AI-508T

ARTIFICIAL INTELLIGENCE

TEMPERATURE CONTROLLER

Operation Instruction

.General

AI-508, a tiny intelligent temperature controller which is newly issued by YUDIAN company, is specially designed for application in plastic machinery, food machinery, packing machinery and bake oven. Incorporated with AI artificial intelligence control algorithm and auto tuning system which are specially optimized for electric heating application, features:

Equipped with universal AI-708T hardware module, it is advanced and reliable and conformed by ISO9001 certification.

It is the first one home instrument conformed by European CE certification, and has a good anti-interference performance. Lighting and surge protection and unique 380VAC wrong connection protection are also available.

With programmable input including PT100 and various thermocouple such as K, S, T, E, J and N. AI artificial intelligence control and ON/OFF control and high/low alarm function come as standard function.

Besides traditional relay contact and SSR voltage output, SCR trigger output and no contact discrete output is also available.

. Model code symbol

The type of AI-508T is made up of 4 parts, for example:

<u>AI-508T</u>   <u>A</u>   <u>L</u>   <u>LL</u>

1   2   3   4

1. Shows the base function of instrument

AI-508T   tiny intelligent temperature controller

2. Shows the front panel dimension, the depth of the instrument is about 13.5mm(foreside)+100mm(rearward)

A   front panel 96× 96mm(width× height), cut out 92× 92mm

E   front panel 48× 96mm(width× height), cut out 45× 92mm

F   front panel 96× 48mm(width× height), cut out 92× 45mm

D2 front panel 48× 48mm(width× height), cut out 92× 92mm

3. Shows the module type of main output, selectable modules are as follows:

L   relay contact output module (Capacity:2A/250VAC)

G   SSR voltage output module (DC 12V/30mA)

K   SCR zero cross trigger output module (can trigger TRIAC or 2 SCR inverse parallel connected with current rating of 5-500A)

W1   SCR no contact normal open discrete output module(Capacity: 85-264VAC/0.2A)

4. Shows the module type of alarm output, selectable modules are as follows:

N   (or none) without module installed

LL High alarm and Low alarm output (contact normal open and normal close, only for the front panel dimension type   A   E and F)

L   High alarm output (contact normal open and normal close, only for the front panel dimension type D2)

LL   High alarm and Low alarm output (contact normal open, only for the front panel dimension type D2)

For example,

AI-508T **D2** **G** **L**

1   **2**   **3   4**

It shows that the basal function of this instrument is AI-808 type, front panel dimension is 96 96mm, main output is linear current output without isolation, alarm 1 is relay contact output module, alarm 2 is not installed in, a RS485 communication interface with photoelectric isolation is installed. After equipped with enhanced lateral plate, auxiliary output is relay contact output module. Optional input type (F2 radiation type pyrometer) and No.3 software function are also available. The following is the meanings of the ten parts.

. TECHNICAL SPECIFICATION

1. Input type :
    Thermocouple: K, S, E, J, N
    Resistance temperature Detector: Pt100

2. Instrument Input range :
    K(-50--+1300   ), S(-50--+1700   ), E(0—800   ), J(0--1000   ), N(0—1300   )
    Pt100(-200--+600   )

3. Measurement accuracy : 0.5%FS± 1

4. Temperature display resolution : 1

5. Control mode :
    On-off control mode (deadband adjustable)
    AI artificial intelligence control, including fuzzy logic PID control and advanced control algorithm with the function of parameter auto tuning.

6. Output mode :
    L   Relay contact discrete output (NO+NC): 264VAC/1A or 30VDC/1A
    G   SSR Voltage output: 12VDC/30mA (used to drive SSR)
    K   BCR cross zero trigger output: can trigger TRIAC of 5—500A, two parallel-connected BCR or BCR power module
    W   BCR NO contact discrete output (NO): 100—240VAC/0.2A (continuous), 2A (20mS instantaneous, repeat period   5s)

7. **Alarm function:** upper limit, low limit.

8. **Power supply voltage rating**: 100-240VAC/50-60Hz.

9. **Power consumption:** 3W.

10. **Ambient temperature:** 0—55

. FRONT PANEL AND OPERATION

Output indicator lamp

Alarm 1 indicator lamp

Alarm 2 indicator lamp

Auxiliary indicator lamp
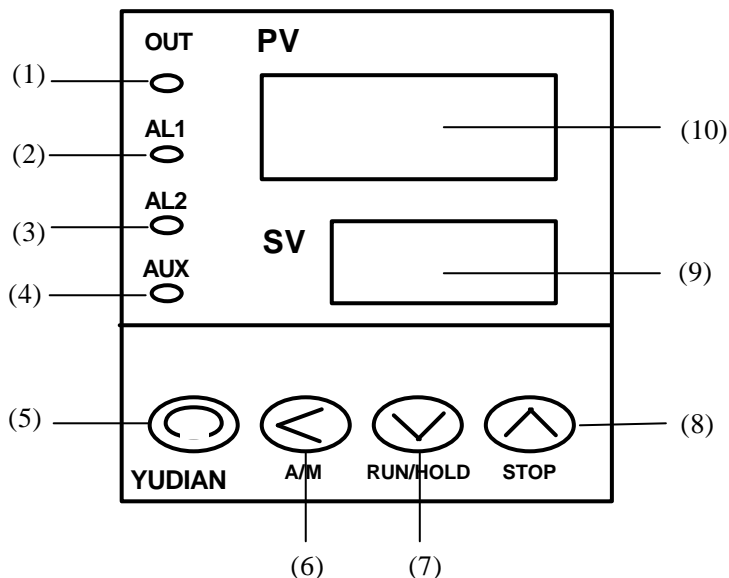
Display transfer (and Setup key)

Data shift key

Data decrease key

Date increase key

SV display

PV display

. Basal operation description

1. Temperature setting:

   If the parameter lock isn't locked, we can setup most of the data displayed in the lower display window. For example, setpoint input of AI-508T is as follows:

   Press ⬭ key to change the status to setpoint input. Now the decimal point of the last one digit (unit's place) of the displayed SV value begins blinking (like curse). Press ⬇ key to decrease the value, press ⬆ key to increase the value, and ⬅ key to move to the digit expected to modify. To complete the set point changing, press ⬭ again.

2. Parameters Setting:

   press ⬭ and hold for about 2 seconds until parameter is displayed. Then the key ⬅ ⬆ ⬇ can be used to modify parameters. Press and hold the ⬅ key can return to the preceding parameter. Press ⬅ key (don't release) and then press ⬭ key simultaneously can escape from the parameter setup. The instrument will escape auomatically from the parameter setup operation if no key is pressed within 30 seconds

. AI artificial intelligence control and auto tuning

AI artificial intelligence control, which is a new algorithm using fuzzy logical PID control, is adopted in AI series instrument. The ordinary PID algorithm can give accurate control to processes, with disadvantages of having large overshoot, having a long upset response time, and having difficulty for PID parameters to be determined, and is not suitable for process which

are not stable or have a long lag time. Contrarily, fuzzy control algorithm can be suitable for processes that have a long lag time and have small overshoot, and it is easy for parameters to be determined, but it has bad control accuracy, and its control curve may have tiny saw-teeth. AI artificial intelligence algorithm has fuzzy control algorithm and concurrent PID algorithm improved with new derivative integral function added. Which of these two control algorithms is activated is determined by the deviation between measurement value and setpoint. When the magnitude of the deviation is large, the fuzzy control algorithm is activated to remove PID reset windup, and when the magnitude of the deviation is small, the improved PID algorithm is activated. Therefore, AI artificial intelligence control has the characteristic of having no overshoot, high control precision and easy parameter tuning and having good control effect for complicate process. Further more, AI series instrument has the function of selflearning, it is able to learn the process character while working. Users are probably unsatisfied with the control effect at the instrument first use after auto tuning, but predominant control result will be obtained after its first use because of the selflearning function.

In order to obtain perfect control, the instrument need to get optimum configuration parameter through auto tuning when instrument is used at the first time. Note: If the setpoint value is different, the parameter obtained from auto tuning will not always the same. So if you want to execute auto tuning, you must adjust setpoint to an often-used value first, and then press and hold the ⬯ key for about 2 seconds until the "At" symbol is displayed in the lower display window if you want to start up auto tuning function (Auto tuning is not allowed to start up again unless you set parameter Ctrl to 2 manually if the function has been executed once). During auto tuning, the instrument executes on-off control. After 2-3 times on-off action, the microprocessor in the instrument will analyze the period, amplitude, waveform of the oscillation generated by the on-off control, and calculate the optimal control parameter value. The instrument begins to perform accurate AI artificial intelligence control after parameter auto tuning is finished. If you want to escape from auto tuning status, press and hold the ⬯ key for about 2 seconds until the blinking of "At" symbol is stopped in the lower display window. Generally it will meet you need to perform auto tuning one time only. After the auto tuning is finished. the instrument will set parameter CtrL to 3 (factory set is 1), and now it is not allowed to start up auto tuning by pressing ⬯ key on front panel. This will avoid repeat auto tuning by mistake.

If the setpoint value is different, the parameter obtained from auto tuning will not always the same. So if you want to execute auto tuning, you must adjust setpoint to an often-used value first, and then start up auto tuning function. Parameter Ctl and dF have influence on the accuracy of auto-tuning. Auto tuning accuracy (deadband), generally, the smaller for these two parameters setting value, the higher for the precision of auto tuning. But dF parameter value should be large enough to prevent the instrument from error action around setpoint due to the oscillation of input. There are also some restrictions in application rot parameter "Ctl" (refer to function description for these 2 parameters in the later text). Normally, parameters are recommended to be Ctl=0-2, dF=0.3 (dF=2.0 for AI-508T).

. **PARAMETER AND SETTING**

Code	Description	Setting Range	Default	Remarks
HIAL	High limit alarm	-1999—+9999	9999	
LOAL	Low limit alarm	-1999—+9999	-1999	
dF	Deadband	0—20	2.0	ON/OFF control and alarm only
CtrL	Control mode	0—5	1	see the following text for details
Ctl	Control period	0—125 SEC	2 SEC	
Sn	Input specification	0—21	1	see the following text for details
SC	Input Shift	-1999—+4000	0.0	
dL	PV input filter	0—40	1	Define digital filter intensity
Loc	Configuration privilege	0—9999	0	

1. Alarm parameter HIAL, LOAL

These 2 parameters set instrument's alarm function. Alarm signal will be triggered to make instrument's relay contact close (NC contact open), if alarm condition is satisfied. Alarm messages is displayed in turn in SV display window. When the cause of alarm is removed, then the alarm is cleared automatically.

Alarm condition is as following:

HIAL   High Limit absolute alarm. If the process value is greater than the value specified as "HIAL+dF", then the alarm 1 is set, and the alarm 1 will be cancelled if the process value is less than the value of "HIAL-dF".

LoAL   Low Limit absolute alarm. If the process value is greater than the value specified as "LoAL-dF", then the alarm 2 is set, and the alarm 2 will be cancelled if the process value is less than the value of "LoAL-dF".

2. Deadband parameter dF

Deadband parameter dF is set to permits protection of position control output from high switching frequencies caused by process input fluctuation. Deadband parameter is used for position control, 4-alarm control as well as the position control at auto tuning.

For example: dF parameter can affect upper absolute alarm as the following, provided upper alarm parameter "HIAL" is set as 800 , dF parameter is set as 2.0 .

Instrument is in normal status at the beginning, when process value is greater than 802   (HIAL+dF), the upper absolute alarm can be triggered.

Instrument is in upper alarm status at the beginning, when process value is less than 798   (HIAL-dF), then alarm can be cleared.

Another example: Provided the instrument is used for position control or at auto tuning. SV is set as 700 , dF parameter is set as 2.0 , control is reverse action (heat control).

Output is on at the beginning, when process value is greater than 702   (SV+dF), then output is shut down.

Output is off at then beginning, when process value is less than 698   (SV-dF), then output is on again to start heating.

As for position control, the larger for dF parameter value, the longer for output proportion period time and worse for control accuracy. Conversely, the smaller for dF parameter, the shorter for output proportion period time, and error action will occur easily due to input fluctuation and make mechanical contactors of relay or contactors shorten their service life.

dF don't affect AI artificial intelligence algorithm, but affect the position control at auto tuning, Theoretically the smaller for dF parameter, the batter for auto tuning accuracy, but error action, which caused by process value fluctuation due to noise, should be avoided. Watch process value for some time, if fluctuation is too large, increase input fitter parameter value dL at first to make the fluctuation smaller than 2-5 unit, then set dF parameter equal to process fluctuation value.

3. Control mode parameter CtrL

ON-OFF control mode and AI artificial intelligence control mode is available and can be selected through parameter CtrL for AI-508T series instrument.

CtrL=0 ON OFF control, suitable for the application which don't need high precision.

CtrL=1 AI artificial intelligence control, it is improved on the basis of PID control and fuzzy control, having more extensive adaptability to the process, and it is possible to get a good control for processes rapidly changed or having significant reaction lag time. This is the default setting value, and auto tuning can be started up from front panel on this setting.

CtrL=2 Starting up auto tuning, points for attention have been described in preceding text. The function is the same as starting auto tuning from front panel. After auto tuning is done, once setting parameter CtrL to 2 can start up more auto tuning.

CtrL=3 AI artificial intelligence control, this configuration is automatically set after auto tuning is done. At this setting, starting auto tuning from front panel is inh9ibited to prevent error operation from starting auto tuning repeatedly.

CtrL=4 Comparing with the control mode of CtrL=3, these 2 setting have then same control effect. In the application of rapidly changed temperature (changes by more than 200 /second). After auto tuning is done, Ctrl is set to 3 or 4 automatically.

4. Output Period CtI

Parameter CtI can be set between 0.5 to 125 seconds. It represent the calculate speed of the instrument. When CtI increased, proportion function will be increased and derivative function will be decreased.

In case of time proportional output mode, if SSR (Solid state relay)or SCR is used as executive bodies, then control period can be set smaller (generally 0.5 through 2 seconds) to improve control precision. If relay contact output is used, then parameter "Ctl" should be set to be larger than or equal 4 seconds generally, because a small value set will decrease service life of mechanical contacts. A large value set will increase service life of relay, but will decrease control precision, so select a value to satisfy both sides.

5. Input Specification Parameter Sn

AI series instrument is available with varied input function. Different input type such as thermocouple, RTD can be selected in the same instrument through parameter setting. Automatic non-linear calibration of nigh precision for thermocouple and RTD is available in the instrument, with measurement input accuracy less than 0.5%.F.S.

Sn	Input spec.	Sn	Input spec.
0	K	1	S
2	Spare	3	Spare
4	E	5	J
6	Spare	7	N
26	Spare	21	Pt100

6. Input shift parameter Sc

Parameter Sc is used to make input shift to compensate the error produced by sensor or input signal itself.

For thermocouple input, parameter Sc is used to correct reference junction compensation error.

The instrument itself will not produce error after a long time used, because the technology of digital calibration is used in the instrument to substitute potentiometer of bad stability, and the function of automatic zero modulation will guarantee no zero drift produced in the instrument.

Parameter "Sc" is used to make input shift to compensate the error produced by measurement. For example, provided input signal keep unchanged, if when parameter "Sc" is set to 0.0 , the temperature measurement of the instrument is 500.0 , then when parameter "Sc" is set to 10.0 , the temperature measurement display will be 510.0 .

Instruments are all calibrated before delivering, and so the default value of parameter "Sc" is zero. Only adjust this parameter when recalibration of measurement is necessary.

7. Input digital filter parameter dL

There is one intermediate-value filter system and one second order integral digital filter system in AI series instrument, among which intermediate value filter takes intermediate value among three continuous values, and second order digital filter has the same effect as resistance-capacity integral filter. If measurement input fluctuates due to noise, then digital filter can be used to smooth the input. Parameter "dL" may be configured in the range of 0 to 20, among which, 0 means no filter, 1 means intermediate-value filter and 2—20 means that intermediate-value filter and second order integral filter can be selected simultaneously.

The multiples of second integral filter is the square parameter "dL", and can be up to hundreds times. When a large value is set, the measurement input is stabilized but the responsibility at the time is deteriorated. Generally if great interference exist, then you can increase parameter "dL" gradually to make momentary fluctuation of measurement input less than 2 to 5 values. I f the instrument is being tested at laboratory, then parameter "dL" should be sit to 0 or 1 to short the time responsibility.

8. Privilege for parameter set Loc

**Loc=0,** modification of field parameters and setpoint is allowed.

Loc=1, allowed to display and view parameters, and to set setpoint. But the modification of parameters is not allowed.

Loc=2, allowed to display and view parameters, but the modification of parameters and
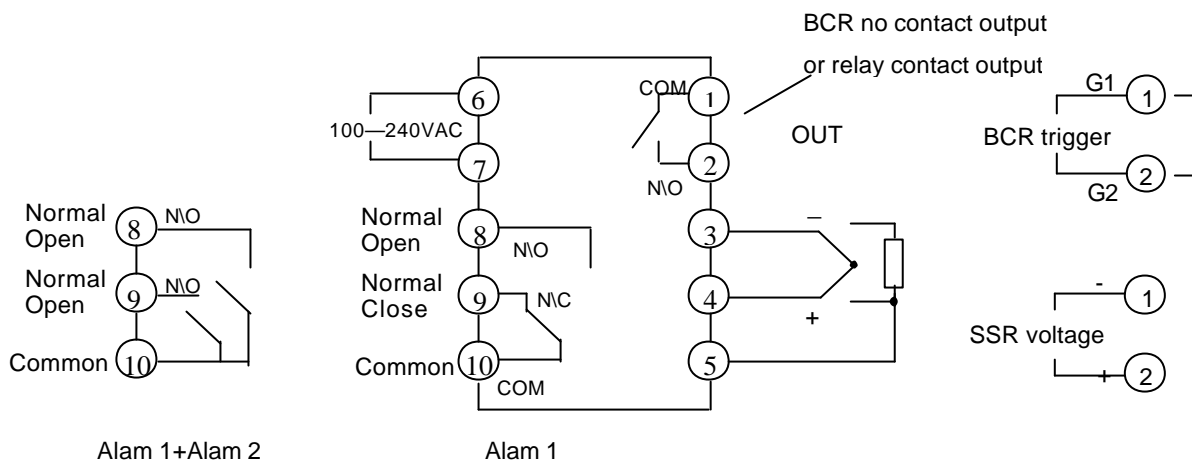
setpoint is not allowed.

Loc=808, configuration of all parameters and setpoint is allowed.

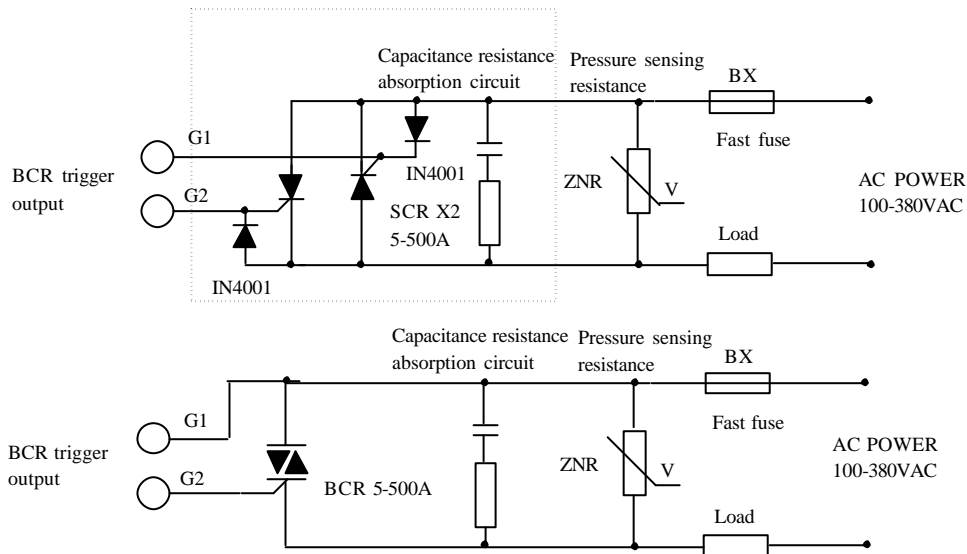# . INSTRUMENT INSTALLATION AND WIRING
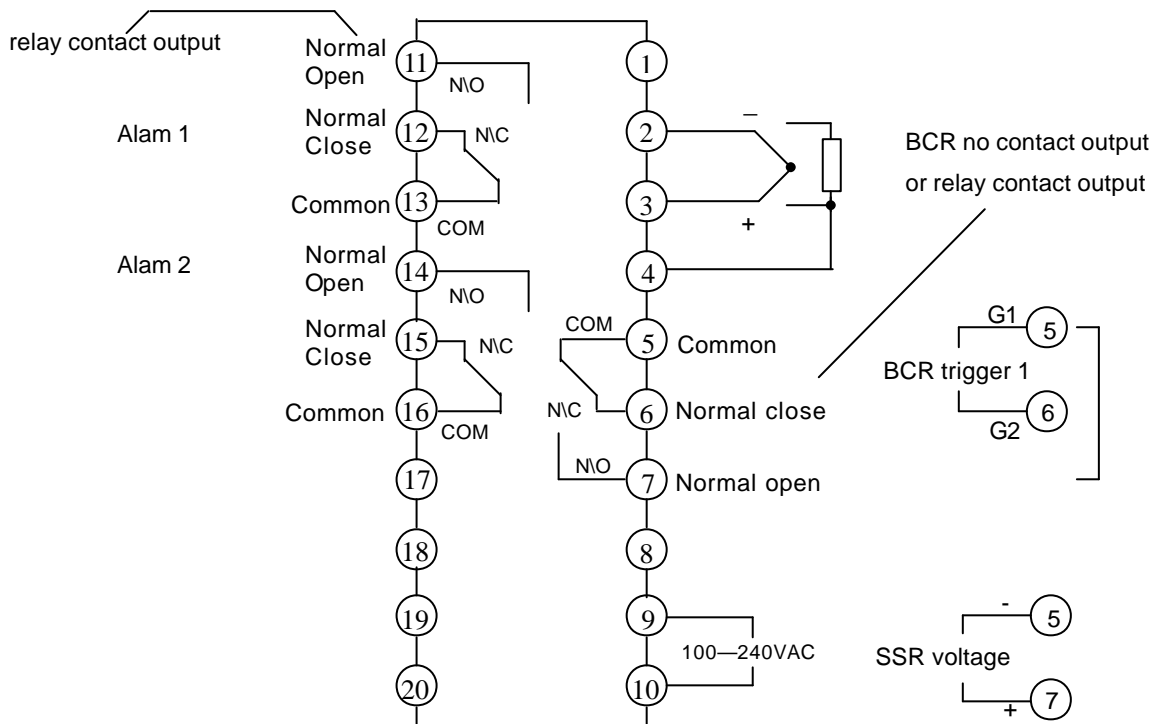
96x96mm, 48x96mm, Front panel specification and wiring diagram

Note: This diagram suits for upright instrument with front panel type A and E. For front panel type F, just rotate 90 degree anti-clockwise.

48x48mm, Front panel specification and wiring diagram

Writing *diagram* for BCR trigger output

Note:

1 *Select pressure-sensing resistance to protect BCR on the basis of the voltage and current of load. Capacitance resistance absorption circuit is needed under inductive load or phaseshift trigger.*

2 *BRC power module is recommended, there are two BCR in one module as showed in the broken line.*