

TC-408 PID TEMPERATURE CONTROLLER INSTRUCTION MANUAL



WARNING

·Wiring precautions

-Install an external protection circuit if failure of this instrument could result in damage to your system.

·Power supply

- Supply power of the specified rating.
- Do not turn on the power until all of the wiring is completed.
- Never use this instrument in the presence of inflammable gases or vapor.
- In order to prevent electric shock or burns, never touch the inside of the instrument.
- Do not attempt to modify this instrument.

·Maintenance

- Only authorized service engineers should replace parts.
- In order to use this instrument continuously and safely, conduct periodic maintenance. Some parts used in this instrument have a limited service life and may deteriorate over time.

1. Features

- ◆ Dual display for both setting temperature and process temperature
- ◆ Compact size, 1/16 DIN that is only 48 x 48 x 75 mm (~ 1.89 x 1.89 x 3")
- ◆ Supports 10 different types of commonly used temperature sensors, including Pt100 and Cu50 RTDs, T、R、J、B、S、K、E、 and WRe3-WRe25 thermocouples.
- ◆ The PID control output can be configured by user for either relay contact or SSR.
- ◆ Two contact relays can be configured as one PID and one alarm output, dual alarm outputs, or dual on/off control.
- ◆ Auto-tune function can automatically find the best PID parameters.
- ◆ Temperature can be displayed in Fahrenheit and Celsius.
- ◆ Can be used with either DC or AC power source.

2. Specification

- ◆ Power supply: 85~260VAC or 85~360VDC
- ◆ Power consumption: <2W
- ◆ Sampling rate: 4 sample/sec
- ◆ Accuracy: 0.2% full scale
- ◆ Display range: -1999~9999
- ◆ Display resolution: 1 °C , 1°F, or 0.1 °C , 0.1°F with Pt100 RTD sensor input.
- ◆ SSR driving output: 8 VDC, 40 mA
- ◆ LED display: 0.28" red color
- ◆ Out of range display: "EEEE"
- ◆ Working condition: 0~50°C , ≤85%RH
- ◆ Relay contact rating: 220VAC @ 3A
- ◆ Outside dimensions: 48×48×75mm
- ◆ Mounting cutout dimension: 45×45mm

3. Front Panel and Operation

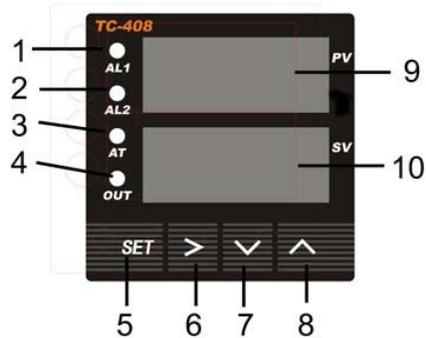


Figure 1

- ① AL-1 Relay J1 indicator
- ② AL-2 Relay J2 indicator
- ③ AT- blinking during auto-tuning process
- ④ OUT- Output indicator
- ⑤ Set/Confirm
- ⑥ Digit shift/Auto tuning
- ⑦ Select next parameter/value increment.
- ⑧ Select previous parameter/value decrement
- ⑨ Measured temperature, Process Value (PV)
- ⑩ Set temperature, Set Value (SV)

4. Parameter Setting

a) Configuration Parameters

Table 1, Configuration Parameter Setting

Code	Description	Setting Range	Initial Setting	Note	
Inty	Inty	Input Type	See table 2	K	
outy	outy	Controlled output device	0, 1, 2	2	1
Atdu	Atdu	Auto-tune offset	0~200(deg)	0	2
PSb	PSb	Input offset	-100~100(deg)	0	
rd	rd	Control function	0: heating 1: Cooling	0	
CorF	CorF	Display Unit	0: °C 1: °F	1	
End	End	Exit			

Note 1. 0: Relay J1, J2 as alarm output; SSR output disabled. Can be used as On/Off control.

1: Relay J1 as alarm output. J2 as PID controlled relay contact output. SSR output disabled.

2: Relay J, J2 as alarm output; SSR PID controlled with 12 V output.

Note 2. The auto-tune offset will shift the SV value down by the Atdu value during the auto tune process. That will preventing the system from damaging from over temperature during the auto-tune.

Press **SET**, The enter code “0089” press **SET** again. Then, following the flow chart in Fig. 3

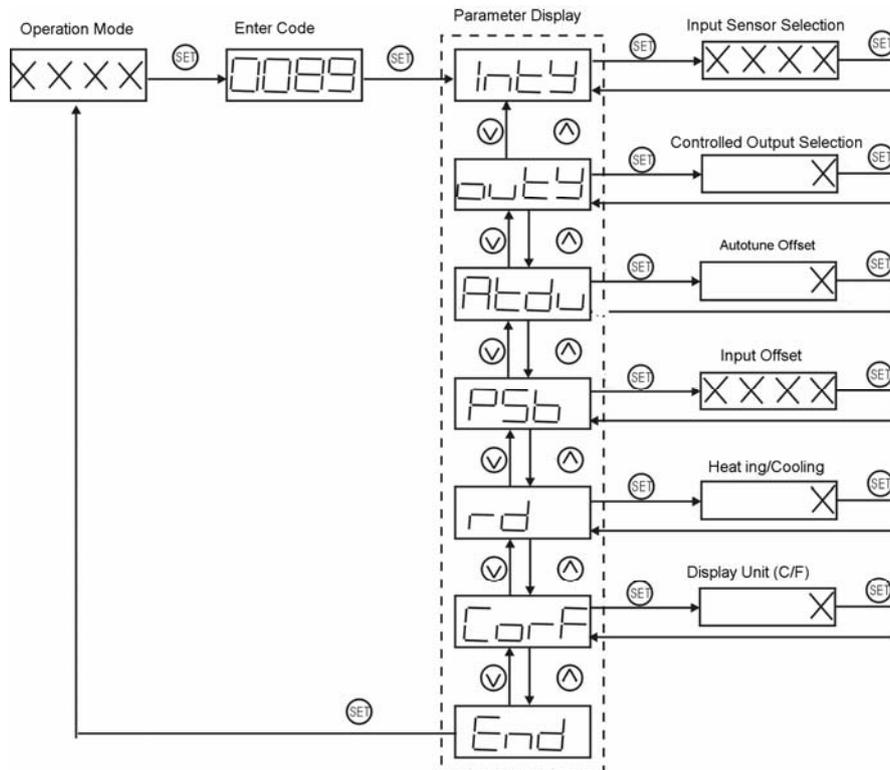


Figure 2 Setup flow chart

- 1) Press **SET** to enter setting mode;
- 2) Press **⊙**, **⊕** and **⊖** to enter parameters;
- 3) Press **SET** to confirm;
- 4) Press **⊕** or **⊖** to select the new parameter

Table 2, Temperature sensor code.

Symbol	Description	Working Temperature Range
t	T Thermocouple	-200~400 °C; -320~752 °F
r	R Thermocouple	-50~1600 °C; -58~2900 °F
j	J Thermocouple	-200~1200 °C; -320~2200 °F
WRE	WRe3- WRe25 Thermocouple	0~2300 °C; 32~4200 °F
b	B Thermocouple	350~1800 °C; 660~3300 °F
S	S Thermocouple	-50~1600 °C; -58~2900 °F
K	K Thermocouple	-200~1300 °C; -320~2400 °F
E	E Thermocouple	-200~900 °C; -320~1650 °F
P100	Pt100 RTD	-99.9~600.0 °C; -99.9~999.9 °F
P100	Pt100 RTD	-200~600 °C; -320~1100 °F
Cu50	Cu50 RTD	-50.0~150.0 °C; -60~300 °F

b) PID Parameters

To enter PID parameter setting mode, press SET , then enter code “0036”, press SET again. The parameter flow chart is similar to Fig. 3

Table 3, PID and relevant parameters

Symbol	Description	Setting range	Initial Setting	note	
P	P	Proportional Constant	0.1~99.9 (%)	5.0	4
I	I	Integral time	2~1999(Sec)	100	5
d	d	Derivative time	0~399(Sec)	20	6
SouF	SouF	Damp constant	0.1~1.0	0.2	7
ot	ot	Cycle rate	2~199(sec)	2	8
FILT	FILT	Digital filter strength	0~3	0	9
End	End	Exit			

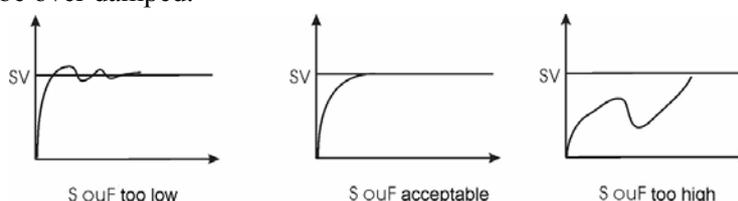
The values of the P, I, and D parameters are critical for good response time, accuracy and stability of the system. Using the Auto-Tune function to automatically determine these parameters is recommended for the first time user. If the auto tuning result is not satisfactory, you can manually fine-tune the PID constants for improved performance.

Note 4. Proportional Constant (P): Represents the gain of the signal amplifier. Larger gain means the controller will have more output power change for the same difference between set temperature (SV) and measured temperature (PV). Smaller P value represents higher gain, or faster action.

Note 5. Integration time (I): Brings the system up to the set value by adding a constant to the output that is proportional to how far the process value (PV) is from the set value (SV) and how long it has been there. When I decreases, response speed is faster but the system is less stable. When I increases, respond speed is slower, but system is more stable.

Note 6. Differentiation time (d): Responds to the rate of change of the process value so that the controller can compensate in advance before $|SV-PV|$ gets too big. A larger number increases its action. Setting d-value too small or too large would decrease system stability, causing oscillation or even non-convergence.

Note 7. Damp constant: This constant can help the PID control further improve the control quality. It helps to damp the temperature overshoot. When its value is too low, the system might overshoot. When it is too high, the system will be over damped.



Note 8. Control Period (also called cycle rate) (ot): When ot gets smaller, heating/cooling cycle is drive faster, system respond speed is faster. For SSR output, ot is normally set at 2. But when using contact control (Relays), contacts wear out faster so it is normally at 5~30 seconds.

Note 9. Digital Filtering (Filt): Filt=0, filter disabled; Filt=1, weak filtering effect; Filt=3, strongest filtering effect. Stronger filtering increases the stability of the readout display, but causes more delay in the response to changes in temperature.

c) Temperature setting and Alarm setting

To enter the temperature and alarm parameter setting mode, press **SET**, enter the code “0001”, and press **SET** again. The parameter flow chart is shown in Fig. 3

Table 4. Temperature and Alarm Parameter

Symbol		Description	Initial setting	Note
SV	SV	Target temperature (Set Value)	800	11
AH1	AH1	J1 on temperature	800	12
AL1	AL1	J1 off temperature	900	
AH2	AH2	J2 on temperature	800	
AL2	AL2	J2 off temperature	900	
End	End	Exit		

Note 11. The SV can also be set directly during the normal operation mode. Press (^) or (v) key again to increase or decrease SV by 1 degree.

Note 12. Relay value

- ① When AH1=AL1, (AH2=AL2) relay is disabled,
- ② AH1 > AL1 (AH2 > AL2) is for absolute high alarm. See fig. 4.
- ③ AH1 < AL1 (AH2 < AL2) is for absolute low alarm. See fig. 5.

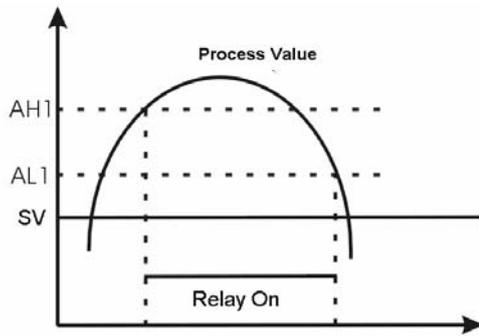


Figure 4

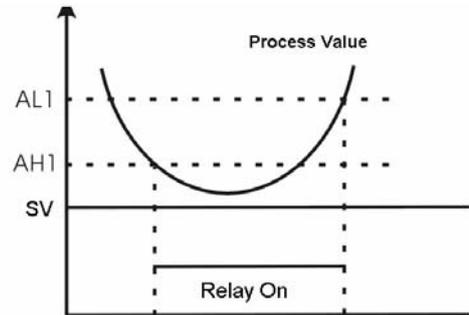


Figure 5

5. Auto-Tuning

Auto-Tuning function (also called self tuning) can automatically optimize the PID parameters for the system. The auto-tuning function will heat up the system then let it cool down. It will repeat several times. Based on the response time of the system, the built-in artificial intelligence program will calculate and set the PID parameters for the controller.

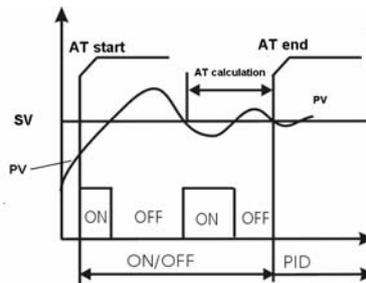


Figure 6

A) To activate auto-tuning, press and hold **⊙** key until the “AT” indicator starts to blink, which indicates

auto-tuning is in progress. When “AT” stops blinking, the auto-tuning is finished. Now, newly calculated PID parameters are set and are used for the system. Please note that Auto-tuning is only for PID control mode (when “outy” is set at 1 or 2)

B) To stop the auto-tuning, press and hold \odot key until “AT” indicator stops blinking. Then, the previous PID parameters value are resumed.

6. Terminal Wiring (back view)

The polarity of power at terminal 1 and 2 do not matter.

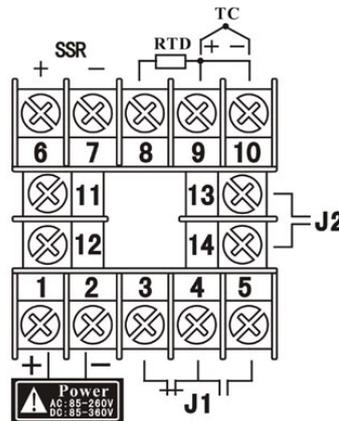


Figure 7. Wiring diagram.

Please note a) if the RTD is connected by two wires instead of three wires (for short distance application), the terminal 6 and 7 need to be shorted. b) relay contact output (J1, J2) are electromechanical relays that does not provide power by itself. External power is needed to drive the load. See wiring example on Fig 8 for more information.

7. Application Example

A furnace that can operate in the $0^{\circ}\text{C} \sim 1000^{\circ}\text{C}$ range needs to be controlled at 800°C . Alarm 1 will go off if $T > 850^{\circ}\text{C}$, Alarm 2 will go off if $T < 750^{\circ}\text{C}$. Power source is 220VAC, Heating element is switched by a SSR. K type thermocouple is used as the temperature sensor.

a) Wiring diagram

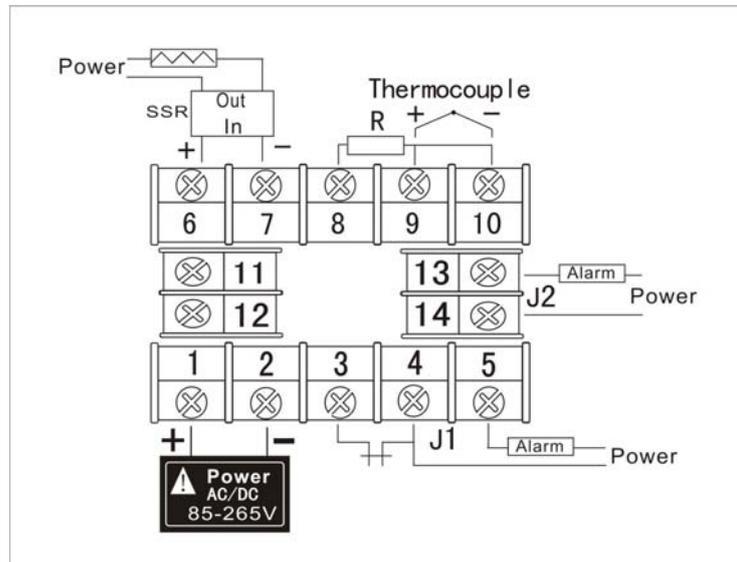


Figure 8, Application example

b) Parameter setting,

(Inty) =K, (outy) =2, (Caty) =0, (PSb) =0, (rd) =0, (CorF) =0, (FILt) =0

Auto-tune is used to set the PID parameters.

(SV) =800°C, (AH1) =850°C, (AL1) =848°C, (AH2) =750°C, (AL2) =752°C

Power up the controller. Press and hold the  key until "AT" starts to blink. The controller starts the Auto-tuning. When the "AT" stops blinking, the new PID parameters are generated for the system. The controller is in normal operation mode. The furnace will be maintained at 800°C .

