



## ARTIFICIAL INTELLIGENCE TEMPERATURE CONTROLLER

### AI-508/AI-509 (V7.5) User Manual



## GENERAL

AI-508/509, an economical and easy operated model of Yudian artificial intelligence industry controller, is specially designed for use in the industries of plastic machinery, food machinery, packaging machinery, baking machinery and environmental testing equipment. It features:

- Application of artificial intelligence control algorithm with auto tuning function, avoiding the overshoot problem of standard PID algorithm and achieving precise control.
- Multiple thermocouples and RTDs are selectable. Integrated non-linear graduation tables, digital calibration and auto zero technology, and achieving accurate and stable measurement.
- Advanced modular structure, conveniently providing various outputs options, and making quick delivery and easy maintenance.
- High quality and performance hardware design, using high performance tantalum capacitor or ceramic capacitor. Compared to competing models, it consumes less electricity, experiences less temperature shifting, provides higher stability and reliability and can work in a wider range of temperature.
- ISO9001 certification and CE certified, achieving world class level of quality, anti-interference ability and safety.

## MODEL CODE SYMBOL

The model code of AI-508/509 is made up of 5 parts, for example:

AI-508/509    A    G    L2    L2  
 ①        ②    ③    ④    ⑤

### ① shows the basic function of instrument:

AI-508 Economical artificial Intelligence Temperature Controller 0.3%FS ± 1℃  
 AI-509 Economical artificial Intelligence Temperature Controller 0.3%FS ± 0.1℃

### ② Shows the front panel dimension:

Size	Front Panel width×height	Cut Out width×height	Depth Behind Mounting Surface
A	96×96mm	92×92mm	100mm
D	72×72mm	68×68mm	95mm
D2	48×48mm	45×45mm	95mm
E	48×96mm	45×92mm	100mm
F	96×48mm	92×45mm	100mm

③, ④ and ⑤ indicate the module installed in OUP, ALM and AUX sockets.  
 Allowed modules in each socket are as below:

Module Socket \ Allowed Type	N	L0	L1	L2	L3	G	W1	K1	K3
③ OUP (main output)			✓	✓		✓	✓	✓	✓
④ ALM (Alarm)	✓	✓		✓	✓		✓		
⑤ AUX (Auxiliary output)	✓	✓		✓	✓		✓		

- N (or none) no module installed
- L0 Relay contact output module (Capacity: 2A/250VAC, only normal open terminal can absorb electrical spark), usually use for alarm
- L1 Relay contact output module (Capacity: 2A/250VAC, only normal open terminal can absorb electrical spark), usually use for control
- L2 Relay contact output module (Capacity: 1A/250VAC, small volume)
- L3 Output module of dual normally open relay contact (Capacity: 2A/250VAC, support AL1 and AL2 alarm output)
- G SSR voltage output module (30mA/12DC)
- W1 TRIAC no contact normally open discrete output module, suitable for AC contactors up to 80A, and has low interference and long life.
- K1 TRIAC zero crossing trigger output module. One loop of output, suitable for single-phase power.
- K3 Three phases TRIAC zero crossing trigger output module (can trigger triple of TRIAC, 2 inversely parallel connected SCR or TRIAC power module of current 5-500A), will plug in OUP slot and MIO slot at same time.

Note 1: For instrument of dimension D2, because of its limited volume, when L1 or L3 module is installed in AUX slot, L1 can't be installed in OUP slot, but L2, which is smaller, can be installed instead.

Note 2: K3 can't be installed in instrument with dimension D or D2. There isn't ALM slot in D2 instruments. L3 module can't be installed in ALM slot of instrument with dimension D.

## 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:** AI-508: 0.3%FS±1℃  
 AI-509: 0.3%FS±0.1℃
- **Temperature display resolution:** AI-508: 1℃/F  
 AI-509: 0.1℃/F
- **Control Mode:** On-Off Control or Artificial Intelligence PID control with auto tuning.
- **Output mode (modularized):**
  - L1 Relay contact output module (Normal open + normal close. Capacity: 2A/250VAC or 30VDC/2A)
  - L2 Relay contact output module (Capacity: 1A/250VAC, small volume)
  - G SSR voltage output module (12VDC/30mA)
  - W1 TRIAC no contact normally open discrete output module (Capacity: 100-240VAC/0.2A, instantaneous current 2A with time<20ms and repeat period>5s)
  - K1 Thyristor zero crossing trigger output module (can trigger TRIAC, a pair of inversely parallel connected SCRs or SCR power module with current rating of 5-500A)
  - K3 Three-phase Thyristor zero crossing trigger output module (can trigger three phases of TRIAC, 2 inversely parallel connected SCRs or SCR power module of current 5-500A)
- **Alarm function:** High limit/low limit, and deviation high/deviation low alarm.
- **Power supply:**

100-240VAC, -15%, +10%; 50-60Hz

- **Power consumption:** < 3W
- **Ambient:** Temperature of -10~+60℃ /14-140 ℉; humidity of 0-90RH%
- **Reliability:** repairing and returning rate < 0.8% (according to the statistics data from 2003 to 2004.)
- **Electromagnetic compatibility (EMC):** IEC61000-4-4: ± 4KV/5KHz; IEC61000-4-5: 4KV

## FRONT PANEL AND OPERATION

- ① Upper display window, displays PV, or code of a parameter
- ② Lower display window, displays SV, alarming code, or value of a parameter
- ③ Setup key, for accessing parameter tables, and confirming change
- ④ Data shift key, also for activating auto turning
- ⑤ Data decrease key
- ⑥ Date increase key
- ⑦ Indicator lamps: (OP1, AL1, AL2, AU1 and AU2 indicate the I/O actions of the corresponding modules)



**Basal display status:** When power on, the upper display window of the instrument shows the process value (PV), and the lower window shows the setpoint (SV). This status is called basic display status. When the input signal is out of the measurable range (for example, the thermocouple or RTD circuit is break, or input specification sets wrong), the upper display window will alternately display "orAL" and the high limit or the low limit of PV, and the instrument will automatically stop output.

## OPERATION DESCRIPTION

- **Setpoint Setting:**  
 In basic display status, if the parameter lock "Loc" isn't locked, we can set setpoint (SV) by pressing (◀) / (▼) or (▲). Press (▼) key to decrease the value, (▲) key to increase the value, and (◀) key to move to the digit expected to modify. Keep pressing (▼) or (▲), the speed of increasing or decreasing value gets quick. The range of setpoint is between the parameter SPL and SPH. The default range is 0-400℃.
- **Parameter Setting**  
 In basal display status, Press (Ⓢ) and hold for about 2 seconds can access Field Parameter Table. Press (Ⓢ) can go to the next parameter; pressing (◀) / (▼) or (▲) can modify the value of a parameter. Press and hold (◀) can return to the preceding parameter. Press (◀) (don't release) and then press (Ⓢ) simultaneously can escape from the parameter table. The instrument will escape automatically from the parameter table if no key is pressed within 25 seconds. Setting Loc=808 and then press (Ⓢ) can access System Parameter Table.
- **Artificial Intelligence control and auto tuning**  
 When AI PID control method is chosen (Ctrl=APId), 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 cycles of on-off action, the instrument will obtain the values of PID parameter. If you want to escape from auto tuning status, 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 cancelled.

Note 1: If the setpoint is different, the parameters obtained from auto-tuning are

possible different. So you'd better set setpoint to an often-used value or middle value first, and then start auto-tuning. For the ovens with good heat preservation, the setpoint can be set at the highest applicable temperature. It is forbidden to change SV during auto tuning. Depending on the system, the auto-tuning time can be from several seconds to several hours.

Note 2:Parameter CHYS (on-off differential, control hysteresis) has influence on the accuracy of auto-tuning. Generally, the smaller the value of CHYS, the higher the precision of auto tuning. But CHYS parameter value should be large enough to prevent the instrument from error action around setpoint due to the oscillation of input. CHYS is recommended to be 2℃

Note 3:AI series instrument has the function of self-learning. It is able to learn the process while working. The control effect at the first run after auto tuning is probably not perfect, but optimal control result will be obtained after a period of time because of self-learning.

## PARAMETERS AND SETTINGS

### Field parameter table (Press and hold for 2 seconds to access)

Code	Name	Description	Setting Range	default
HIAL	High limit alarm	Alarm on when PV>HIAL; Alarm off when PV<HIAL-AHYS.Set to 3000 will disable this function	-999~+3000	3000
LoAL	Low limit alarm	Alarm on when PV<LoAL; alarm off when PV>LoAL+AHYS.Set to -999 will disable this function	-999~+3000	-999
HdAL	Deviation high alarm	Alarm on when PV-SV>HdAL; alarm off when PV-SV<HdAL-AHYS.Set to 3000 will disable this function	-999~+3000	3000
LdAL	Deviation Low alarm	Alarm on when PV-SV<LdAL; alarm off when PV-SV>LdAL+AHYS;Set to -999 will disable this function	-999~+3000	-999
Loc	Parameter lock	0: auto-tuning and modification of field parameters and setpoint are allowed. 1: allowed to modify field parameters and setpoint value, but can't run auto-tuning. 2: allowed to modify field parameters, but can't change the setpoint or run auto-tuning. 3-255: can only modify "Loc" 808: setting Loc=808 and then pressing  can access system parameter table	0~255	0

### System parameter table (set Loc=808 and then press to access)

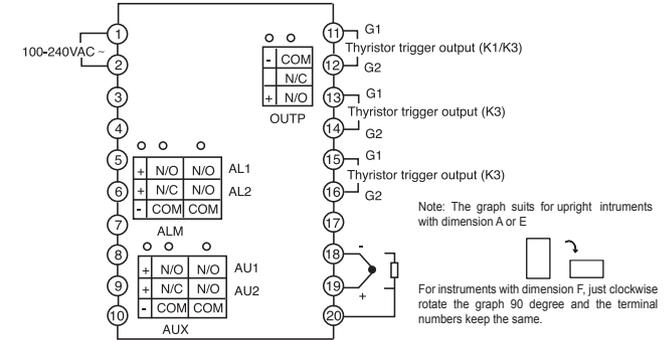
Code	Name	Description	Setting Range	default																														
AHYS	Alarm Hysteresis	Avoid frequent alarm on-off action because of the fluctuation of PV.	0~200	2																														
AoP	Alarm output assignment	<table border="1"> <thead> <tr> <th>Alarm Output</th> <th>LdAL (x1000)</th> <th>HdAL (x100)</th> <th>LoAL (x10)</th> <th>HIAL (x1)</th> </tr> </thead> <tbody> <tr> <td>None</td> <td>0</td> <td>0</td> <td>0</td> <td>0</td> </tr> <tr> <td>AL1</td> <td>1</td> <td>1</td> <td>1</td> <td>1</td> </tr> <tr> <td>AL2</td> <td>2</td> <td>2</td> <td>2</td> <td>2</td> </tr> <tr> <td>AU1</td> <td>3</td> <td>3</td> <td>3</td> <td>3</td> </tr> <tr> <td>AU2</td> <td>4</td> <td>4</td> <td>4</td> <td>4</td> </tr> </tbody> </table> <p>Example: AOP = <math>\frac{0}{LdAL} \frac{1}{HdAL} \frac{0}{LoAL} \frac{1}{HIAL}</math> ; It shows that HIAL and HdAL are sent to AL1, and LoAL has no output.</p>	Alarm Output	LdAL (x1000)	HdAL (x100)	LoAL (x10)	HIAL (x1)	None	0	0	0	0	AL1	1	1	1	1	AL2	2	2	2	2	AU1	3	3	3	3	AU2	4	4	4	4	0~4444	111
Alarm Output	LdAL (x1000)	HdAL (x100)	LoAL (x10)	HIAL (x1)																														
None	0	0	0	0																														
AL1	1	1	1	1																														
AL2	2	2	2	2																														
AU1	3	3	3	3																														
AU2	4	4	4	4																														
Fru	Selection of power frequency and temperature scale	50C: 50Hz, ℃ 50F: 50Hz, ℉ 60C: 60Hz, ℃ 60F: 60Hz, ℉		50C 50F 60C 60F																														
SPL	Low limit of SV	Minimum value that SV allowed to be	-999~3000	0																														
SPH	Upper limit of SV	Maximum value that SV allowed to be		400																														

Act	Acting Method	rE:Reverse acting. Increase in measured variable causes an 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																									
P	Proportion band	Proportion band in PID with unit ℃ or ℉	1~999 Sec	30																								
I	Time of Integral	No integral effect when I=0	0~9999 Sec	100s																								
d	Time of Derivative	No derivative effect when d=0	0~999.9 Sec	50.0s																								
Ctl	Control period	Small value can improve control accuracy. For SSR or TRIAC output, generally 0.5 to 3 seconds. Large value can increase using life of relay. For Relay output, generally 15 to 40 seconds.	0.5~120 Sec	2s Or 20s																								
CHYS	Control Hysteresis	CHYS is used for ON-OFF Control to avoid frequent on-off actuation of relay. For a heating system,if PV > SV, Output turns OFF;PV<SV-CHYS, Output turns ON.	0~200	2																								
INP	Input specification	<table border="1"> <thead> <tr> <th>InP</th> <th>Input type</th> <th>InP</th> <th>Input type</th> </tr> </thead> <tbody> <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>SPARE</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> </tbody> </table>	InP	Input type	InP	Input type	0	K	1	S	2	R	3	SPARE	4	E	5	J	6	SPARE	7	N	8~20	SPARE	21	Pt100	0~21	0
InP	Input type	InP	Input type																									
0	K	1	S																									
2	R	3	SPARE																									
4	E	5	J																									
6	SPARE	7	N																									
8~20	SPARE	21	Pt100																									
dPt	Resolution	0: 1 ℃ / ℉ 0.0: 0.1 ℃ / ℉ (only AI-509 have)	0 / 0.0	0.0																								
Scb	Input Shift	Scb is used to make input shift to compensate the error produced by sensor or input signal. PV_after_compensation=PV_before_compensation+Scb.	-200~+400	0																								
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. Generally, if great interference exists, then you can increase parameter "FILT" gradually to make momentary fluctuation of measured value less than 2 to 5. When the meter of the instrument is being examined at laboratory, "FILT" should be set to 0 or 1 to short the response time.	0~40	1																								
Fru	Selection of power frequency and temperature scale	50C: 50Hz, ℃ 50F: 50Hz, ℉ 60C: 60Hz, ℃ 60F: 60Hz, ℉		50C 50F 60C 60F																								
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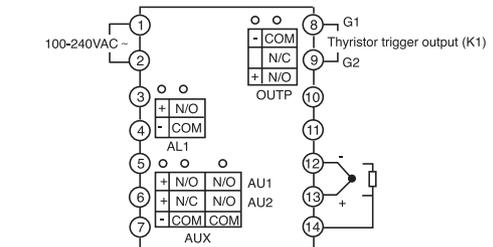
## INSTRUMENT INSTALLATION AND WIRING

### Wiring graph for instruments with dimension A, E or F

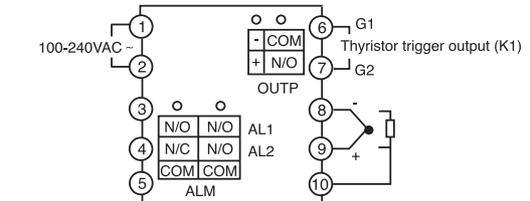
Note:The compensation wires for different kinds of thermocouple are different, and should be directly connect to the terminals. Connecting the common wire between the compensation wire and the terminals will cause measurement error.



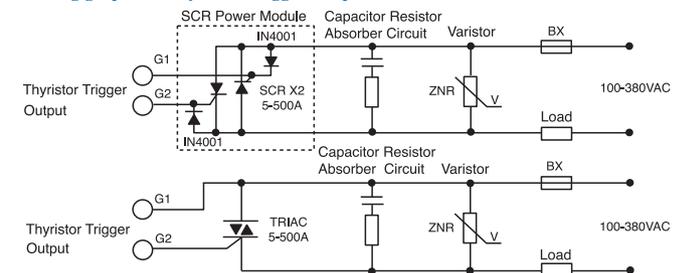
### Wiring graph for D dimension(72mmX72mm) instruments :



### Wiring graph for D2 dimension (48mmX48mm) instruments



### Wiring graph for Thyristor Trigger Output



Note: it is recommended to use the SCR power module,which includes a pair of SCRs and diodes. Compared to TRIAC, it is more reliable and consumes less electricity