AI-218 ARTIFICIAL INTELLIGENCE TEMPERATURE CONTROLLER

User Manual (V9.18)

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 24VDC power supply with rang 100~240VAC, 50Hz/60Hz power frequency and ℃ /F unit selection function.
- The thermocouple or thermal resistance can be freely selected for input, while the voltage of solid state relay and relay output can be available for the output, what’ s more, it is with rapid delivery and convenient maintenance.
- AI artificial intelligence regulation algorithm with automatic tuning (AT) function is adopted to control accurately without overshoot.
- 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 4KV/5KHz.
- 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. Ordering code definition

The type of AI-218 is made up of 4 parts:

AI— 218	A1	G	L3	L3 - 24VDC
①	②	③	④	⑤ ⑥

① Model number

AI-218 artificial intelligence temperature controller with 0.3%FS±1 ℃ and 1 ℃ display resolution

② Front panel dimension

Size	Front Panel (width×height:mm)	Opening Dimension (width×height:mm)	Depth (mm)
A1	96x96	$92^{+0.5}\times92^{+0.5}$	70
B1	160x80	$152^{+0.5}\times76^{+0.5}$	70
C1	80x160	$76^{+0.5}\times152^{+0.5}$	70
D1	48x48	$45^{+0.5}\times45^{+0.5}$	80
D2	48x48	$45^{+0.5}\times45^{+0.5}$	95
D61	48x48	$46^{+0.5}\times46^{+0.5}$	80
D	72x72	$68^{+0.5}\times68^{+0.5}$	70
E1	48x96	$45^{+0.5}\times92^{+0.5}$	70
F1	96x48	$92^{+0.5}\times45^{+0.5}$	70

③ Module available in main output (OUPT)

L1 Relay contact output 2A/250VAC, large capacity, sparks suppression at normal open.
G1 SSR voltage output, 5VDC/30mA.
X3 Programmable linear current output module with photoelectric isolation

④ Alarm output(ALM)

L0, L2, L4 and other single-loop relay modules or L3 double-loop relay moduleas alarm outputs

⑤ Auxiliary output(AUX)

L0, L2, L3, L4 and other relay modules as alarm outputs

⑥ Power Supply

Null indicates 100~240VAC power supply and 24VDC indicates 20~32VDC/AC power.

3. Technical Specification

- **Input type:** K、S、R、E、J、N、Pt100
- **Measurement range:** K(0~1300℃)、S(0~1700℃)、R(0~1600℃)、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(NO): 250VAC/2A or 30VDC/2A
  G1 SSR voltage output: 5VDC/30mA(to drive SSR solid-state relay)
  X3 0~20mA or 4~20mA for users to define(output voltage ≥ 10.5V when installing X3 module; output voltage ≥ 7Vwhen installing X5 module)
- **Alarm:**High limit alarm, low limit alarm and high/low deviation alarms, optional relay module to output alarm signal
- **Power supply:** 100~240VAC, -15%, +10%/50~60Hz
- **Power consumption:** ≤ 0.3W
- **Ambient temperature:** -10~+60℃ ; Humidity: 0~90%RH

4. Operation Description

4.1Basic display status

When power on,the upper display window shows the process value (PV) and the lower display window shows the set value(SV). This status is called basal display status. When the input signal is out of the measurable range (for example, the thermocouple is break),the upper display window will alternately display “orAL”and the high limit or the low limit of PV, and the instrument will automatically stop the control output.

According to different dimensions, the instrument panel has 6~10 indicators, of which OP1 is used to indicate the control output, AL1, AL2, AU1 and AU2 correspond to different alarm outputs respectively, and the other indicators are not used for this series of instruments.

4.2 Change the set temperature

In the basic display state, if the parameter lock is not locked, press ◁、▽ 、△ to edit the set temperature value displayed in the lower display window. Press ▽ o decrease the value while press △ to increase the value. The decimal point of the numeric digits can be edited and the value flashes at the same time (like the cursor). Press and hold to quickly increase/decrease the value, and the speed will automatically get faster and faster as the decimal point moves to the right (at the speed of level 3). Press ◁ to directly move the position (cursor) of the modified value, and press △ or ▽ to edit the value in the flashing position, which is easy to operate. The maximum value for set value is limited by the parameters SPL and SPH.

Press ▼ to decrease the value; Press and hold to quickly decrease the value

Press ▲ to increase the value; Press and hold to quickly increase the value

Press ◀ to directly move the position (cursor) of the modified value

4.3Auto-tuning

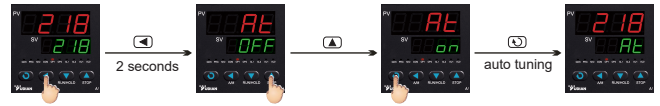
When PID control method of artificial intelligence(AI) is chosen, the parameters PID can be regulated with auto-tuning(AT). In basal display status, press ◁ for 2 seconds to call out At. Press △ to change the value of At from oFF to on, then press ↺ to active the auto-tuning process. In the basic display state, the lower display window of the instrument will flash At. Here the instrument will perform ON-OFF regulation. After two oscillation periods, the microprocessor inside the instrument can automatically calculate the PID parameters and end the auto-tuning. If users want to exit auto-tuning in advance, press and hold ◁ for 2 seconds to call out At. Change on to oFF, and press ↺ to confirm.

Remark 1: AI-218 adopts the PID regulation algorithm (APID) of advanced AI artificial intelligence technology, which solves the problem that the standard PID is easy to overshoot and has high control accuracy.

Remark 2: Under different set values, the parameter values from the system auto-tuning are different. Before starting the auto-tuning, set the set value SV to the most common value or the intermediate value. If the system is an electric furnace with good thermal insulation, the set value should be set to the maximum value. But it is forbidden to edit the SV value during the auto-tuning process. Depending on the system, the time required for auto-tuning can vary from seconds to hours.

Remark 3: 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, CHYS=2.0 is recommended.

Remark 4: At the end of auto-tuning, the control effect is not the best. Because of its learning function, the best effect can be obtained after using for a period of time.



5. Parameter setting

In basal display status,press and hold ↺ for 2 seconds to access Field Parameter Table. Press ↺ to go to the next parameter; If the parameter lock"Loc"isn't locked, the parameter value can be edited with Press ◁、▽ 、△ Press and hold ◁ to return to the previous 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 20 seconds. Setting Loc=808 to access Parameter Table.

5.1Parameter table

Code	Name	Description	Setting Range
HIAL	High limit alarm	Alarm on when PV>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 about defining parameter AOP.	-999~ +3200
LoAL	Lower limit alarm	Alarm on when PV<LoAL; alarm off when PV>LoAL+AHYS Note: In order to avoid that the lower limit alarm is always triggered due to low temperature upon power on, the lower limit alarm is always temporarily turned off upon power on. The alarm will be activated only when the temperature rises above LoAL and falls below LoAL.	
HdAL	Deviation high alarm	Alarm on when PV-SV>HdAL; alarm off when PV-S <HdAL-AHYS. When HdAL=maximum value, the alarm turns off.	
LdAL	Deviation low alarm	Alarm on when PV-SV<LdAL; alarm off when PV-SV>LdAL+AHYS. When LdAL=minimum value, the alarm turns off.	
Loc	Parameter Lock	Loc=0, allow to edit the field parameters and directly edit the set value in the basic display status; Loc=1, prohibit to edit the field parameters, but allow to directly edit the set value in the basic display status; Loc=2~3, allow to edit the field parameters, but prohibit to directly edit the set value in the basic display status; Loc=4~255, neither allow to edit any parameter other than Loc, nor to perform all shortcut operations. Loc=808, press ↺ again to enter the parameter table.	
AHYS	Hysteresis	Known as dead zone and hysteresis, used to avoid frequent alarm on/off because of PV fluctuation.	0~200

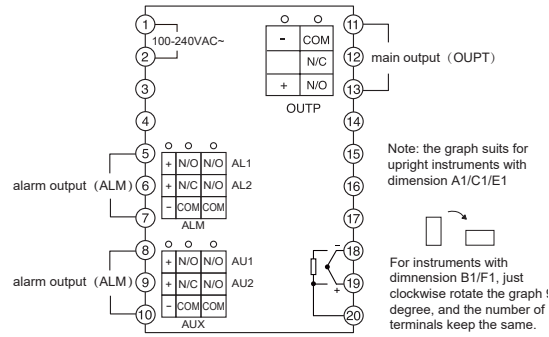
AdIS	Alarm display	OFF, No alarm signal in the lower display window even there is an alarm. On, Alternately flashes alarm signal in the lower display window when there is an alarm, recommended. FOFF, energy saving/confidential display mode; In this mode, the instrument will not only turn off the display of process value and set value, which can save power consumption of the instrument or keep the process temperature confidential, but also display the current program number in the lower display window, and display the alarm symbol when giving an alarm.	
AOP	Alarm output allocation	<table><tr><th>Alarm / Output to</th><th>LdAL (x1000)</th><th>HdAL (x100)</th><th>LoAL (x10)</th></tr><tr><td>None</td><td>0</td><td>0</td><td>0</td></tr><tr><td>AL1</td><td>1</td><td>1</td><td>1</td></tr><tr><td>AL2</td><td>2</td><td>2</td><td>2</td></tr><tr><td>AU1</td><td>3</td><td>3</td><td>3</td></tr><tr><td>AU2</td><td>4</td><td>4</td><td>4</td></tr></table> Example: AOP = 3 (LdAL) 3 (HdAL) 0 (LoAL) 1 (HIAL) ; It shows that HdAL and LdAL are sent to AU1, LoAL has no output, HIAL is sent to AL1. Installing L3 dual relay output module in ALM or AUX, AL2 or AU2 can be used.	0~ 4444
CtrL	Control mode	onoF: ON-OFF control, for situation not requiring high precision APId: advanced artificial intelligence PID control, with high precision control but without overshoot. nPId: standard PID algorithm with anti integral-saturation function.	
Srun	Running Status	run, running status. StoP, stop status, the lower display flashes StoP. HoLd, keep running status and prohibit to run or stop 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 blocking at the beginning of power on. drbA: Direct acting with high limit alarm and deviation high alarm blocking at the beginning of power on.	rE dr rEbA drbA
At	Auto tuning	oFF: Auto tuning is off. on: Active auto turning of PID and Ctl parameter, automatically return to FoFF after auto tuning FoFF : Auto tuning is off, cannot activate again by pressing key from panel AAt, fast auto-tuning, automatically returns to OFF after self-tuning.	
P	Proportional band	Define the proportional band controlled by PID and APID in ℃ / ℉ , instead of percentage of the measurement range. Note: Generally, optimal P, I, D and Ctl can obtained by AT auto tuning. They can also be manually input if users already know the correct values of P, I, D and Ctl when batch production of heating equipment is required.	0.1~ 3200
I	Time of Integral	No integral effect when I=0, in seconds.	0~9999 秒
d	Time of Derivative	No derivative effect when d=0, in 0.1 seconds.	0~3200 秒
Ctl	Control period	For SSR or thyristor output, it is generally 0.5~3 sec. For relay output, generally 15~40 sec, because small value will shorten its service life and cause the frequent heating/ refrigerating switch of the mechanical switch. Ctl is recommended to be 1/4 – 1/10 of derivative time(basically equal to the lag time of the system).	0.1 ~300 秒

CHYS	Control Hysteresis	Used to avoid frequent action of ON-OFF relay control. For heating, when PV > SV, relay output turns off; when PV<SV-CHYS, output turns on.	0~200
InP	Input specification Code	<table><tr><th>InP</th><th>Input spec</th><th>InP</th><th>Input spec</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>	0~21
dPt	Resolution	"0" for 1 ℃ or ° F display resolution. "0.0" for 0.1℃ or F display resolution.	0/0.0
Scb	Input Shift	Used to shift input to compensate the error caused by transducer, input signal, or auto cold junction compensation of thermocouple. It is generally set to 0. The incorrect setting will cause inaccurate measurement.	-999~ +400
FILt	PV input filter	The value of FILt will determine the ability of filtering noise. The larger the value is set, the more stable the measurement input is, but the slower the response speed is. If great interference exists, it is allowable to increase “FILt” gradually to make momentary fluctuation of process value less than 2 to 5 words. When the instrument is being metrological verified, “FILt” s can be set to 0 or 1 to shorten the response time.	0-100
Fru	Selection of power frequency and temperature scale	50C: Power at 50Hz and maximum anti-interference is achieved ; Display in ℃ 50F: Power at 50Hz and maximum anti-interference is achieved; Display in ℉ 60C: Power at 60Hz and maximum anti-interference is achieved; Display in ℃ 60F: Power at 60Hz and maximum anti-interference is achieved, Display in ℉ .	
OPt	Main Output type	SSr: Output SSr drive voltage or thyristor zero crossing trigger signal. The period is generally 0.5~4 seconds. rELy: for relay contact output or for execution system with mechanical contact switch(such as contactor or compressor). To protect the mechanical switch, the output period is limited to 3~120 seconds, and it is recommended to be 1/5 ~1/10 of derivative time. 0-20: 0~20mA linear current output. X3 or X5 module should be installed. 4-20: 4~20mA linear current output. X3 or X5 module should be installed. PHA1: Single-phase phase-shift output. K50/K60 module should be installed.	
AF	Advanced function code	AF, which is used to select the advanced functions, with calculation method as follows: AF=Ax1 + Bx2 + Ex16 A=0, HdAL and LdAL as deviation alarms; A=1, HdAL and LdAL as absolute value alarms, so that the instrument has two absolute limit alarms. B=0, the return difference between alarm and on-off regulation is unilateral; B=1, bilateral difference. E=0, HIAL and LOAL as high limit alarm and lower limit alarm of absolute value respectively; E=1, HIAL and LOAL as high limit alarm and lower limit alarm of deviation respectively, so that 4 deviation alarms are generated. Note: please set AF=0 for ordinary users.	0~255
bAud	Baud rate	Set bAud=3 for dimension 48x48 when AU2 is used, set bAud=9600 for other dimensions.	
SPL	Low limit of SV	Minimum value that SV allows to be.	-999~ +3200
SPH	Upper limit of SV	Maximum value that SV allows to be.	

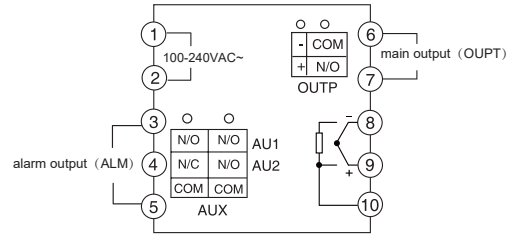
6. Wiring Diagram

Note: If the attached wiring diagram of the instrument is inconsistent with this manual due to technical upgrading or special ordering, please refer to the attached wiring diagram.

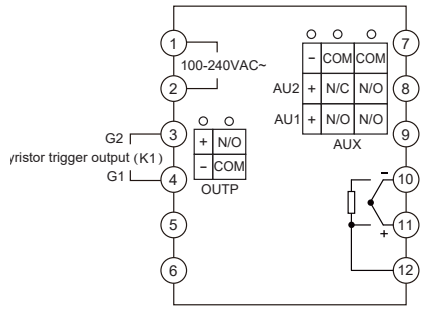
Wiring graph for instruments with dimension A1, B1, C1, E1 and F1:



Wiring graph for instruments with dimension D21/D2(48mmx48mm):



Wiring graph for instruments with dimension D61(48mmx48mm):



Note 1: Connect the thermocouple directly to the input terminal of the rear cover of the instrument with compensation wire instead of ordinary wire, and pay attention to the correct model and polarity of the compensation wire.

Note 2: The external solid state relay (SSR) shall be connected with products with isolation and withstand voltage greater than 2300V between input and output (safety requirements of CE certification).

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