ARTIFICIAL INTELLIGENCE TEMPERATURE CONTROLLER

AI–208 (V9.3) User Manual

1.Main features

- Specially designed for plastic machinery, food machinery, packaging machinery, ovens, environmental experimental equipment and other industries; with the characteristics of simple operation, easy learning and use, and low price;
- as well as universal power supply 100-240VAC, 50Hz/60Hz power frequency and ℃ /F unit selection function.
- Inputs can be freely selected from thermocouples or RTDs, and outputs have an advanced modular structure with a wide range of specifications for quick delivery and easy maintenance.
- AI artificial intelligence regulation algorithm with automatic tuning (AT) function is adopted to control accurately without overshoot.
- Its advanced fast self-tuning (AAT) function can be started when the heating furnace is powered on for the first time. PID parameter auto-tuning can be completed quickly without oscillation control of traditional AT, which can greatly save debugging time for most control systems.
- The hardware design of "fever" class enables it to have lower power consumption, higher reliability, stability and wider temperature range than the products of the same class; and its power supply and I/O terminals have passed the group pulse anti-interference test of 6KV5KHz.
- It has passed ISO9001 quality certification, ISO14001 environmental management system certification and CE certification, and conforms to international standards in terms of quality, anti-interference ability and safety standards.

2.Model Code Symbol

The type of AI-208 is made up of 4 parts:

AI-208	A1	G1	L0
Part 1 (Series)	Part 2 (Size)	Part 3 (Oupt)	Part 4 (AUX)

① Model number

AI-208, standard artificial intelligence temperature controller 0.3%FS±1℃ accuracy. 1℃ display resolution

② Front panel dimension

Size	Front Panel width×height	Cut Out width×height	Depth Behind Mounting Surface
A1	96x96mm	92x92mm	70mm
D	72x72mm	68x68mm	70mm
D21	48x48mm	45x45mm	80mm
D62	48x48mm	45x45mm	67mm
E1	48x96mm	45x92mm	70mm
F1	96x48mm	92x45mm	70mm

③ Module installed in main output (OP1) socket

L1 Relay contact output 2A/250VAC, low consumption coil, long life span, energy saving, environmental friendly. Sparks suppression by varistor at normal open.

G1 Standard SSR voltage output, 5VDC/30mA, energy-saving and environmental friendly, without photoelectric isolation.

G 12VDC/30mA SSR voltage output, photoelectric isolated.

K50/K60 Single 220VAC/380VAC 'burn-in' single Thyristor phase-shift trigger output module

X3 Opto-isolated Programmable Linear Current Output Modules

④ Auxiliary alarm output

N (or leaving blank) no module installed

L0 Common economical relay contact output at large size, with 2A/250VAC normal open / normal close and AU1 alarm output

L3 Dual relay Output at 2A/250VAC, normal open, energy saving, environmental friendly, supporting AU1 and AU2 alarm output

3.Technical Specification

- **Input type:** K, S, R, T, E, J, N, Pt100
- **Measurement range:** K(0~1300℃), S(0~1700℃), R(0~1600℃), T(-200~+350℃), E(0~1000℃), J(0~1200℃), N(0~1300℃), Pt100(-200~+800℃)
- **Measurement accuracy:** 0.3%FS±1℃ or 0.3%FS±1℃
- **Control mode:** On-off control mode , or PID control by artificial intelligent (AI) regulating with auto-tuning
- **Output specification:**
  L1 Relay contact output 250VAC/2A or 30VDC/2A at normal open
  G1 SSR voltage output 5VDC/30mA
  G SSR voltage output 12VDC/20mA
  Thyristor Trigger Output : Trigger 5~500A bi-directional Thyristor, 2 uni-directional Thyristors in anti-parallel or Thyristor Power Module.
  Linear current output: 0~20mA or 4~20mA definable.
- **Alarm:**
  High limit alarm, low limit alarm and high/low deviation alarms, optional relay module can be installed to output alarm signal
- **Power supply:** 100~240VAC, -15%, +10%/50~60Hz
- **Power consumption:** ≤0.3W(the energy consumption required for output should be increased accordingly when there is no output or alarm, if there is output action.)
- **Ambient temperature:** -10~+60℃ ; Humidity: 0~90RH%

4.Operation Description

4.1Changing Set Value

After the instrument is powered on, the upper display window displays the measurement value (PV) while the lower display window displays the set value (SV). This is the basic display status of the instrument. When the input measurement signal exceeds the range (such as when the thermocouple is disconnected), the upper display window alternately displays "orAL" and the upper or lower limit measurement value. At this time, the instrument will automatically stop controlling the output, and the flashing function will be affected by the AdIS parameters.

There are 5 indicator lights on the instrument panel according to different sizes, among which OP1 is used to indicate the controlling output, AU1 and AU2 correspond to the alarm output action respectively, PRG indicates the operating status of the program, and the other indicator lights are not used in this series of instruments.。

4.2 Program Setting

When the upper display window displays the measurement value, press◁ to set the program state. First, SP1 is displayed as the set value, and the set temperature value of the lower display window can be modified by pressing ◁ ▽ and△. Press↻ again to display t1 as the running time and be modified by pressing◁ ▽ and△.

4.3 Operating control

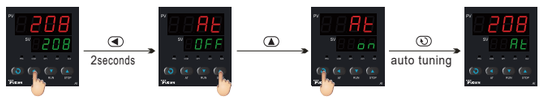
When the upper display window displays the measurements, press▽ and hold for 2 seconds to make the lower display window display "run" to make the instrument enter the running state. Press △and hold for 2 seconds to to make the instrument flash "stop" and enter the stop state.

4.4 Preparation

The program will start timing after it is started. If it is not expected to start in the heating stage, the preparation function will be employed, and once this function is started, when the deviation of the measured value is greater than the deviation alarm value (HdAL and LdAL), the instrument will not conduct the deviation alarm immediately. The and the timing will be suspended at this time until the positive and negative deviations meet the requirements.

4.5 Auto-tuning

When artificial intelligence(AI) control method is chosen (CtrL=AI), the PID parameters can be obtained by running auto-tuning. In basal display status, press◁ for 2 seconds, the "At" parameter will appear. Press△ to change the value of "At" from "oFF" to "on", then press↻ to active the auto-tuning process. During auto tuning, the instrument executes on-off control. After 2-3 times of on-off action, the instrument will obtain the optimal control parameter value. If you want to quit auto-tuning, press and hold◁ for about 2 seconds until the "At" parameter appear again. Change "At" from "on" to "oFF", press↻ to confirm, then the auto tuning process will be canceled. Set "At" to "AAt" for rapid auto-tuning (AAt).



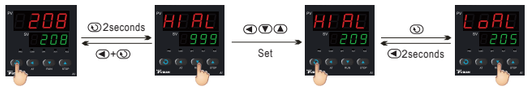
Remark 1: The calculated PID parameters from auto-tuning will be different depending to different set values (SV). SV is recommended to assigned to a commonly used or mean values. If the whole system is a good insulating furnace, the SV should be assigned to the maximum values during application. SV is forbidden to change during auto-tuning. Auto-tuning takes time from seconds to hours depending on the whole system.

Remark 2: Control Hysteresis (CHY) may affect the process of auto-tuning. The smaller CHY value is assigned, the higher accuracy of PID parameters will be obtained. However, if the CHYS value is too small, it may lead to improper on-off action due to input fluctuation, which in turn may set the completely wrong parameter, it is recommended that CHYS=2.0.

Remark 3: Rapid auto-tuning (AAT) should be started before the heater starts to rise. If the heater has risen to a certain temperature, the AAT effect will be worse. Rapid auto-tuning (AAT) does not require traditional periodic oscillation and system analysis of heater temperature rise curve to determine PID parameters. If the above can be realized successfully, it can greatly save regulating time compared to traditional AT. If the AAT exits the full power output state before the instrument is automatically completed, the AAT fails and the auto-tuning is terminated, and the PID parameter will not be modified. At this time, the traditional auto-tuning AT can be started to regulate the parameters. If the control effect of AAT is not desirable, the traditional auto-tuning AT can be performed again.

5.Parameter Setting

In basic display status, press↻ and hold for about 2 seconds to access Field Parameter Table. Press↻ to go to the next parameter; press◁ ▽ △to edit a parameter. Press◁ and hold to return to the preceding parameter. Press(without releasing) and press ◁ and hold to return to the preceding parameter. Press(without releasing) and press ↻ simultaneously to exit from the parameter setting. The instrument will exit automatically from the parameter table if no key is pressed within 30 seconds. Setting Loc=808 and then press ↻ to access System Parameter Table.



6.Parameter Table

Code	Name	Description	Setting Range
HIAL	High limit alarm	Alarm on when PV (Process Value) >HIAL; alarm off when PV<HIAL-AHYS Note: Each alarm can be freely defined to control AU1, AU2 and other output terminals, or do nothing. Please refer to the description of alarm output definition parameter AOP later.	-999~+3200 or -9990~+32000 Unit
LoAL	Lower limit alarm	Alarm on when PV (Process Value) <LoAL; alarm off when PV>LoAL+AHYS Note: In order to avoid that the lower limit alarm is always triggered due to low temperature when the power is just turned on, the lower limit alarm function is always temporarily removed when the power is turned on. The alarm will be generated only when the temperature rises above LoAL and then falls below LoAL.	
HdAL	Deviation high alarm	Alarm on when PV-SV > HdAL; alarm off when PV-SV < HdAL-AHYS. When the maximum value is set for HdAL, the alarm is canceled.	
LdAL	Deviation low alarm	Alarm on when PV-SV < LdA; alarm off when PV-SV > HdA-AHY. When the minimum value is set for LdAL, the alarm is canceled.	
Loc	Parameter Lock	Loc=0, allowed to modify the field parameters and to directly modify the set value in the basic display state; Loc=1, prohibited to modify the field parameters, but allowed to directly modify the set value in the basic display state; Loc=2~3, allowed to modify the field parameters, but prohibited to directly modify the set value in the basic display state; Loc=4~255, neither allowed to modify any parameter other than Loc, nor to perform all shortcut operations. Loc=808, press↻ again to enter the system parameter table.	0~9999
AHYS	Hysteresis	Also known as dead zone and hysteresis, used to avoid frequent alarm on-off action because of the fluctuation of PV	0~999.9℃ or 0~+9999 Unit
AdIS	Alarm display	OFF, No alarm message shown in the lower display even there is an alarm On, Alternately showing alarm message and value in the lower display when there is an alarm FOFF, spare Aon, spare	
AOP	Alarm Output Assignment	AOP is to define the output position of HIAL, LOAL, HdAL and LdAL as following: AOP = C (HdAL + LdAL) B (LoAL) A (HIAL) The range of A and B is 0~2. Setting it as 0 or other number means that particular alarm will not mapped to any output port. 1 and 2 means the alarms come out from AU1 and AU2. C value has below definitions:	0~999

C	HdAL	LdAL
0	N/A	N/A
1	AU1	N/A
2	AU2	N/A
5	AU1	AU1
6	AU2	AU1
7	N/A	AU1
8	N/A	AU2
9	AU1	AU2

E.g. AOP=901 means both alarm HIA and HdAL are assigned to AU1 while alarm HdAL is assigned to AU2.

CtrL	Control mode	OnoF, adopts on-off regulation (ON-OFF), only suitable for control in low requirements. APId, adopts PID regulation of artificial intelligence AI, with high precision control effect but without overshoot. nPId, adopts standard PID regulation and with anti-saturation integration function.	
Srun	Running state	Run, always running StoP, stop status, with lower display flashes "StoP" HoLd, control status, no running or stopping operations from the panel.	
Act	Acting method	rE, reverse acting.Increase in measured variable causes a decrease in the output,such as heating control. Dr, direct acting.Increase in measured variable causes an increase in the output,such as refrigerating control. rEbA, reverse acting with low limit alarm and deviation low alarm exemption at the beginning of power on. drbA, direct acting with high limit alarm and deviation high alarm exemption at the beginning of power on.	
At	Auto tuning	OFF, auto tuning disabled. on, auto turning function to calculate PID and Ctl values, this parameter setting will switch to FOFF when the auto-tuning is completed. FOFF, auto-tuning is disabled. Activating auto-tuning by shortcut key from front panel is also prohibited. AAt, rapid auto-tuning. This parameter setting will switch to OFF when the auto-tuning is completed.	

P	Proportional band	Proportional band in APID and PID with unit ℃ or F. This is not the percentage of input measurement range. Remark: P, I, D and Ctl parameter values are often obtained by auto-tuning. Direct input of these values are also possible if the instruments are used in manufacturing a batch of electronic heating devices.	0.1~3200
I	Time of Integral	Time of integral in PID.No integral effect when I=0	0~9999s
d	Time of Derivative	Time of derivative in PID.No derivative effect when d=0	0~3200s
Ctl	Control period	Small value can improve control accuracy. For SSR output, this value is set 0.5~3.0 seconds. For relay output, generally 15 to 40 seconds, Short Ctl shortens the life span of mechanical relay or causes frequent switches of cooling/heating output. Ctl is recommended to be 1/4 - 1/10 of derivative time. When on-off control method is used, Ctl acts as restart delay time after the regulated output is being off, for protecting compressor application.	0.1~300s
CHYS	Control Hysteresis	CHY is used When it is in heating regulating, the relay opens when PV>SV. It closes when PV < (SV-CHY).	0~999.9℃ or 0~+9999 Unit
InP	Input Specification	<table><tr><th>InP</th><th>Specification</th><th>InP</th><th>Specification</th></tr><tr><td>0</td><td>K</td><td>1</td><td>S</td></tr><tr><td>2</td><td>R</td><td>3</td><td>T</td></tr><tr><td>4</td><td>E</td><td>5</td><td>J</td></tr><tr><td>6</td><td>Spare</td><td>7</td><td>N</td></tr><tr><td>8-20</td><td>Spare</td><td>21</td><td>Pt100</td></tr></table>	
dPt	Resolution	"0" for 1 ℃ or °F display resolution. "0.0" for 0.1℃ or F display resolution.	0/0.0
Scb	Input Shift	Scb compensates the error produced by sensor or input signal or the error from auto-compensation of cold terminals of thermocouple. PV(after compensation) = PV(before compensation) + Scb. Remark: Scb should be 0, measurement error will be generated for incorrect settings.	-999~+400 or -9990~+4000 unit
FILt	PV input filter	The value of FILt will determine the ability of filtering noise. When a large value is set, the measurement input is stabilized but the response speed is slow. If great interference exists, then FILt can be increased gradually to smoothen momentary fluctuation of measured value within 2~5 digit. When the instrument is being metro-logical verified, FILt should be set to 0 or 1 to shorten the response time.	
Fru	Selection of power Frequency and Temperature scale	50Cmeans 50Hz,display unit is ℃。 50F,means 50Hz,display unit is ℉。 60Cmeans 60Hz,display unit is ℃。 60Fmeans 60Hz, display unit is ℉。	

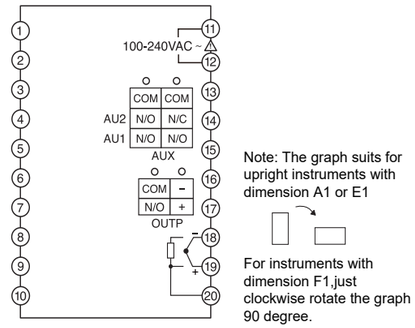
OPT	Main output type	SSr: Output SSr drive voltage or thyristor zero crossing trigger signal. G, K1 module should be installed. The output power can be adjusted by the on-off time proportion. The period (Ctl) is generally 0.5~4 seconds. rELy: for relay contact output or for execution system with mechanical contact switch. To protect the mechanical switch, the output period (Ctl) is limited to 3~120 seconds, and generally is 1/5 to 1/10 of derivative time. 0-20: 0~20mA linear current output. X3 module should be installed in OUTP slot. 4-20: 4~20mA linear current output. X3 module should be installed in OUTP slot. (Not applicable for heating/refrigerating bidirectional control.) PHA: Single-phase phase-shift output. K50/K60 module should be installed in OUTP slot.	
OPH	Output upper limit	Limits the maximum output value of the main output OUTP.	0~110%
AF	Advanced function code	AF, which is used to select the advanced functions, with calculation method as follows: AF=A*1 + B*2 + E*16 A=0, HdAL and LdAL are deviation alarms; A=1, HdAL and LdAL are absolute value alarms, so that the instrument can have two absolute limit alarms and absolute limit alarms respectively. B=0, the return difference between alarm and on-off regulation is unilateral; B=1, bilateral difference. E=0, HIAL and LOAL are upper limit alarm and lower limit alarm of absolute value respectively; E=1, HIAL and LOAL are changed to upper limit alarm and lower limit alarm of deviation respectively, so that 4 deviation alarms are generated. Remark: for non-expert users, please set this parameter to 0.	0~255
bAud	Baud rate	The default value for the "bAud" parameter is 9600. The COM can be used for other functions by setting the "bAud" parameter as follows: When bAud=3, the COMM/AUX port is used as an AUX, which can be utilized for D2 size gauge.	
SPL	Low limit of SV	Minimum value that SV is allowed to be.	-999~+3200
SPH	Upper limit of SV	Maximum value that SV allowed to be.	-999~+3200 or -9990~+32000 unit
Pno	Timing mode	Pno=0, constant temperature mode; Pno=1, set the temperature control time length, and automatically enter the stop state after reaching the top time.	0~1
PonP	Automatic operation after power on	Cont, remain stop state if it is stopped before the power failure; otherwise, continue to execute at the original termination after power on. StoP, no matter what happens after power on, the instrument will enter stop state. run1, remain stop state if it is stopped before the power failure; otherwise, run automatically from the beginning after power on. dASt, continue to run when no deviation alarm occurs after power on, and stop when the deviation alarm occurs. HoLd, enter stop state no matter what happens after power on if the instrument is powered off during operation; yet still remain stop state if it is stopped before the power failure.	

PAF	Running mode	PAF, which is used to select the program control function, with calculation as follows: PAF=A*1 + C*4 + F*32 A=0, preparation function (rdy) invalid; A=1, preparation function valid. C=0, time unit in minutes; C=1, in hours. F=0, standard running mode; F=1, RUN enters pause (Hold) state.	

7.Installation and Wiring

Note: Please follow the wiring diagram of the instrument on site when there is any discrepancy between the wiring diagram and this manual due to any technical upgrade or special order.
Wiring graph for instruments with dimension A1, E1 and F1.

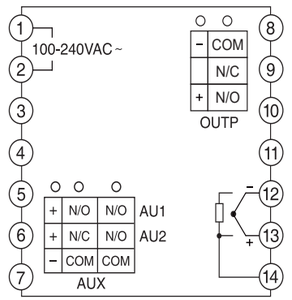
Wiring graph for instruments with dimension A1, E1 and F1:



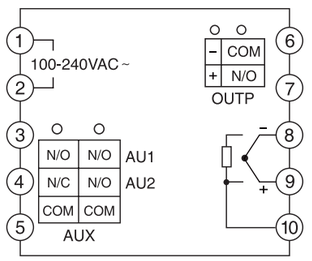
Note: The graph suits for upright instruments with dimension A1 or E1

For instruments with dimension F1,just clockwise rotate the graph 90 degree.

Wiring graph for dimension D (72X72mm)instruments:



\Wiring graph for dimension D21 (48X48mm)instruments:



Note 1: Thermocouple should be directly connected to the back of the instrument wiring screws by compensation wires. No conventional conducting wires should be used in the input circuit. Pay attention to the correct type of compensation wires and polarity.
Note 2: The external solid-state relay (SSR) connected should have isolated voltage between input and output larger than 2300V (safety requirement of CE certification).

Wiring graph for dimension D62 (48X48mm)instruments: