YUDIAN

ARTIFICIAL INTELLIGENCE TEMPERATURE CONTROLLER

AI-509 (V9.2) Operation Manual

1.FEATURES

- Designed for plastic machinery, food machinery, packaging machinery, industrial kilns, furnace and environmental testing equipment. This is an economic and time-efficient controller. Operation interface is simple and user-friendly.
- Universal 100~240VAC or 24VDC supply power supported. Power frequency 50Hz/60Hz and C/F unit supported.
- Multiple thermocouples and RTDs are selectable. Advanced modular structure, conveniently providing various outputs options, and making quick delivery and easy maintenance.
- Artificial intelligence control algorithm with auto tuning applied. Precise control achieved with no overshooting.
- 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.

2.MODEL CODE DEFINITION

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

AI-509	A	G	L21	L21
①	②	③	④	⑤

① **Model number**

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

② **Panel Dimension**

Size	Front Panel width×height	Cut Out width×height	Depth Behind Mounting Surface
A	96×96mm	92×92mm	69mm
D	72×72mm	68×68mm	70mm
D2	48×48mm	45×45mm	94mm
E	48×96mm	45×92mm	71mm
F	96×48mm	92×45mm	71mm

③ **Modules available for main output (OUTP)**

L1 Relay contact output, capacity 2A/250VAC, large size, electrical sparks absorption only in normal open terminals
L2 Relay contact output NO+NC, capacity 1A/250VAC, compact size
G SSR voltage output, 12VDC/30mA
W1 TRIAC non-contact normally open discrete output, suitable for AC contactors ≤ 80A. Low interference and longer lifespan.
K1 TRIAC zero crossing trigger output. One loop of trigger output, suitable for single-phase power.
K3 Three phases TRIAC zero crossing trigger output. triggering 0~500A TRIAC, 2 inversely parallel connected SCR or TRIAC power module.
K50 Single channel 220VAC/380VAC burn-proof thyristor phase-shift trigger output module.
X3 Photoelectric programmable linear current output module.

④ **Modules available for alarm (ALM), as first alarm channel**

N (or leaving blank) No module installed
L2 Relay contact output NO+NC, capacity 1A/250VAC, large size, supporting AL1 alarm
L21 Relay contact output NO+NC, capacity 1A/250VAC, compact size, supporting AL1 alarm
L3 Two channel relay contact output NO+NO, capacity 2A/250VAC, supporting both AL1 and AL2 alarms

⑤ **Modules available for alarm (ALM), as first alarm channel**

N (or leaving blank) No module installed
L2 Relay contact output NO+NC, capacity 1A/250VAC, large size, supporting AU1 alarm
L21 Relay contact output NO+NC, capacity 1A/250VAC, compact size, supporting AU1 alarm
L3 Two channel relay contact output NO+NO, capacity 2A/250VAC, supporting both AU1 and AU2 alarms
Note 1: For instrument of dimension D2, because of its limited volume, when L21 or L3 module is installed in AUX slot, L1 can't be installed in OUPT 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.

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 :** AI-509： 0.3%FS±0.1℃
- **Temperature display resolution :** AI-509： 0.1℃/℉
- **Control Mode:** On-Off Control or Artificial Intelligence PID control with auto tuning.
- **Output mode (modularized) :**
  L1 Relay contact output module (Normal open. Capacity: 2A/250VAC or 30VDC/2A)
  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 phases TRIAC zero crossing trigger output. triggering 0~500A TRIAC, 2 inversely parallel connected SCR or TRIAC power module.
  K50 Single channel 220VAC/380VAC burn-proof thyristor phase-shift trigger output module.
  X3 Photoelectric programmable linear current output module.
- **Alarm function :** High limit/low limit, and deviation high/deviation low alarm. Installing relay modules as alarm is optional.
- **Power supply :** 100-240VAC, -15%, +10% ; 50-60Hz
- **Power consumption:** ≤ 3W
- **Ambient :** Temperature of -10~+60℃ /14-140 ℉ ; humidity of 0~90RH%

4.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, AU1and 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.

5.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.

● Parameter Setting

In basal display status, Press ↻ and hold for about 2 seconds can access Field Parameter Table. Pressin ↻ can go to the next parameter; pressing ◁ / ▽ or △ can modify the ralue 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: AI-509 adopts artificial intelligence control algorithm with auto tuning function, avoiding the overshoot problem of standard PID algorithm and achieving precise control.

Note 2: 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 3: 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 4: 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.

6.PARAMETERS AND SETTINGS

6.1Field parameter table (Press ↻ and hold for 2 seconds to access)

Code	Name	Description	Setting Range
HIAL	High limit alarm	Alarm on when PV>HIAL; Alarm off when PV<HIAL-AHYS.Set to 3000 will disable this function. Note: All alarms can be assigned to AL1, AL2, AU1, AU2 or none. More alarm allocation is explained in AOP section below.	-999~ +3000
LoAL	Low limit alarm	Alarm on when PV<LoAL; alarm off when PV>LoAL + AHYS.Set to -999 will disable this function. Note: To avoid the lower limit alarm always being triggered due to low temperature when first powered on, the lower limit alarm function is always temporarily exempted during power on. Only when the temperature rises above LoAL and falls further below LoAL will an alarm be generated	-999~ +3000
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
LdAL	Deviation Low larm	Alarm on when PV-SV<LdAL; alarm off when PV-SV >LdAL+AHYS;Set to -999 will disable this function.	-999~ +3000

Loc	Parameter lock	0: auto-tuning and modification of field parameters and setpoint are allowed. 1: allowed to run auto-tuning and setpoint value, but can't modify field parameters. 2: allowed to modify field parameters and run auto-tuning, but can't change the setpoint . 4~255: can only modify "Loc" and run auto-tuning. 808: setting Loc=808 and then pressing ⟲ can access system parameter table.	0~255

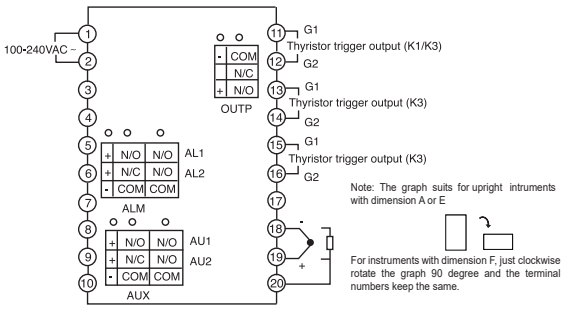
6.2 System parameter table (set Loc=808 and then press ⟲ to access)

Code	Name	Description	Setting Range
AHYS	Alarm Hysteresis	Avoid frequent alarm on-off action because of the fluctuation of PV.	0~200
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. 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 assignment	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 Example: AOP = 3 (LdAL) 3 (HdAL) 0 (LoAL) 1 (HIAL) ; It shows that HIAL and HdAL are sent to AL1, and LoAL has no output.	0~4444
CtrL	Control mode	onoF : On-off control. APId : AI PID control, high precision and no-overshoot. nPID: standard PID algorithm with anti integral-saturation function.	onoF, APId
Srun	Running Status	run: Control is activated. StoP: Control is deactivated as is stopped. HoLd: Control is activated and kept active.	
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
At	Auto tuning	OFF: Auto tuning was off. on: Active auto turning of PID and CtI parameter, automatically return to FOFF after auto tuning FOFF : Auto tuning was off, cannot activate again by pressing key from panel AAt, fast auto-tuning, automatically returns to OFF after self-tuning. Note: If AAt is selected as the AT parameter, the AAt auto-tuning function can be automatically started when the instrument is in the output status of full power heating after power on. PID parameters can be set in advance without traditional periodic oscillation. In most cases, accurate control can be achieved by first heating. If the AAT has not completed the auto-tuning, but the instrument has already exited the full power output status, then the AAT fails and the auto-tuning will be terminated, but the PID parameters will not be modified.	
P	Proportion band	Proportion band in PID with unit ℃ or ℉ , Instead of using the percentage of the range. Note: Generally, optimal P, I, D and CtI can be obtained by AT auto tuning. They can also be manually input if you already know the correct values of P, I, D and CtI when batch production of heating equipment is required.	1~999 Sec
I	Time of Integral	No integral effect when I=0.	0~9999 Sec
d	Time of Derivative	No derivative effect when d=0.	0~999.9 Sec
Ctl	Control period	For SSR, thyristor or linear current output, it is generally 0.5~3 sec. For Relay output or in a heating/refrigerating dual output control system, generally 15~40 sec, because small value will cause the frequent on-off action of mechanical switch or frequent heating/refrigerating switch, and shorten its service life. CtI is recommended to be 1/5 – 1/10 of derivative time. (It should be integer times of 0.5 second.)	0.5~120 Sec
CHYS	Control Hysteresis	CHYS is used for ON-OFF Control to avoid frequent on-off actuon of relay. For a heating system,if PV > SV, Output turns OFF;PV<SV-CHYS, Output turns ON.	0~200
INP	Input specification	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
dPt	Resolution	0 : 1 ℃ / ℉ ; 0.0 : 0.1 ℃ / ℉	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. Note: It is generally set to 0. The incorrect setting will cause measurement inaccurate.	-200~ +400
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 it is allowable to increase parameter "FILt" gradually to make momentary fluctuation of process value less than 2 to 5. When the instrument is being metrological verified, "FILt" s can be set to 0 or 1 to shorten the response time.	0~40
Fru	Power frequency / temperature scale	50C: 50Hz,display ℃ 50F: 50Hz, display ℉ 60C: 60Hz,display ℃ 60F: 60Hz, display ℉ Input will has maximum anti-interference ability when the corresponding power frequency is selected.	
OPt	Main output type	SSr: Output SSr drive voltage or thyristor zero crossing trigger signal. G, K1 or K3 module should be installed. The output power can be adjusted by the on-off time proportion. The period (CtI) 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 (CtI) 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 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	AF is used to select advanced function. The value of AF is calculated as below: AF=A*1 + B*2 + E*16 + H*128 A=0, HdAL and LdAL work as deviation high and low limit alarms; A=1, HdAL and LdAL work as high and low limit alarms, and the instrument can have two groups of high and low limit alarms. B=0: Alarm and control hysteresis work as unilateral hysteresis; B=1: As bilateral hysteresis. E=0, HIAL and LOAL work as high and low limit alarms respectively; E=1, HIAL and LOAL work as deviation high and low limit alarms respectively, then there are four deviation alarms. H=0, HIAL and LOAL can alarm independently; H=1, HIAL and LOAL become interval alarm, and will alarm only when LOAL>PV>HIAL is met. The alarm code is HIAL, and HIAL is also used for output. Note: AF=32 is recommended for ordinary users.	0~255
bAud	Comm module function selection	The baud parameter defaults to 9600. By setting the baud parameter, the COM slot can be used for other functions . Baud=3, COMM/AUX slot used as AUX, which can be used for Dimension D2.	
SPL	Low limit of SV	Minimum value that SV allowed to be	-999~ 3000
SPH	Upper limit of SV	Maximum value that SV allowed to be	

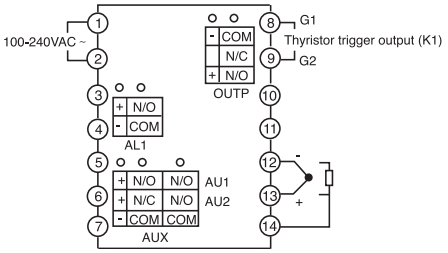
7. INSTRUMENT INSTALLATION AND WIRING

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.

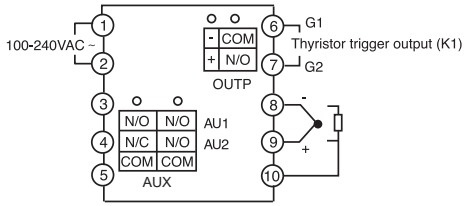
Wiring graph for instruments with dimension A, E or F



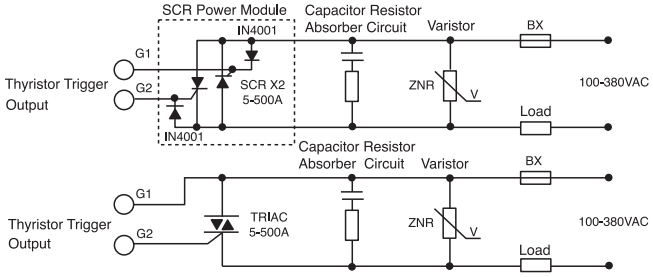
Wiring graph for D dimension(72mmX72m) instruments :



Wiring graph for D2 dimensio (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.

Important note: Due to technical upgrade or customized order, the wiring diagram on the side on the instrument may vary with the the digram above. The version of the diagram on instrument shall prevail.