

Instruction Manual

TD420A Programmable Temperature Controller

Version 1.0 (June, 2025)

1. Overview

The TD420A is a plug-and-play, dual-output temperature controller equipped with updated firmware (v1.3.5), offering significantly enhanced programming capabilities compared to the previous model TD420P.

It supports up to eight programmable steps spanning up to 33 days. For each step, users can define a target temperature and a step timer, or even configure a special action. Programs can run either in a linear sequence or as a loop, depending on program configuration.

This controller can be used for applications such as beer fermentation, sourdough rising, or in research studies where the environment needs to be controlled in certain cycles. The TD420A is a plug-and-play controller. No wiring is needed for the heater or cooler.

The controller comes with one temperature probe and provides two independent outputs: one for cooling devices (e.g., refrigerators, ventilation fans); one for heating devices (e.g., space heaters, heating lamps). By using both outputs, users can maintain the desired chamber temperature regardless of external conditions.

2. Specifications

Table 1. Specifications.

Temperature Control Range	-50 ~ 105°C, -58 ~ 221°F
Temperature Display 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
Power Output *	10A, 120 V or 240 V AC **
Step Timer Range	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" (50 mm) long
Ambient Temperature	-20 ~ 50°C (0 ~ 120°F)
Dimension	91 x 140 x 46 mm
Input Power	85 ~ 242 VAC, 50/60 Hz
Sensor Cable Length	6 ft (2 m)
Power Cable Length	3 ft (1 m)
Warranty	One (1) year for the controller

* The total combined output (heating and cooling) is limited to 10 Amps at either 120 VAC or 240 VAC. Each individual output is also limited to 10 Amps.

** The output voltage matches the input voltage.

3. Front Panel



Figure 1. The front panel of TD420A.

- Display Window.** Display the temperature reading and parameters.
- UP and DOWN arrow keys.** Increase or decrease values; scroll the parameter list.
- START key.** Start running the program.
- STEP key.** Check the current step; jump to another step.
- MUTE key.** Silences the built-in alarm buzzer.
- Heating Device Output Indicator.** A red LED that lights up when the heating device output is active.
- Heating Device Output Socket.** Supplies the power to the heating device.
- Sensor Input Connector.** Used to connect the temperature sensor.
- SET key.** Access the program, system menu, and save new values.
- PAUSE/STOP key.** Short-press to pause the program; long-press for 4 seconds to stop the program.
- Cooling Device Output Indicator.** A green LED that lights up when the cooling device output is active.
- Cooling Device Output Socket.** Supplies power to cooling device.

4. Getting Started

Upon receiving the controller and probe, take a moment to familiarize yourself with the layout, key functions, and indicators. Then you can set up the controller by following the steps below.

1) Powering On

Plug the controller's power cord into a wall outlet. The controller will power up, displaying "8.8.8.8." briefly, followed by "run", and then "Err" – an error code for no sensor detected.

2) Connecting the Temperature Sensor

Insert the sensor into the sensor input connector located at the bottom of the controller. Align the notch on the sensor plug with the key in the socket (see Section 10 for details). The controller should display the current temperature reading from the sensor in the display window.

3) Programming the Temperature Profile

Up to 8 steps can be programmed. Please read Section 6 for details.

4) Adjusting System Parameters

Customize system settings as needed. Please read Section 7 for details.

5) Stopping the Program Before Connecting Devices

Before plugging in any external devices, press and hold the PAUSE/STOP key until the display shows "STOP". This ensures the controller is idle before device connection.

6) Connecting Cooling and Heating Devices

Plug the appropriate devices into their designated output sockets.

7) Starting the Program

Press the START key to begin operation.

5. Basic Operations

5.1. Checking and Editing the Program

To modify the temperature control profile, briefly press the SET key to access the program settings. For each step (from Step 1 to Step 8), users can configure a **target temperature** (C-X) and a **step timer** (t-X), where X represents the step number. For example, "C-1" means the target temperature for Step 1.

Editing Parameters

When C-X or t-X appears on the display, press the SET key to view its current value. Use the UP or DOWN arrow keys to adjust the value as needed. Then press the SET key again to save changes and return to the menu.

Navigating the Program Menu

Use the UP or DOWN arrow keys to scroll through the list of parameters. When "END" appears, press the SET key to exit the menu.

5.2. Checking and Editing System Parameters

To access the system menu, press and hold the SET key for 2 to 3 seconds. This menu allows you to adjust alarms, the temperature control band, the timer unit, and other system parameters.

Use the UP or DOWN arrow keys to scroll through the list of parameters. If you want to edit a parameter, press the SET key to view its current value. Use the UP or DOWN arrow keys to adjust the value as needed. Press the SET key again to save changes and return to the menu. If you want to exit from the menu, scroll through the parameter list until "END" appears and press the SET key to exit.

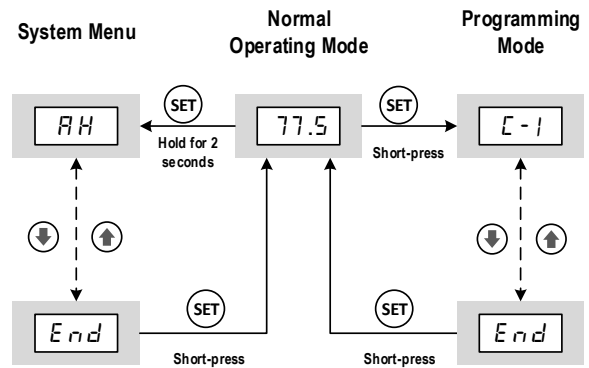


Figure 2. Navigate the Program Menu and the System Menu.

5.3. Starting, Pausing, and Stopping the Program

When powered on, the controller automatically starts running its program, briefly displaying "RUN" before proceeding. This behavior is determined by the Power Outage Parameter (A-M) (see Note 7 in Section 7).

Program Control Commands:

- **Pause the Program:** Press the PAUSE/STOP key and the display will alternate between "HOLD" and the current temperature.
 - **Start or Resume the Program:** Press the START key.
 - **Completely Stop the Program:**
 - Press and hold the PAUSE/STOP key for approximately 4 seconds.
 - The display will alternate between "STOP" and the current temperature.
- This stops all outputs and halts program execution.

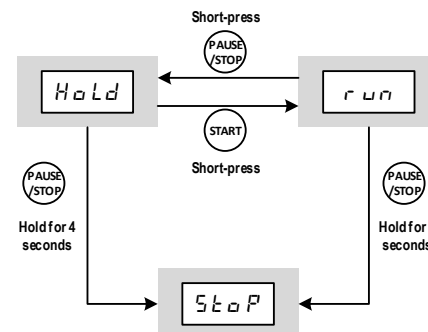


Figure 3. How to start, pause, and stop the program.

5.4. Checking Program Status

To view the current program step and elapsed time, press the STEP key.

Program Step:

- The display briefly shows "P-X", where X represents the step number.
- A number will follow, indicating how long the current step has been running.

Total Runtime:

- Press the STEP key again.
- The display then shows "toL", followed by the total runtime since power-up.

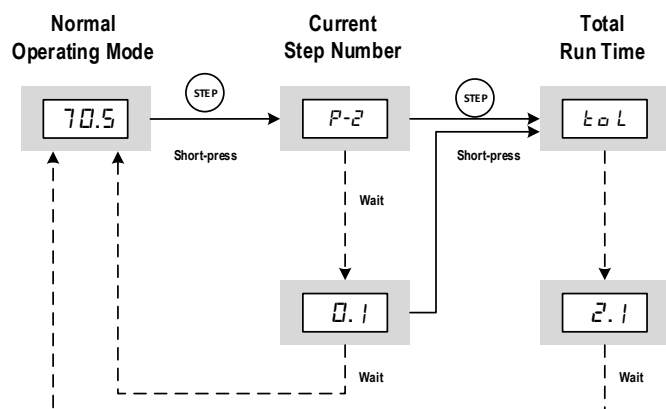


Figure 4. How to check the program status.

5.5. Jumping to Another Step

This function allows users to skip part of the program by jumping directly to a specified step. For example, if the controller has been running for a few minutes in Step 2, and the user wishes to skip the remainder of Step 2 and all of Step 3, they can initiate a jump directly to Step 4. Refer to the diagram below in Figure 5 for a visual representation of the jump operation.

To perform a step jump:

- 1) Put the program in either Hold or Stop mode by pressing the PAUSE/STOP key.
- 2) Press the STEP key. The display flashes "J-PX", indicating a jump action to step "X".
- 3) Use the UP or DOWN arrow keys to select the desired step number.
- 4) Press the START key to confirm. The display will briefly show "JUMP" to indicate the step change has been accepted.
- 5) The controller begins executing the selected step, and the display resumes showing the current temperature.

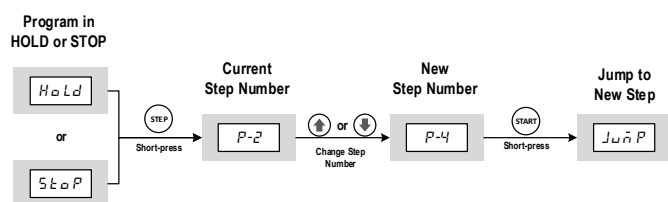


Figure 5. How to jump to another step.

5.6. Muting the Buzzer

When the internal buzzer sounds, press the MUTE key to silence it.

6. Programming the Temperature Control Steps

6.1. Understanding Program Steps

Users can configure up to eight temperature control steps, each defined by a target temperature (C-X) and a step timer (t-X), where X represents the step number (1 to 8).

The factory default program is listed as below in Table 2. In this default program:

- Step 1 sets the temperature to 70.0°F and maintains it for 2 hours.
- Step 2 then lowers the temperature to 60.0°F, maintaining it for 2 hours.
- The program then ends, as Steps 3 through 8 are skipped.

Table 2. Factory Default Program.

Step #	Settings	Description
1	C-1 = 70.0, t-1 = 2.0;	Step 1, maintain the target temperature at 70.0°F for 2 hours.
2	C-2 = 60.0, t-2 = 2.0;	Step 2, maintain the target temperature at 60.0°F for 2 hours.
3	C-3 = 0, t-3 = 0;	Step 3, skipped.
4	C-4 = 0, t-4 = 0;	Step 4, skipped.
5	C-5 = 0, t-5 = 0;	Step 5, skipped.
6	C-6 = 0, t-6 = 0;	Step 6, skipped.
7	C-7 = 0, t-7 = 0;	Step 7, skipped.
8	C-8 = 0, t-8 = 0.	Step 8, skipped.

6.2. Access the Program Step Settings

To program the temperature profile:

1) Enter the Program Menu

- Briefly press the SET key once—the display will show C-1.
- Press the SET key again to view the set temperature for Step 1.

2) Adjust the Temperature

- Use the UP (▲) or DOWN (▼) key to set the desired temperature.
- Press the SET key to save the changes and exit the C-1 setting.

3) Set the Step Timer

- Press the UP key to navigate to t-1 (Step 1 timer setting).
- Press the SET key to view its current value.
- Adjust using the UP or DOWN key, then press SET again to save and exit t-1.

4) Repeat for Subsequent Steps as Needed

- Continue adjusting values for each necessary step.
- To exit program editing mode, scroll to "END" and press SET.
- If no keys are pressed for 10 seconds, the controller automatically return to normal operation.

Important: Changes are only saved after pressing the SET key.

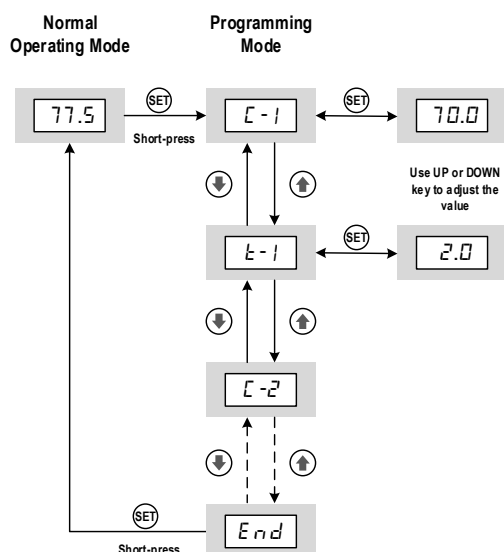


Figure 6. How to access program step settings.

6.3. Programming Special Actions

The TD420A allows users to configure Special Actions within **t-X** (step timer settings) to control program execution. These actions allow users to:

- **Skip** a step
- **Hold** a step indefinitely
- **Jump** to a specific step
- **Stop** the program without executing remaining steps

By using these Special Actions, users can create:

- A **single-step** program
- A **multiple-step** program
- An **infinite loop**

The table below summarizes each special action and its function. Please also refer to Section 8 for some example programs.

Table 3. Acceptable Values of C-X and t-X.

Parameter	Value Range	Details
C-X (Temperature Value)	-99.9 ~ 999.9 °F/°C	The valid target temperature range is limited by the sensor's working range, which is -58 ~ 221°F (-50 ~ 105°C)
t-X (Timer Value or Special Action)	0.1 ~ 99.9 hours; 1 ~ 999 minutes.	Execute the current step for the duration defined by the t-X .
	0	Skip this step
	HOLD	Hold the program at this step indefinitely.
	J-CX	Jump to Step X without running this step.
	STOP	Stop the program without running this step.

(Note: letter X represents a step number between 1 and 8.)

7. System Parameters

System parameters define key operational settings that regulate temperature control, alarms, and device behavior. They allow customization of time units, temperature units, and reset options to suit various applications. Additionally, they also ensure stability, accuracy, and efficiency while protecting equipment from potential issues like rapid cycling or sensor failures.

To access the System Menu, press and hold the SET key for 2 seconds until "AH" appears on the display—this is the first parameter in the menu. Use the UP or DOWN key to navigate through the menu. To exit, scroll to "End" and press SET or leave the keys untouched for 10 seconds, after which the controller will return to the normal operation. Please refer to Figure 6 on accessing parameters in the System Menu. For a full list of system parameters and their descriptions, see Table 4 and their corresponding notes.

Important Note: Parameter values will only update if you press the SET key to confirm the change.

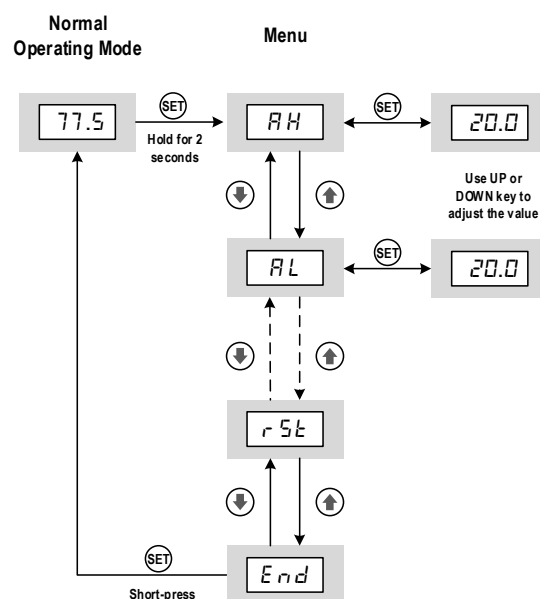


Figure 7. How to access system parameters.

Table 4. System Parameters.

Code	Description	Setting Range	Initial	Note
AH	Deviation Alarm, High	0.5 ~ 999.9	20.0	1
AL	Deviation Alarm, Low	0.5 ~ 999.9	20.0	1
Hy	Temp. Control Hysteresis Band	0.5 ~ 99.9	1.0	2
CdF	Cooling Differential	0.5 ~ 99.9	5.0	3
HdF	Heating Differential	0.5 ~ 99.9	5.0	4
oFS	Temp. Offset	-99.9 ~ 99.9	0	5
AS	Anti-short Cycle Delay (only for cooling socket)	M 0 ~ M 99 (0 ~ 99 min)	M 0	6
A-M	Power Outage/Startup Modes	S, M, C	S	7
SFA	Sensor Failure Operation	0-0, 0-1, 1-0	0-0	8
Time	Time unit	H, M	H	9

C-F	°F	Temperature unit	°F, °C	°F	10
VER	1.2.3	Show the firmware version.			11
RST	Y	Reset all parameters to factory default.	N, Y	N	12

Details About Each Parameter

Note 1. Deviation Alarm High (AH) & Deviation Alarm Low (AL):

The controller activates an alarm when the measured temperature (PV) deviates too far from the Set Temperature (C). If PV exceeds C by more than AH, the high alarm triggers; if PV falls below C by more than AL, the low alarm triggers. The built-in buzzer sounds, which can be muted by pressing the MUTE key. The alarm remains inactive until the process value returns to the normal range. These alarms are suppressed during startup or program transitions and reactivate once the process temperature returns to within the acceptable range (between C - AL and C + AH).

Note 2. Hysteresis Band (Hy):

This setting defines a neutral zone (between C - Hy and C + Hy) where neither heating nor cooling devices operate. The minimum value for Hy is 0.5. If set too low, the system may oscillate, wasting energy, and reduce efficiency.

Note 3. Cooling Differential (CdF):

Determines when the cooling device turns on and off relative to the temperature set point (C + Hy). The cooling device activates when the temperature exceeds (C + Hy + CdF) and deactivates when it falls below (C + Hy). For compressor-based systems, CdF should be set high enough to prevent frequent cycling.

Note 4. Heating Differential (HdF):

Defines activation points for the heating device relative to the temperature set point (C - Hy). The heating device turns on when the temperature drops below (C - Hy - HdF) and turns off when it exceeds (C - Hy).

For example, with C = 50, Hy = 5, CdF = 3, and HdF = 2:

- The heating device activates below 43°F (C - Hy - HdF) and deactivates above 45°F (C - Hy).
- The cooling device activates above 58°F (C + Hy + CdF) and deactivates below 55°F (C + Hy).

Note 5. Temperature Offset (oFS):

Compensates for sensor inaccuracies. If the unit displays 33 when the actual temperature is 32, setting oFS to "-1" adjusts the displayed value to match the actual temperature. The displayed process temperature = actual measured temperature + oFS.

Note 6. Anti-Short Cycle Delay (AS):

This parameter sets the minimum off-time before the cooling device turns back on, preventing rapid cycling that could damage compressor-based systems. When the compressor shuts off, it must remain off for the specified delay period to allow refrigerant pressure to stabilize. During this time, any controller demand to restart the compressor is overridden until the delay expires. The typical setting is 4 ~ 6 minutes. This setting only applies to cooling device control. By default, AS is set to "M 0" for zero minutes (disabled).

Note 7. Power Outage & Startup Modes (A-M):

This parameter defines how the controller behaves after a power interruption. It also determines how the program starts upon power restoration. A-M can be set to one of three modes:

- Mode C:** Resumes the program from where it was interrupted. For example, if Step 3 is set to 40°F for 5 hours and power is lost at 2.1 hours, the controller will continue at 40°F for the remaining 2.9 hours after power is restored.
- Mode S:** Restarts the program from Step 1 each time the controller powers up. This mode is ideal for applications that require restart from the beginning after each power cycle. This is the default settings of A-M.
- Mode M:** Holds the program at the step where power was lost, maintaining the last set temperature. The lower display alternates between "hold" and the process temperature, requiring operator intervention before proceeding.

Note 8. Sensor Failure Operation (SFA):

SFA determines how the controller reacts if the sensor fails. It can be set to 0-0, 0-1, or 1-0, specifying whether the cooling and heating devices remain on or off.

- 0-0:** Both cooling and heating devices remain off.
- 1-0:** The cooling device remains on, while the heating device stays off.
- 0-1:** The cooling device remains off, while the heating device stays on.

Note 9. Timer Unit Setting (TIME):

Defines the time unit for timer functions, which can be set to hours (H) or minutes (M). The default setting is H.

Note 10. Temperature Unit (C-F):

Determines the display format for temperature readings. Options are Fahrenheit (°F) and Celsius (°C).

Note 11. Firmware Version (VER):

A display-only parameter that shows the version number of the current firmware.

Note 12. Reset (RST):

Select "Y" to restore factory defaults. Select "N" to keep existing settings.

8. Program Examples

Here are a few program examples to show our users how to make a program to be single-step, multiple-step, or an infinite-loop.

8.1. Single-Step Program

To set up a single-step program to run certain amount of time, edit the desired target temperature (C-1) and step timer (t-1) in Step 1. Then in Step 2, ignore the C-2 settings, simply change the t-2 to "STOP". No other steps need to be configured. For example:

- C-1 = 70.0, t-1 = 2.0 (Step 1, maintain temperature at 70.0°F for 2 hours.)
- C-2 = 60.0, t-2 = STOP (Stop the program.)

To hold a temperature indefinitely, simply set the step timer to "HOLD". No other steps need to be configured. For example:

- C-1 = 55.0, t-1 = HOLD (Maintain 55°F continuously.)

8.2. Multiple-Step Program

To set up a multiple-step program, edit each step to set up desired target temperature and step timer. There are a few ways to handle the rest of the steps. You can set the step timer for the next step to "STOP" and ignore the rest settings, or you can change all the step timer in the rest steps to be zero. For example:

- C-1 = 70.0, t-1 = 4.0 (Step 1, maintain temperature at 70.0°F for 4 hours.)
- C-2 = 60.0, t-2 = 48.0 (Step 2, maintain temperature at 60.0°F for 48 hours.)
- C-3 = 55.0, t-3 = 240.0 (Step 3, maintain temperature at 55.0°F for 24 days.)
- C-4 = 55.0, t-4 = 0 (Step 4, skipped.)
- C-5 = 0.0, t-5 = 0 (Step 5, skipped.)
- C-6 = 0.0, t-6 = 0 (Step 6, skipped.)
- C-7 = 0.0, t-7 = 0 (Step 7, skipped.)
- C-8 = 0.0, t-8 = 0 (Step 8, skipped.)

8.3. Infinite Loop Program

To set up an infinite-loop, we need to use a special action to jump from one step to a previous step. Suppose you want to cool a chest freezer from the room temperature to 40°F and then cycle the temperature in the chamber between 30°F and 40°F to simulate a freeze-thaw cycling, set the program steps as follows:

- C-1 = 40.0, t-1 = 2.0. (Step 1, maintain temperature at 40.0°F for 2 hours.)
- C-2 = 30.0, t-2 = 14.0. (Step 2, maintain temperature at 30.0°F for 14 hours.)
- C-3 = 40.0, t-3 = 10.0. (Step 3, maintain temperature at 40.0°F for 10 hours.)
- C-4 = 40.0, t-4 = J-C2. (Step 4, jump to Step 2.)

8.4. Skipping Steps in a Program

If a program has already been entered and you wish to run a shortened version by omitting certain steps, you can modify the program to skip those specific steps.

For example, if your original program included 8 steps and you now wish to skip **Step 2** and **Step 7**, set **t-2** and **t-7** to "0" to skip those steps. No changes are needed for the temperature values in skipped steps. This will cause the controller to bypass those steps during program execution.

9. Alarm Buzzer

The controller includes a built-in buzzer that activates under the following conditions:

- **Temperature Alarm** – Beeps continuously until the MUTE key is pressed.
- **Step Completion** – Beeps twice at the end of each step (except Step 8).
- **Program Completion** – Beeps six times to indicate the end of the program.

When the alarm buzzer is active, pressing the MUTE key will silence the buzzer.

10. Connecting the Sensor to the Controller

The sensor connectors are keyed to ensure proper alignment: the male connector features a guide key, while the female connector has a corresponding notch. The female connector also includes a spring-lock mechanism to help prevent accidental disconnection.

To connect the sensor:

- Identify the key on the male connector (see Figure 8(a)) and the notch on the female connector (see Figure 8(b)).
- Grip the back of the female connector, align the notch with the key, and push the female connector forward until it is fully seated (see Figure 9(a)).

To remove the sensor:

- Hold the spring-loaded collar on the female connector and pull it back to release the connection (see Figure 9(b)).

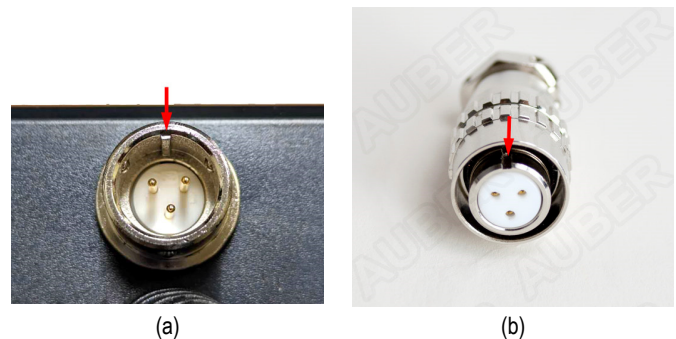


Figure 8. (a) Key on the male connector (controller side). (b) Notch on the female connector (sensor cable side).

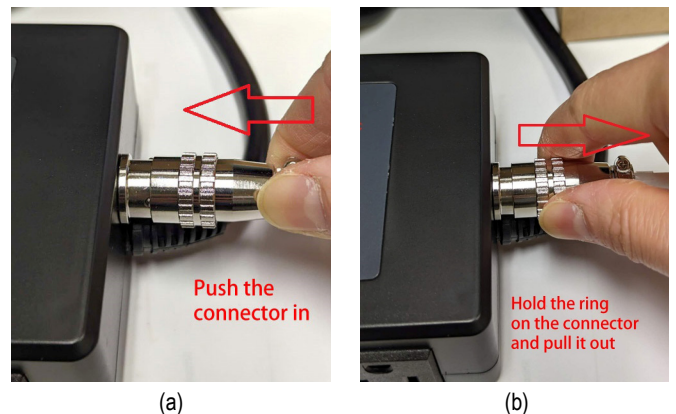


Figure 9. (a) To connect the sensor, push the connector forward from behind the locking ring. (b) To disconnect, pull back the locking ring while gently withdrawing the connector.

(END)

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