55 (C + Hy).

**Note 5.** oFS, Temperature Offset:

oFS is used to compensate the error produced by the sensor or input signal itself. For example, if the unit displays 37 when the actual temperature is 32. Set parameter oFS = - 5 will make the controller display 32. Displayed process temperature = actual measured temperature + oFS.

**Note 6.** AS, Anti-short Cycle Delay:

The Anti-short is the delay time to turn on the cooling device. If the cooling device is compressor based, compressor should not be turned on immediately 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 compressor remains off (after reaching cutout) before turns on again. The delay overrides any controller demand and does not allow the compressor to turn on until the set time-delay value has elapsed. It gives time to release the refrigerant pressure through evaporator. It typically set to 4- 6 (minutes). The unit is in minutes. This setting is only valid for cooling device control. By default, AS is set to 0 (disabled).

**Note 7.** A-M, Power Outage/Startup Mode:

This parameter determines what the controller should do in an event of power interrupt or outage. It also decides how the controller starts the program while powered up. A-M can be set to three modes: C, S and M.

Mode C. After being powered on, the controller will continue the program from the where it was powered off. For example, if step 3 is set for 40 and 5 hours, the power was interrupted at 2.1 hours. Then, when the controller power up, the controller will continue to control at 40 for 2.9 hr.

Mode S. The controller will run the program from step 1 every time the controller is powered up. This is suitable for situations where the power never fails, or when the program mode "PrG" is set to "off".

Mode M. The program will be held at the step at which the controller was powered off. The controller will hold the temperature at the set value. The controller lower display will flash "hold" and process temperature alternatively. This mode is suitable for situations where the operator's attention is needed after power interruption occurs.

**Note 8.** PrG, Program Mode:

When PrG is set to "ON", user can program up to 8 steps (Section 7). When set it to "OFF", this multi-step function is disabled and controller is in single step mode. User can only set "C-1" value (without timer t-1) when disabled. The start key, pause key and STEP key are disabled. You can check the cooling device indicator (green on the left) and heating device indicator (red on the right) for the socket output status. When the light is on, the corresponding socket will be activated.

**Note 9.** SFA, Sensor Failure Operation:

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 3 for details. For example, in some applications, you may want the cooling device to be working and the heating device to be off when sensor fails. Hence you need to set SFA to "1-0".

Table 3. 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 10.** Time, Time unit setting:

The Time defines the timer unit setting for its timer function. It can be set to hour (H) or minute (M). By default, Time is set to H.

**Note 11.** C-F, Temperature unit:

°F: Display in Fahrenheit degree; °C: Display in Celsius degree.

**7. Program the temperature profile**

To program the temperature profile, briefly press SET key once. The display will show "C-1". Press SET key again then it will show the temperature set value for step 1. Use ▲ or ▼ key to adjust the temperature to the desired value. Then press SET key again to save the change and exit "C-1" setting. Use ▲ key to go to next the parameter "t-1", the preset time for step 1. Press SET key to view the value, use ▲ or ▼ key to adjust it to the desired value, and then press SET key again to save the change and exit "t-1" setting. Use ▲ key to go to the next step, or use ▼ key to go back to the previous parameter. Repeat operation till you finish programming all necessary steps. You can set the time for rest of the steps to zero so that the controller will skip these steps. Go to "End" to exit the program editing mode.

**Note:** The set value will not be saved unless SET is pressed. If no adjustment is needed for any followed steps, you can go to "End" by pressing the ▲ key and then the SET key. The controller will also return to the normal operating mode if it is left alone for 10 seconds.

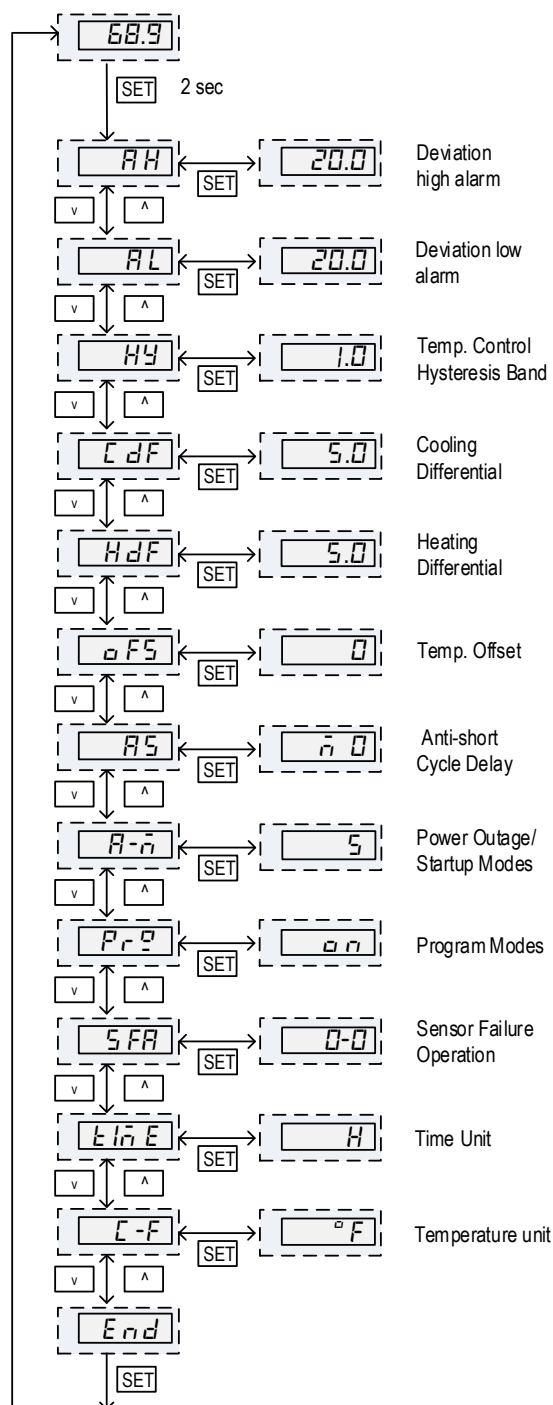


Figure 3. Flow chart of setting up parameters.

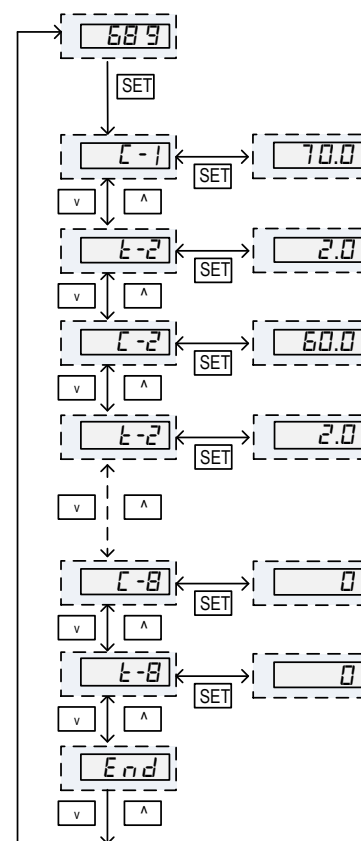


Figure 4. Flow chart of setting up control program.

## 8. Check the Status

**Step Running Time:** how much time has passed since the beginning of the current step. You can check the Step Running Time while the controller is in the Program Running Mode:

- 1) Short press the STEP key once so the display window will show the current step number "P - X".
- 2) Wait about 1 second for the step running time to appear in the display window.
- 3) Press STEP key again to check the Total Power-on Time (see below) or not touching any key for 10 seconds so that the display window will show the temperature reading again.

**Total Power-on Time:** how much time has passed since the controller is powered on. You can check the Total Power-on Time in Program Running, Holding, or Stop Mode:

- 1) Short press the STEP key twice, you can see "toL" shown in the display window shortly, and then the Total Power-on Time will be shown.
- 2) Press STEP again to return to temperature reading.

Once the whole program is finished, the display will show "End" and buzzer will be ON. Press start key once to restart the program.

## 9. Program Jump

This controller allows its user to skip part of the program by jumping to a specified program step. For example, the controller has run 3 minutes in its 2<sup>nd</sup> step. If the user wants to skip the rest of the 2<sup>nd</sup> step and the entire 4<sup>th</sup> step, then the user can jump to step 4.

To jump to a specified step:

- 1) Put the controller in either Program Hold or Stop Mode.

2) Press STEP key so the controller will flash "J-PX", where "J" indicates this operation is for jumping to a step, "X" is the step number. Use UP or DOWN arrow key to increase or decrease the step number to desired value, then press START key to confirm. The display window will show "JUMP" briefly to confirm that jump is accomplished. Then controller will execute the step and display window should show temperature reading.

#### 10. Alarm Buzzer

The controller has a build-in buzzer. Under the following situations, the alarm buzzer will be triggered:

- 1) When the temperature alarm is triggered, the buzzer will keep on beeping until the MUTE key is pressed.
- 2) When a program step (other than the 8<sup>th</sup> step) is finished, the buzzer will beep twice.
- 3) When the entire program is finished (the 8<sup>th</sup> step), the buzzer will keep on beeping until the MUTE key is pressed.

When the alarm buzzer is beeping, you can press MUTE key to mute the alarm.

#### 11. Quick Operation Guide

- If you see "Err" message in the display window, check the sensor connection.
- To run the program: if the controller is in Hold or Stop mode, press START key.
- To hold the program: when the program is running, short press PAUSE key to put the program on hold.
- To stop the program: put the program to Hold mode, then long press the STOP key for 4 seconds until you see "Stop" in the display window.
- To set up program steps: press SET key.
- To set up system parameters: long press SET key for 2 seconds.
- To mute the alarm: press MUTE key.
- To check the current step number and the step running time: in the program running mode, press STEP key once, the display will show "P-X", where X is the current step number, then the display window will show the elapsed time in the current step.
- To check the total time since the controller is powered up: in the program running mode, press STEP key twice. The display window will show "toL" and then it will display the total time since controller is powered up.
- To start from a specific step (or jump to a specific step): when the program is on hold or stopped, press STEP key once, it will flash "J-PX". Use the UP or DOWN key to change the step number to the desired value, then press START key to confirm. The display will show "JUMP" for a second and then the controller will start executing the specified program step.

#### 12. Connect the 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.

To install the sensor to the controller: 1) Identify the key on the male sensor connector (Figure 5, a) and the notch on the female connector (Figure 5, b). 2) Hold the tail of the female connector, align the notch and the key, and push the female connector forward.

To remove the connector, hold the spring-loaded collar on the female connector and pull it back. Please see Figure 6.



(a)



(b)



(c)

Figure 5. Install the sensor.

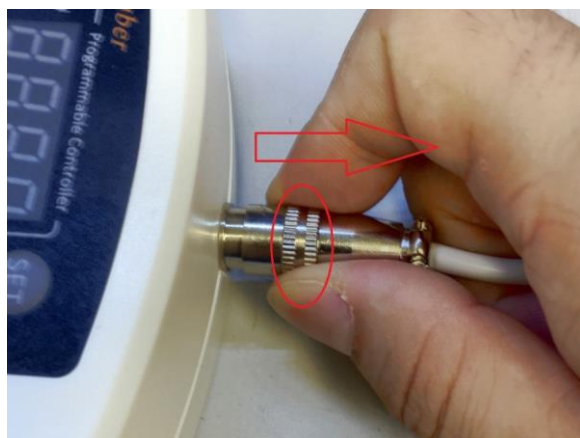


Figure 6. Remove the sensor.

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