AI-719/719P High Precision Intelligent Industrial Controller

Operating Instruction

(V8.2)

CONTENTS

1. SUMMARY

1.1 Main Features

- Input as thermocouple, thermal resistance, voltage and current can be freely selected, while expanded input and user-defined nonlinear calibration form are permitted, with measuring accuracy of 0.1%
- Advanced AI intelligent PID algorithm eliminates over-adjustment and provids auto tuning (AT) function and brand new fine control mode
- Advanced modular construction and directly three-phase and three-wire phase-shift trigger are adopted, which can widely meet the demands of various electrical heating applications, with quick delivery and convenient maintenance
- Integrating the design of energy saving and environmental protection, high quality components are used to lower power consumption and lower temperature offset and to effectively save energy for customers
- With sampling frequency of 12.5 times per second and the minimum control cycle of 0.24s, control accuracy on fast changing subject can be maintained
- Personalized operation method which is easy to learn and use
- User-defined operation authorization and interface
- Universal 100-240VAC input range for switching power supply or 24VDC power supply. Different panels and dimensions are available
- Emissions of and immunity to electromagnetic interference meets the electromagnetic compatibility (EMC) under severe industrial conditions.

POINTS FOR ATTENTION

● This *Operating Instruction* introduces AI-719/719P intelligent PID temperature controller of V8.2, in which part of functions may not suit other instruments. The model and software version of the instrument will be shown on the display when powered on. Users shall pay attention to the difference among various models and instrument versions. Please read the *Operating Instruction* carefully, correctly use and fully play the function of the instrument.

Before the use of AI instrument, please specify appropriate input and output .The instrument should only be put into use with proper parameters.

1.2 Ordering Code Definition

The hardware of AI series instrument adopts advanced modular design. AI-719/719P instrument can install at most 5 modules, i.e. output, alarm, communication and other modules on demand. Modules can be bought along with the instrument or bought separately for free combination. The input modes of the instrument can be freely set as thermocouple, thermal resistance and linear voltage (current). AI-719/719P instrument totally has 9parts, for instance:

AI – 719	A	N	X3	L5	N	S4	–	24VDC	–	(F2)
①	②	③	④	⑤	⑥	⑦		⑧		⑨

It shows that the model of this instrument is AI-719, front panel dimension is A size(96×96mm), no module is installed in MIO slot, X3 linear current output module is installed in OUTP (main output), ALM (alarm) is L5 (dual relay contact output module), no module is installed in AUX (auxiliary output), S4 (RS485 communication interface module) is installed at COMM , and the power supply of the instrument is 24VDC, an extended input type (F2 radiation type pyrometer) is available

The following is the meanings of the 9 parts:

① Shows the model of the instrument

AI-719 high precision AI intelligent regulator with measurement accuracy 0.1%F.S. It adopts artificial intelligent control technology, and has the functions of control, alarm, retransmission and communication.

AI-719P Base on AI-719 added 50 segments programmable functions.

② Shows the front panel dimension

A(A2) Front panel 96×96mm(width×height), cut out 92×92mm, depth behind mounting surface 100mm.
A2 has a light bar with 25 segments and 4 levels of luminosity.

B Front panel 160×80mm(width×height), cut out 152×76mm, depth behind mounting surface 100mm.

C(C3) Front panel 80×160mm(width×height), cut out 76×152mm, depth behind mounting surface 100mm. C3 has an additional light bar with 50 segments and 2 levels of luminosity.

D Front panel 72×72mm(width×height), cut out 68×68mm, depth behind mounting surface 95mm

D6 Front panel 48×48mm(width×height), cut out 45×45mm, depth behind mounting surface 95mm`

E(E2) Front panel 48×96mm(width×height), cut out 45×92mm, depth behind mounting surface 100mm
E2 has a light bar with 25 segments and 4 levels of luminosity.

E5 Rail mounted 48×96×110mm(width×height×depth), installed on DIN trail and programmed by external display E8.

F Front panel 96×48mm(width×height), cut out 92×45mm, depth behind mounting surface 100mm

③ Shows the module type of multiple functions I/O (MIO). Selectable modules are I4, I5, K3 and V, etc. N means no module been installed.

④ Shows the module type of main output (OUTP). Selectable modules are L1,L2,L4,W1,W2,G,K1,K3,K5,K6,X3,X5 etc.

⑤ Shows the module type of alarm (ALM). Selectable modules are L1, L2, L4, L5, W1, W2, G, etc.

⑥ Shows the module type of auxiliary output (AUX). Selectable modules are L1, L2, L4, L5, W1, W2, G, K1, X3, X5, etc.

⑦ Shows the module type of communication (COMM). Selectable modules are S, S4, V, etc.

⑧ Shows the power supply of the instrument. If left blank, the power of the instrument is 100~240VAC. Added "24VDC" means the power supply of 20~32V DC or AC power

⑨ Shows the optional extended graduation spec (If none, leave it blank). AI-719 series instruments support many input types including popular thermocouples, RTDs, linear voltage, current and resistance inputs. If needed, an additional specification not mentioned in input type selection (InP) table can be extended.

Note 1: The instrument applies the technology of automatic zero and digital calibration, and is free of maintenance. If the error exceeds certain range, generally, cleaning and drying the inside of the instrument can fix it. If not, send the instrument back to the factory to examine and repair.

Note 2: Customer will be provided 5 years warranty with free maintenance to the instrument. If the instrument must be returned to the factory for maintenance, the failure phenomena and reasons must be clarified, so as to ensure correct and complete recovery.

1.3 Modules

1.3.1 Slots of modules

AI-719/719P series instruments have five slots for modules to be installed (D dimension instruments have 3 slots: OUTP, AUX and COMM/AL1; D2/D6 dimension instruments have 2 slots: OUTP and COMM/AUX). By installing different modules, the controller can meet the requirements of different functions and output types.

- **Multiple function Input / Output (MIO):**
  Can input signal from 2-wire transmitter or 4-20mA signal by installing I4 (current input) module and I4 module can provide 24VDC to transmitter. If a I5 (on-off signal input) module is installed, the instrument can switch between set points SV1 and SV2 by an external switch. Cooperating with OUTP and installing a K3/k9 module can realize three-phase thyristor zero cross triggeringoutput or phase-shifting output .

- **Main output (OUTP):**
  Commonly used as control output such as on-off control, standard PID control, and AI PID control. It can be used as retransmission output of process value (PV) or set point (SV). Installing L1 or L4 modular can realize relay contact output; installing X3 or X5 module can realize 0-20mA/4-20mA/0-10mA linear current output; installing G module can realize SSR voltage output; installing W1 or W2 module can implement TRIAC no contact switch output;installing k51 module can realize thyristor phase-shifting output ;installing L5、W5、G5 module can implement valve direct and inverse rotation

- **Alarm (ALM):**
  Commonly used as alarm output. Support 1 normally open + normally close relay output (AL1) by installing L1 or L2 module or 2 normally open relay outputs (AL1+AL2) by installing L5 module.

- **Auxiliary output (AUX):** In a heating/refrigerating dual output system, module X3, X5, L1, L4, G, W1, W2 can be installed for the second control output. It can also output alarm by installing L1, L2 or L5 module, or be used for communicating with computer by installing R module (RS232C interface).
- **Communication Interface (COMM):** Module S or S4 can be installed in for communicating with computer (RS485 communication interface), and it can also be used as power supply for external sensor when equipped with a voltage output module (except for front panel D2 size).

1.3.2 Commonly used modules:

N No module installed (or null)

L0 Normally open + normally close relay output module (large volume, capacity: 30VDC/2A, 250VAC/2A)

L1 Normally open + normally close relay output module (large volume, capacity: 30VDC/2A, 250VAC/2A)

L2 Normally open + normally close relay output module (small volume, capacity: 30VDC/1A, 250VAC/1A)

L4 Large capacity normally open relay output module (small volume, Capacity: 30VDC/2A, 250VAC/2A)

L5 Dual normally open relay output module (Capacity: 30VDC/2A, 250VAC/2A)

W1/W2 TRIAC no contact normally open (W2 is normally close) discrete output module (Capacity: 100-240VAC/0.2A)

G SSR voltage output module (DC12V/30mA)

G5 Dual SSR voltage driver (DC12V/30mA

K1 Single-phase thyristor zero crossing trigger output module (can trigger one loop of a TRIAC or a pair of inverse parallel SCR with current of 5-500A)

K3 Three-phase thyristor zero crossing trigger output module (can trigger 3-phase circuit; each loop can trigger TRIAC or a pair of inverse parallel SCR with current of 5-500A)

K51/K61 Single-phase 220VAC/380VAC thyristor phase-shift trigger output module (can trigger one loop of TRIAC or a pair of inverse parallel SCR with current of 5-500A), only 50Hz power

X3/X5 Linear current output module (continuous 0-22mA output, selectable in the range of 0-10mA, 4-20mA etc.). X5 is equipped with photoelectric isolated power supply.

S/S4 RS485 communication interface module. S4 is equipped with photoelectric isolated power supply.

R RS232 communication interface module.

I5 Switch / frequency signal input interface for inputting external switch or frequency signal, has a 12VDC power supply for external transducer.

I4 4-20mA/0-20mA analogue input interface, has a 24VDC/24mA power supply for a transmitter.

V24/V12/V10/U5

Isolated 24V/12V/10V/5V DC voltage output with maximum current of 50mA, can supply power for transmitter.

1.3.3 Installation and replacement of modules

Before the instrument delivery, module installation is done on request, with corresponding parameter set correctly. Users can replace or install modules by themselves when needed. When replacing a module, you should pull the controller out of the housing at first, insert a small flat-tip screwdriver into the opening between the original module and the slot on motherboard to remove the old module, and then install a new module. Changing module type needs to modify the corresponding parameters.

1.3.4 Electric isolation of the modules

There are a group of 24V and a group 12V power supply built in the instrument and isolated to the main circuit. The 24V power commonly supplies voltage output module, such as V24/V12/V10/V5, I2 and I4. The 12V power is commonly supplies output or communication module. Generally, the relay contact output and TRIAC no contact discrete output are self

insulated from the other circuit, no matter whether other modules are installed or not. SSR output voltage does not need to be insulated from input circuit, because SSR itself has isolation function. Therefore, only the electric isolation between the communication interface and the current output should be considered. Those modules, for example, S (RS485 communication interface), R (RS232 communication interface) and X3 (linear current output), all need the 12V power supply. If more than one of the above modules are installed, in order to be electric isolated, only one of them can be module without electric isolation, the other modules should be S4 or X5, which has its own isolated power supply. For example, if an X3 module is installed in OUTP (main output) slot, for isolate purpose, COMM slot should be install S4 or X5.

1.3.5 Further descriptions about module applications

- **Voltage output module:** The voltage output modules like V24, V12, V10 or V5 are often used for supplying power for external transducer or feedback resistance of transmitter. These modules can be installed in any slot. To standardize the wiring, it is recommended to be installed in the first idle slot in the order of MIO, AUX, and COMM.

- **No contact switch module:** W1 and W2 are new types of no contact switch module which apply the advanced technology of "burn proof" and zero crossing conduction. It can replace the relay contact switch. Compared to the relay contact output module, W1 and W2 have longer life and lower interference. They can be largely lower the interference spark of the equipment, and greatly improve the stability and reliability of the system. Protection elements are series wound to the output terminals, so it can control continuous current up to 0.2A with maximum allowed instantaneous current 2A. Since the driver element is TRIAC, it is suitable for controlling 100-240VAC (not for DC power) with contactor which current below 80A. For the current larger than 80A, an intermediate relay is needed.

- **Relay switch module:** The relay modules are widely used in industrial control. However, they are the only modules with life time limit and volume limit and have much electromagnetic interference. It is important to choose a suitable

relay module. To control equipments with 100~220VAC supply, such as contactor and electromagnetic valve, W1 module is recommended. To control DC or AC above 50VAC, users can only use relay module. L2 module is small, and both its normal open and normal close terminals have the function of spark absorption, but the capacity is small. It is suitable for alarm output. L1 and L5 have bigger volume and capacity. In the 48mm dimension instrument (for example, D4, E, F and E5), only one of L1or L5 can be installed. L5 has dual output, can be used to support two loops of alarm, for example, AL1+AL2. If you don't like mechanical switch, you can choose G5 (dual SSR voltage driver) and connect with external SSR instead.

1.4 Technical specifications

- **Input specifications (universal input):**

  Thermocouple: K, S, R, E, J, T, B, N, WRe3-WRe25,

  WRe5-WRe26, etc. Thermal resistance: Cu50, Pt100

  Linear voltage: 0~5V, 1~5V, 0~1V, 0~100mV, 0~20mV, -5~+5V, -1V~+1V, -20mV~+20mV, etc.

  Linear current (it is required to be connected to shunt resistors): 0~10mA, 0~20mA, 4~20mA, etc.

  Expanded specifications: Users can add an extra input specification on the basis of the above specifications.

- **Measuring range:**

  K (-50~+1300℃), S (-50~+1700℃), R (-50~+1700℃), T (-200~+350℃), E (0~800℃), J (0~1000℃)

  B (200~1800℃), N (0~1300℃), WRe3-WRe25 (0~2300℃), WRe5-WRe26 (0~2300℃)

  Cu50 (-50~+150℃), Pt100 (-200~+800℃), Pt100 (-100.00~+300.00℃)

  Linear input: -9990~+30000 user-defined

- **Measuring accuracy:** 0.1 (note: thermocouple should be connected to Cu50 copper resistor for compensation, while ±1℃

  compensation error will be extra added during internal compensation.)

- **Measuring temperature drift:** ≤ 35PPm/℃ (note: thermocouple should be connected to Cu50 copper resistor for compensation,

  while temperature drift error will be extra added during internal compensation.)

● **Sampling period:** 12.5 times per second; when setting digital filtering parameter FILt=0, the response time displayed is ≤ 0.5s.

● **Control cycle:** 0.24-300.0s adjustable

Control modes:
Position control mode (control hysteresis adjustable)
AI intelligent control, including fuzzy logic PID regulating and parameter self-tuning functions' advanced control algorithm

● Output specification (modularization):
Relay output (NO+NC): 250VAC/1A and 30VDC/1A
TRIAC no contact discrete output (NO or NC): 100～240VAC/0.2A (continuous), 2A (20mS instantaneous, repeat period≥5s)
SSR Voltage output: 12VDC/30mA (used to drive SSR).
Thyristor zero crossing trigger output: Can trigger TRIAC of 5～500A, a pair of inverse paralleled SCRs or SCR power module.
Linear current output: 0～20mA, 4～20mA can scaling by user. (Output voltage : X3≥10.5V; X5≥7V maximum load resistor 500ohm, output precision 0.2%FS)

● **Electromagnetic compatibility:** IEC61000-4-4 (electrical fast transient) ±4KV/5KHz, IEC61000-4-5 (surge) 4KV and under

10V/m high-frequency electromagnetic interference, no system error or I/O malfunction will occur. The fluctuation of the measured values will not exceed ±5% of the range.

- **Isolation withstand voltage:** among the power terminals, the relay contact and the signal terminals: ≥2300V; among isolated weak electrical signal terminals: ≥600V
- **Power supply:** 100~240VAC, -15%, +10% / 50~60Hz; 120-240VDC; or 24VDC/AC, -15%, +10%
- **Power consumption:** ≤0.5W (without any output or alarm actions); the maximum power consumption ≤4W
- **Operating environment:** Temperature: -10~60℃; Humidity: ≤90%RH
- **Panel size:** 96×96mm, 160×80mm, 80×160mm, 48×96mm, 96×48mm,72×72mm
- **Opening size:** 92×92mm, 152×76mm, 76×152mm, 45×92mm, 92×45mm,68×68mm
- **Insertion depth:** ≤100mm

1.5 Energy-saving and environment-friendly design

AI-719/719P adopts energy-saving and environment-friendly design, which is reflected in extremely low temperature drift and its own extremely low power consumption. High-quality key components, which pass pair test, with low temperature drift is used.

The typical temperature drift on the instrument is less than 25PPm/℃. Extra costs on those components are worthwhile to meet the energy-saving target. We try hard to lower the instrument power consumption, by choosing bright-lit LED displays at the same driving current of usual LED. Despite the cost is almost doubled, reduced power consumption, reliability and performance are lastly improved

Compared with conventional temperature controller, the instrument with low temperature drift has less change in the measured temperature under the influence of ambient temperature, which can provide more stable product quality and less energy consumption. Thanks to low temperature drift, high precision instruments are more energy-saving compared with low precision ones. For instance, provided the sintering temperature range of a ceramic material is 1,000-1,010℃, because the temperature drift of an conventional instrument in the market is about ±5℃ (caused by ambient temperature difference in winter, summer, morning and evening), normal production can only be maintained under different ambient temperatures when the instrument is set at 1,005℃ (range of temperature: 1,000-1,010℃), but the temperature drift of AI-719/719P instrument can be reduced to be within ±1℃, for which stable production can be realized when the temperature is set at 1,001℃ (range of temperature: 1,000-1,002℃), as a result, the average temperature of the furnace can be reduced by 4℃. The lower the average temperature of the industrial furnace has, the less the power consumption will be. 0.4%~0.6% of energy will be saved only relying on reduced temperature shift instrument. And the product quality will become more stable, color aberration will become lower, energy consumption will be further

reduced and great contribution will be made to environmental protection. The same result can be obtained from a 0.05- level precision instruments. To realize energy saving and improve product quality, Yudian will adopt components with higher precision and lower temperature drift with prices unchanged, so as to improve the measuring accuracy of AI-518/518P/519/519P series instrument from 0.3% to 0.25%, AI-708/708P series from 0.2% to 0.15%, AI-719/719P series (upgraded AI-808/808P) to 0.1%.

1.6 Rear Terminal Layout and Wiring

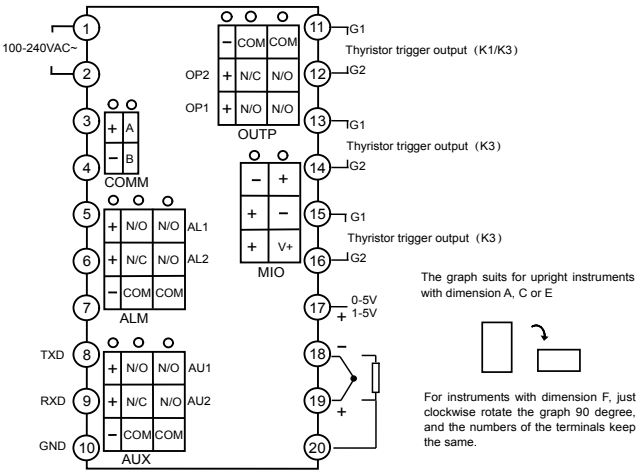
Wiring graph of instruments

Note:

①Linear voltage <1V input to terminal 19, 18 0~5V and 1~5V to terminal 17,18

②Linear current 4~20mA input can be transformed into 1~5V voltage by 250Ω , then input through 17,18

③Thermocouples with different graduation should use corresponding thermocouple compensating wires. If internal automatic compensation mode is taken place, the compensating wire shall be directly connected to the wiring terminals of the instrument back, no conventional wires should be used to avoid measuring errors.

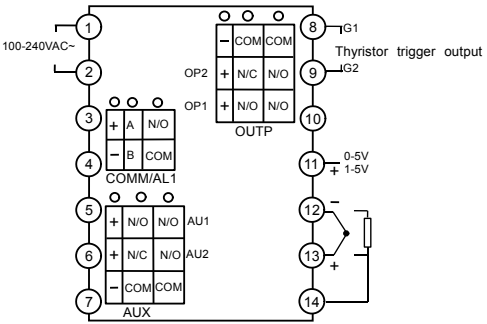


Wiring graph of D dimension instruments (72×72mm)

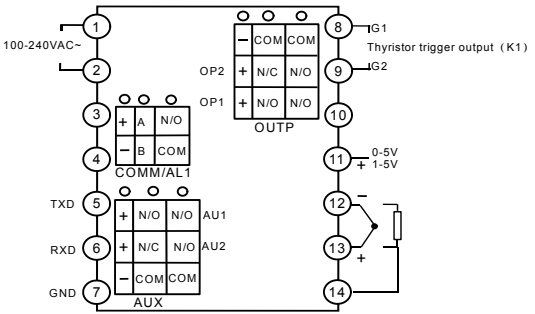
Note 1: Linear voltage signal of range below 1V should be inputted from terminals 13 and 12, and signal of 0～5V and 1～5V should be inputted from terminals 11 and 12.

Note 2: 4～20mA linear current signal can be converted to 1～5V voltage signal by connecting a 250 ohm resistor and inputted from terminals 11 and 12.

Note 3: S or S4 module can be installed in COMM slot for communication. If relay, TRIAC no contact switch, or SSR drive voltage output module is installed in COMM, it can be used as alarm output. If I2 module is installed in COMM and parameter "bAud" is set to 1, SV1 and SV2 can be switching by connecting a switch between terminals 3 and 4.

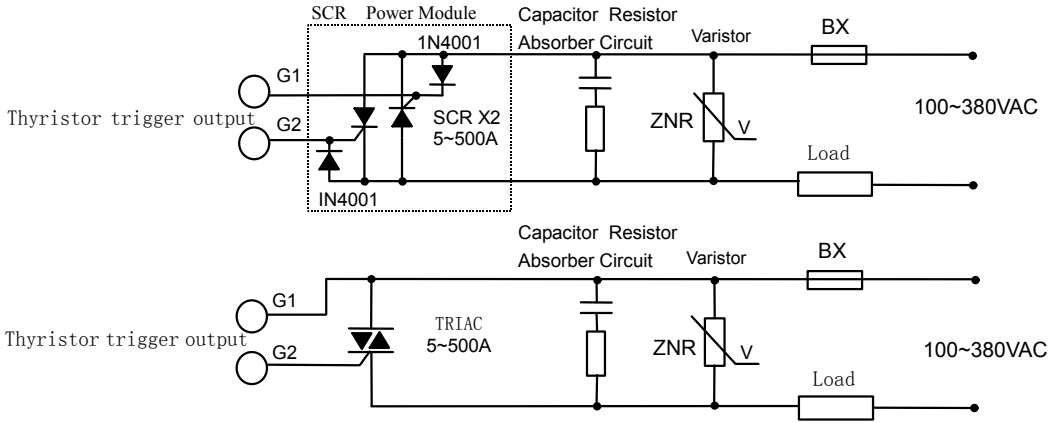


Wiring graph of instruments with D6 dimension as below:

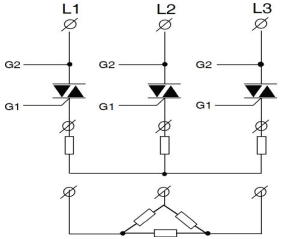


Note 1: 0～5V or 1～5V linear voltage should be inputted from terminals 9+ and 10- . However below 500mV should be inputted from terminals 11+ and 10- .4～20mA can be converted to 1～5V by connecting a 250 ohm resistor, then be inputted from terminals 9+ and 10-

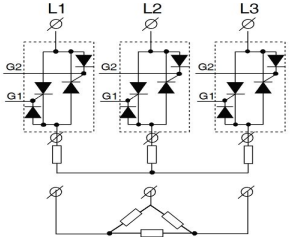
Note 2: For COMM/AUX slot, if L5 module is installed, it has two alarms; if SL module is installed ,it has one alarm and communication function;if S/S4 module is installed,it only has communication function.



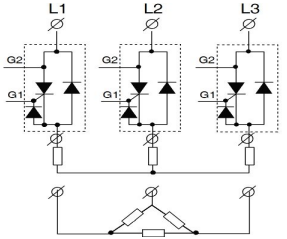
Note 1: According to the voltage and current of load, choose a suitable varistor to protect the thyristor. A resistor-capacitor circuit (RC circuit) is needed for inductance load or phase-shift trigger output.
Note 2: SCR power module is recommended. A power module includes two SCRs, is similar to the above dashed square.
Note 3: K6 TRAIC trigger module the power is 380VAC ; K5 TRAIC trigger module only support 200～240VAC and 50Hz power.



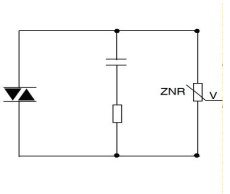
Three-phase and three- wire star and triangle wiring diagram (two-way thyristor)



Three-phase and three-wire fully-controlled power module star and triangle wiring diagram (single-phase thyristor antiparallel)



Three-phase and three-wire half-controlled power module star and triangle wiring diagram (single-phase thyristor + diode)



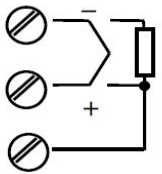
Note: The two ends of each thyristor or power module must be in parallel with the resistance and capacitance absorption components and the piezoresistor at the same time, otherwise it may lead to grid peak pulse interface, cause abnormal trigger, and even damage the thyristor

Note 1: Select the piezoresistor in accordance with the load voltage and current to protect the thyristor. If there is inductive load or phase-shift trigger, resistance and capacitance absorption must be added.
Note 2: It is recommended to use the thyristor power module. A power module includes 2 one-way thyristor, as shown in the dotted part of the figure.
Note 3: The AC range is 380VAC, and the power frequency must be 50Hz.
Note 4: The two trigger lines have polarity, so please do not get polarity reversed.

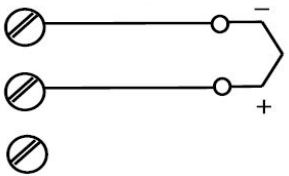
Choosing thermocouple cold junction compensation mode based on wire connection

When using thermocouple as the input, cold junction should be applied for temperature compensation based on the thermocouple temperature measuring principles. AI instrument can automatically compensate cold junction referencing the temperature around the wiring terminals. Due to measuring components' errors, instrument's inherent heating and other heat sources nearby, the deviation of automatic compensation modes is comparatively large, for which the worst may exceed 2℃. So if higher accuracy is required, an external junction box can be used. Put Cu50 copper resistor (to be purchased separately) and thermocouple cold junction together, and keep away from the heat sources, thus the measuring inconformity caused by compensation may be less than 0.3℃. Because the inherent errors of Cu50 copper resistor may cause certain errors at room temperature, it can be modified with "Scb" parameter. Change the externally connected copper resistor into precision fixed resistance, which may achieve constant temperature bath compensation. For instance, connect it to constant 60Ω resistor, check the reference table of Cu50 and find the compensation temperature of 46.6℃. At this moment, put the thermocouple cold junction into the constant temperature bath for accurate compensation at the temperature of 46.6℃., its compensation accuracy will be better than that of copper resistor. If the externally connected resistance is changed into short circuit, ice-point compensation may be archieved. At this moment, it is required to place the thermocouple cold junction (the joints of the thermocouple or compensation wires and conventional wires)

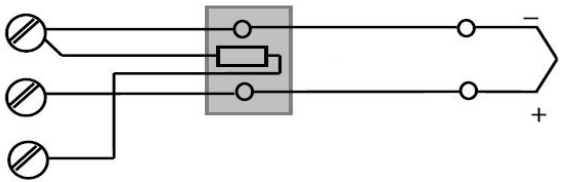
into the ice-water mixture (0℃), its compensation accuracy may reach above 0.1℃. There are two compensation modes' wiring
diagrams as follows:



Instrument's corresponding wiring diagram



(1) Internal automatic compensation mode (Compensating wire shall be directly connected to the connection terminals)

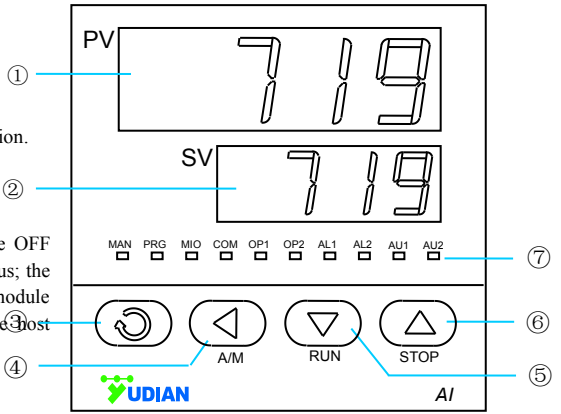


(2) Externally connected to copper resistor automatic compensation mode (Thermocouple cold end terminal box had better keep away from heat sources)

2. Display and operation

2.1 Instruction of panel

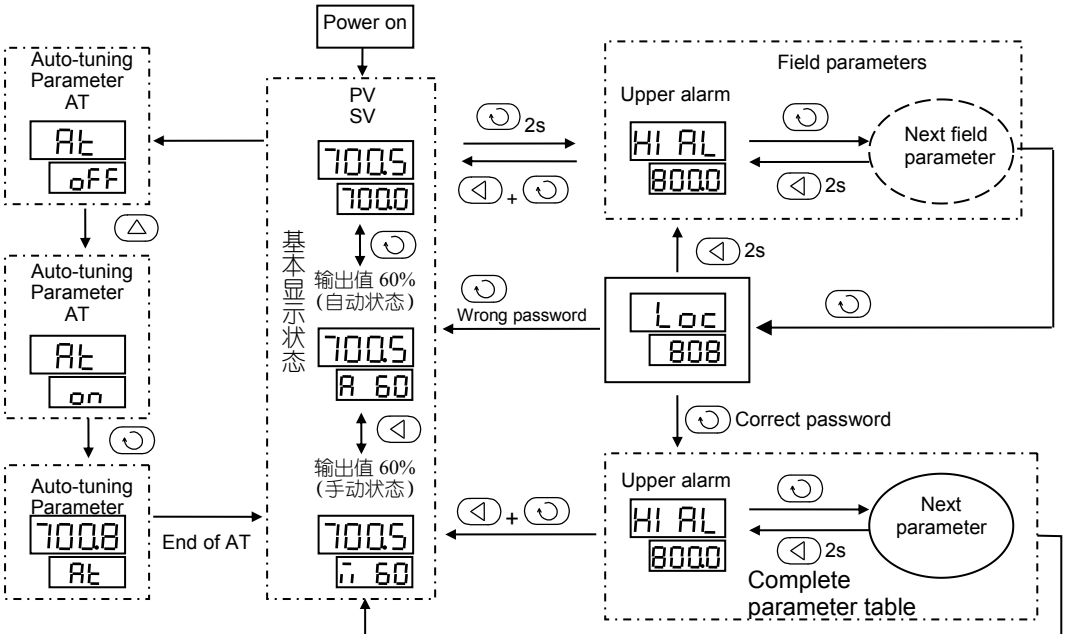
① Upper display window: Displays PV, parameter code, etc.
② Lower display window: Displays SV, parameter value, or alarm message
③ Setup key: For accessing parameter table and conforming parameter modification.
④ Data shift key, start auto tuning and auto/manual control switch.
⑤ Data decrease key, and also run switch
⑥ Data increase key, and also stop key
⑦ 10 LED indicators: the MAN light indicates automatic control mode in the OFF state and manual output mode in the ON state; the PRG light is Running Status; the MIO, OP1, OP2, AL1, AL2, AU1 and AU2 respectively correspond to the module input/output actions; and the COM light indicates communication with the host computer in the ON state.



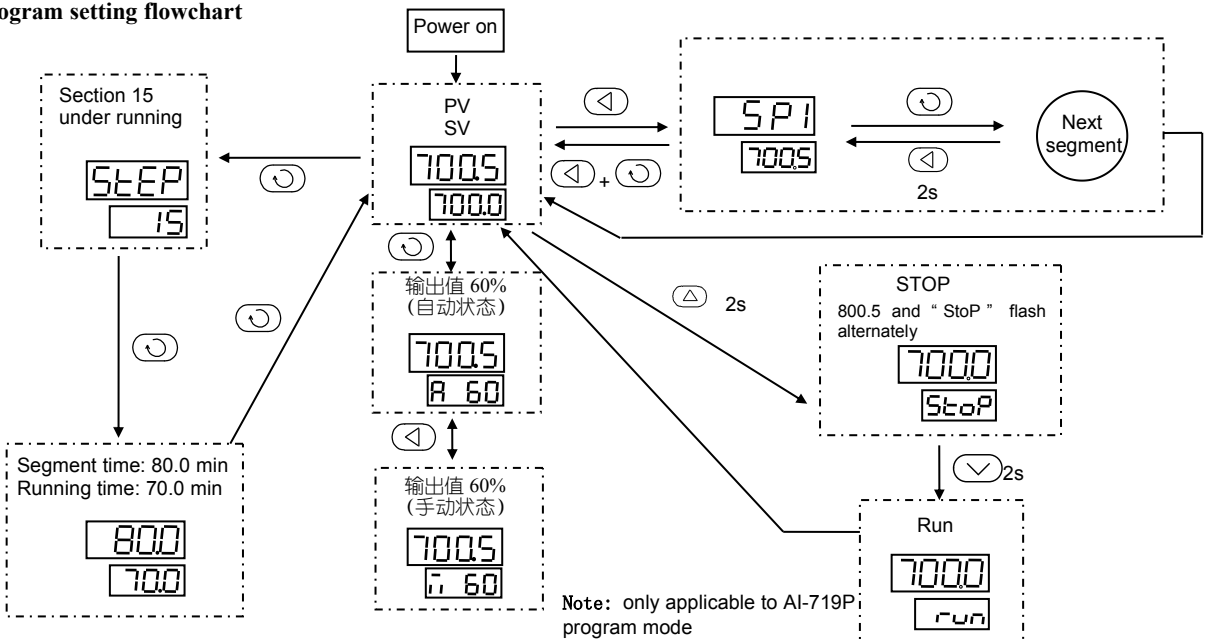
The instrument enters initial status once power on. Upper and lower display respectively show the measured value (PV) and the set value (SV).

The display may also alternately show status or warnings
“orAL” means that the input measured signals out of the range;
“HIAL”, “LoAL”, “HdAL” or “LdAL” respectively represents the High Limit Alarm, Low Limit Alarm, High deviation alarm , or Low deviation alarm ;
“StoP” represents the instrument is in being STOP;
“HoLD” represents the instrument is in being HOLD; (Only AI-719P)
“rdy” represents it is in READY status” (Only AI-719P)

2.2 Parameter setting flowchart



2.3 Program setting flowchart



2.4 Operational Method

2.4.1 Parameter Setting

In basic display status, press (↻) and hold for about 2 seconds can access Field Parameter Table. Press (↻) can go to the next parameter; press (<)、(∨) or (∧) can modify a parameter. Press and hold (<) can return to the previous parameter. Press (<) (don't release) and then press (↻) key simultaneously can escape from the parameter table. The instrument will escape auomatically from the parameter table if no key is pressed within 25 seconds, and the change of the last parameter will not be saved.

In Field Parameter Table,press (↻) till the last field parameter Loc appears. Setting Loc=808 and then press (↻) can (∧) access System Parameter Table.

- **Set Value Setting**

  In basal display status, if the parameter lock "Loc" isn't locked, we can set setpoint (SV) by pressing (<) first、then can press (<),(∨) or (∧) to adjust value. 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 decreasing or inscreasing value get quick. The range of setpoint is between the parameter SPL and SPH. The default range is 0~400.

- **Program segment setting:**

  Press the (<) key once and release in the display status, the instrument will be in the setup program status. The set point of the current program StEP will be displayed. Pressing (<)、(∨) or (∧) can modify the value.

  Pressing (↻) can go to next parameter. The program parameters will be displayed in the sequence of setpoint1, time1, setpoint2, time2. Pressing and holding (<) for about 2 seconds will return to the previous parameter. Program step can modify anytime even the program still in running.

Run / Hold only (for AI-719P)

In basic display status, if the program is in stoP status ("StoP" is alternately displayed on the lower window), press and hold the (∨) key for about 2 seconds until the lower display window displays the "Run" symbol, the instrument then will start the program.

If parameter "PAF" set F=1, user can hold the (∨) key for about 2 seconds, instrument will changes to hold status and lower display window displays the "HoLd" symbol. If parameter "PAF" set F=0, "Hold" status only can activate by parameter setting (Srun).

At Hold status, the program is still executing, and the process value is controlled same as setpoint, but the timer stop working, and the running time and setpoint remains. At Hold status, press and hold the (∨) key for about 2 seconds until the lower display window displays the "Run" symbol, the instrument will back to run program

Stop

Press and hold the (∧) key for about 2 seconds in the basic display status, until the lower display window displays the "stoP" symbol, means the stoP operation is executed now, when program stopped, timer will be reset and stop. This operation forces the instrument to stop running, meanwhile, the StEP number will reset to 1, and control output is also stopped

Auto Tuning

When AI control method is chosen (CtrL=APId / nPId), 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 escape from auto tuning status, press and hold the (<) key 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. (P.S. If parameter "SPr" activate and the heating was running, then will stop the "At" until completed the heat up process.) If the controller was applied on heat/cooling duel output system, PID parameter need separate two group to

process auto tuning. When the controller was cooling control from AUX, this time can enable auto tuning to obtain P2, I2, d2.

Note 1: At AI-719P, when auto tuning was running, the program timer will stop until tuning finish.

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. 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, smaller value of CHYS, will get higher precision of auto tuning result. Too large value of CHYS, will made the controller out of control, so, CHYS is recommended to be 2.0.

Note 4: AI series instrument has the function of self-adaptation. It is able to learn the process while working. The control effect at the first run after auto tuning is probably not perfect, but excellent control result will be obtained after a period of time because of self-adaptation.

Manual auto-tuning: In the system difficult to control or in the applications in which some executive bodies such as control valve is used and therefore outputs are not allowed to be greatly changed, traditional auto tuning is not suitable. AI-719 series instruments have manual auto tuning mode. To do this, switch the instrument to manual mode. After manual control is basically stable, start up auto tuning at manual mode, and the output will be restricted in the range between +10% and -10% of the current manual output. This function can avoid great change of valve and improve the precise of auto-tuning.

Note: before manual auto-tuning, the manual output value should be limited in the range of 10% - 90%, otherwise optimal parameters can be obtained.

2.4.2 DIN guide installation type instrument

AI-719E5 and AI-719PE5 are DIN rail mounted. E5 series provides no display or keypad but it supports RS485 communication with a computer or touch screen to set the parameters and operate. E5 instrument can also connect an optional accessory E8 keypad (with display) to show and set the parameters. E8 supports hot plug, which is handheld and can also be installed on the DIN rail. E8 provides two-row 4-digit display, without LED indicator lamps. The LED indicator lamp of top of the E5 instrument will flash once during every signal sent between the instrument and computer. If the instrument cannot receive signals from the computer for 6s, the LED will flash (on and off at equal time intervals) at certain frequency. The meaning for lighting signal is explained as below.

Flashing slowly in cycle of 1.6 - No communication but the instrument works normally with no alarm.

Flashing quickly in cycle of 0.6s - No communication but there is warnings such as an alarm.

Flashing quickly in cycle of 0.3s - Out of range in input (such as broken thermocouple and thermal resistance RTD)
and other severe warnings
No flash for a long time - The instrument is out of power supply or damaged;
LED lamps ON continuously (above 8s) - The instrument is connected with power but it has been damaged.

3. Parameter

3.1 User-defined Parameter Table

AI-719/719P parameter table can program defined functions, which can be defined by users and protect important parameters from changed accidentally. We call those parameters required to be displayed or modified on site as "**field parameters**". Field parameter table is a subset of the complete parameter table and can be defined and modified by users, while the complete table must be entered by passwords. Parameter lock (Loc) offers several authorization levels to several parameters:

Loc=0 Able to modify field parameters and allow all shortcut operations, such as change of set value (SV) and steps value(time and temperature value in program steps);

Loc=1 Able to modify field parameters and use shortcut to change set values and step values, but not allowed to use shortcuts to perform program RUN/HOLD/STOP, set value control and auto-tuning.

Loc=2 Able to modify field parameters, but not allowed to use shortcuts such as changing set value, program steps and auto-tuning, Able to perform shortcuts of program RUN/HOLD/STOP and set value control

Loc=3 Able to modify field parameters, but not allowed for all shortcuts.

Loc=4~255 Not allowed to modify any parameters except for Loc itself. All shortcuts are disabled.

Set Loc= password (the password can be any number between 256 and 9999, and the default password is 808), and press (↻) to confirm to enter the display and modify the complete parameter table. Once entering the complete parameter table, except for the read-only parameters, all other parameters can be modified.

Parameters EP1~EP8 allow users to define 1~8 field parameters. If the number of field parameters required is less than eight, the first parameter not used shall be defined as nonE. For instance, the parameter table we need has three parameters HIAL, HdAL and At, the EP parameter can be set as follows: EP1=HIAL, EP2=HdAL, EP3=At and EP4=nonE

3.2 Complete Parameter Table

The complete parameter table can be divided into 8 parts including alarm, regulating control, input, output, and communication, system function, set value/program step, and field parameter.

Code	Name	Description	Setting Range
HIAL	High limit alarm	Alarm on when PV>HIAL Alarm off when PV<HIAL-AHYS, When the value set to Max. will disable this function Alarm output action can be defined by parameter AOP.	-9990～+32000 units
LoAL	Low limit alarm	Alarm on when PV<LoAL; Alarm off when PV>LoAL+AHYS When the value set to Min. will disable this function	
HdAL	Deviation high alarm	Alarm on when PV-SV>HdAL; Alarm off when PV-SV<HdAL-AHYS When the value set to Max. will disable this function	
LdAL	Deviation low alarm	Alarm on when PV-SV<LdAL; Alarm off when PV-SV>LdAL+AHYS When the value set to Min. will disable this function HdAL and LdAL can also be used as high limit and low limit alarms when needed. (Refer to the description of parameter AF)	
AHYS	Alarm hysteresis	Avoid frequent alarm on-off action because of the fluctuation of PV	0～2000 units
AdIS	Alarm display	oFF : Will not display alarm message in the lower display window when alarming; on : Alternately display alarm message in the lower display window when alarming.	oFF / on

<table>
<tr>
<td>AOP</td>
<td>Alarm output allocation</td>
<td>
<table>
<tr><th>Alarm / Output to</th><th>LdAL (x 1000)</th><th>HdAL (x100)</th><th>LoAL (x10)</th><th>HIAL (x1)</th></tr>
<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>
</table>
Example:
AOP = 3 3 0 1
LdAL HdAL LoAL HIAL
It shows that HdAL and LdAL are sent to AU1, LoAL has no output, HIAL is sent to AL1.
Note 1: When AUX is used as auxiliary output in bidirectional (heating/refrigerating) control, alarm to AU1 and Au2 won’t work.
Note 2: Installing L5 dual relay output module in ALM or AUX can implement AL2 or AU2 alarm.
</td>
<td>0～4444</td>
</tr>
<tr>
<td>CtrL</td>
<td>Control mode</td>
<td>onoF: on-off control. For situation not requiring high precision
APId: advanced artificial intelligence PID control. (Recommended)
nPId: standard PID algorithm with anti integral-saturation function (no integral when PV-SV > proportional band)
POP: Transmit PV. The instrument works as a temperature re-transmitter.
SOP: Transmit SV. The instrument works program generator.</td>
<td>onoF
APId
nPId
POP
SOP</td>
</tr>
</table>

Srun	Running Status	run: Control or program was running, “RUN” led light on StoP **:** Control or program was stopped. Lower display keep flashing “StoP” and “RUN” led light off. HoLd: This only functioned on AI-719P, this will keeping temperature when this HoLd was appeared. If the parameter Pno=0(Non timing limitation mode), controller will functioning same at AI-719, if Pno>0 (in program mode),and Srun was set as “HoLd”, means the timer stops and the temperature remains; user can resume the timer by pressing the “**Hold”** from panel.	StoP / run / HoLd
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
A-M	Auto/Manual Control Mode Selection	Man: Manual control mode. Manually adjust output value of OUTP. Auto: Auto control mode. The instrument calculates and controls the output value. FMAn: Fixed in manual control mode. Forbidden to switch to auto mode by pressing A/M (<) key in basic display status. FAut: Fixed in auto control mode. Forbidden to switch to manual mode by pressing A/M key in basic display status.	

At	Auto tuning	oFF: Auto tuning function was off. on: Active auto turning function to calculate the values FoFF : Auto tuning function was off, cannot activate again by pressing key from panel .	oFF / On / FoFF
P	Proportional band	Proportional band in PID and APID control. Instead of percentage of the measurement range, the unit is the same as PV. Generally, optimal P, I, D and CtI can obtained by auto tuning. They can also be manually inputted if you already know the correct values.	1~32000 units
I	Time of Integral	No integral effect when I=0	0～9999 seconds
d	Time of Deri vative	No derivative effect when d=0	0～999.9 seconds
CtI	Control period	Small value can improve control accuracy. For SSR, thyristor or linear current output, it is generally 0.5 to 3 seconds. For Relay output or in a heating/refrigerating dual output control system, generally 15 to 40 seconds, 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.) When the parameter OPt or Aut = rELy, CtI will be limited to more than 3 seconds. Auto tuning will automatically set CtI to suitable value considering both control precision and mechanical switch longevity. When the parameter CtrL = onoF, CtI will used as timer to make delay time to avoid the power restart in short period. It suit for compressor protection.	0.2～ 300.0 Sec

P2	2nd Proportional band	The 2nd proportional band in PID and APID control. Instead of percentage of the measurement range, the unit is the same as PV. Generally, optimal P, I, D and CtI can obtained by auto tuning. They can also be manually inputted if you already know the correct values.	1~32000 units
I2	2nd Time of Integral	No integral effect when I=0	0～9999 seconds
d2	2nd Time of Derivative	No derivative effect when d=0	0～999.9 seconds
CtI2	2nd Control period	Same description and function as parameter as “Ctl”	0.2～300.0 Sec
CHYS	Control Hysteresis	CHYS is used for on-off control to avoid frequent on-off action of relay. For a reverse acting (heating) system, when PV > SV, output turns off; when PV<SV-CHYS, output turns on. For a direct acting (cooling) system, when PV<SV, output turns off; when PV>SV+CHYS, output turns on.	0～2000

InP	Input specification Code	**InP**	**Input spec.**	**InP**	**Input spec.**	0～37
		0	K	**20**	Cu50	
		1	S	**21**	Pt100	
		2	R	**22**	Pt100 (-80～+300.00℃) *	
		3	T	**25**	0~75mV voltage input	
		4	E	**26**	0～80ohm resistor input	
		5	J	**27**	0～400ohm resistor input	
		6	B *	**28**	0～20mV voltage input	
		7	N	**29**	0～100mV voltage input	
		8	WRe3-WRe25	**30**	0～60mV voltage input	
		9	WRe3-Wre26	**31**	0～1V voltage input	
		10	Extended input specification	**32**	0.2～1V voltage input	
		12	F2 radiation type pyromter	**33**	1～5V voltage input	
		15	4~20mA(installed I4 module in MIO)	**34**	0～5V voltage input	
		16	4~20mA(installed I4 module in MIO)	**35**	-20～+20mV	
		17	K (0～300.00℃) *	**36**	-100～+100mV	
		18	J (0～300.00℃) *	**37**	-5～+5V	

dPt	Display Resolution	Four formats (0, 0.0, 0.00, 0.000) are selectable Note 1: For thermocouples or RTD input, only 0 or 0.0 is selectable, and the internal resolution is 0.1. When S type thermocouple is used, dPt is recommended to be 0. If Inp= 17,18 or 22, resolution will support display 0.0 or 0.00	0 / 0.0 / 0.00 / 0.000
ScL	Signal scale low limit	Define scale low limit of input. It is also the low limit of transmitter output (CtrL=POP or SOP) and light bar display.	-9990～ +32000 units
ScH	Signal scale high limit	Define scale high limit of input. It is also the high limit of retransmission output (CtrL=POP or SOP) and light bar display.	
Scb	Input Shift Adjustment	Scb is used to shift input to compensate the error caused by transducer, input signal, or auto cold junction compensation of thermocouple. PV after compensation=PV before compensation + Scb It is generally set to 0. The incorrect setting will cause measurement inaccurate.	-1999～ +4000 units
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, it can be set to 1 to 3. 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 instrument is being metrological verified, “FILt” s can be set to 0 or 1 to shorten the response time.	0～40
Fru	Selection of power frequency and temperature scale	**50C**: 50Hz,display ℃. , **50F**: 50Hz, display ℉	50C, 50F, 60C, 60F

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. 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 in OUTP slot. **4-20:** 4～20mA linear current output. X3 or X5 module should be installed in OUTP slot. **PHA1**: Single-phase phase-shift output. K51 module should be installed in OUTP slot. PHA1 is only for 50Hz power supply, and don't support bidirectional control system. **PHA3 :** Three-phase phase-shift output. K9 module should be installed in OUTP slot. nFEd Position proportional output without valve feedback，can directly control valve's direct and inverse rotation. Valve execution time defined by Strt parameter FEd Position proportional output has valve feedback,valve execution time must more than 10s,feedback signal input from 0-5/1-5V terminals.note:in this case forbid useing remote setpoint input function. FEAt Self-tuning valve position .	SSr rELy 0-20 4-20 PHA

Aut	Auxiliary output type	Define AUX only when AUX is worked as the auxiliary output of a heating/refrigerating bidirectional systerm. SSr: to output SSr driver voltage or thyristor zero crossing trigger signal. G or K1 module should be installed. The output power can be adjusted by adjusting 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. 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 in AUX slot. 4-20: 4～20mA linear current output. X3 or X5 module should be installed in AUX slot. (Not applicable for heating/refrigerating bidirectional control.) Note: In a heating/refrigerating bidirectional control system, if any of OPt or Aut is set to rELy, then CtI is limited to 3～120.	SSr rELy 0-20 4-20
OPL	Output low limit	0～100%: OPL is the minimum output of OUTP in single directional control system. -1～-110%: The instrument works for a bidirectional system, and has heating/refrigerating dual output. When ACt=rE or rEbA, OUTP (main output) works for heating, and AUX (Auxiliary output) works for refrigerating. When Act=dr or drbA, OUTP works for refrigerating, and AUX works for heating. In a bidirectional system, OPL for define the limitation of maximum cooling output. So, when the OPL= -100%, means no limitation on cooling output. If set OPL=-110%, it can made current output excess 10% on maximum output. When the output type is SSR output or relay output, maximum of cooling output should not set more than 100%	-110～ +110%

OPH	Output upper limit	OPL limits the maximum of OUTP (main output) when PV<OEF. OPH should be greater than OPL.	0～110%
Strt	valve rotation travel time	When the meter is defined as position proportional output ,Strt is valve rotation travel time. if there is valve feedback signal, the meter will automatically select the valve control signal based Strt hysteresis setting, the shorter travel time, the hysteres is Large, valve positioning accuracy will be reduced. When Use no valve feedback signal mode or feedback signal over the range.the instrument will use valve rotation travel time comparing the output to determine the valve motor action time.	
Ero	Output for out of range.	When the control method is PID or APID, Ero defines the output value when the input value is out of range. Generally, it is set to 0.	
OPrt	Soft start time	At the beginning of power on, if PV<OEF, it takes OPrt for the output value of OUTP to rise to OPH; if PV>OEF, then the time for OUTP output value to rise to 100% is not more than 5 seconds. This function is only needed by special requirement. Soft start function doesn't affect the maximum output at auto tuning or manual control. If it is needed to lower the impulse current of induction load, CtI can be set to 0.5second, and OPrt 5 seconds.	
OEF	Work range of OPH	When PV<OEF, the upper limit of OUTP is OPH; when PV>OEF, the upper limit of OUTP is 100%. For example, to avoid that the temperature raises too quickly, under 150℃, a heater can work only under 30% of power, then we can set OEF=150.0 (℃), OPH=30 (%)	-999～ +3200

Addr	Communication address	In the same communication line, different instrument should be set to different address.	0～80
bAud	Baud rate	The range of baud rate is 1200～19200bit/s. When COMM/AUX slot is used as AUX, bAud should be set to 0. For D2 dimension instrument, If set parameter bAud = 2, it can be used for AU1 + AL1 alarm output. It can apply on AI-719P, event output function, because event output only can output by AL1 or AL2 For D2 dimension instrument, if I2 is installed and bAud = 1, then it can input on-off signal to switch SV1 and SV2 (AI-719) or switching the program status RUN/Stop (AI-719P) by connecting a switch between terminals number 3 and 5.	0～19.2K
Et	Event input type	When I5 module was installed, the meter have following functions, **nonE** : Disable event input function **reSt** : Run / Stop switching function. Connected in short time, start to running program, keep connect more than 2 sec, program switch to stop. **SP1.2** : Switching between setpoint 1 and setpoint 2 when use AI-719 or Pno=0 at AI-719P. MIO in open status, SV=SP1, when MIO in close status, SV=SP2 **PId2** : Switching 1st PID and 2nd PID. When use as single direction control, MIO in open status, P, I, d and Ctl was active, when MIO in close status, P2, I2, d2 and Ctl2 was active Eact: when MIO in close status,use P, I, d and Ctl to heating control,when MIO in open status,use P2, I2, d2 and Ctl 2 to refrigerating control.	nonE / rest / SP1.2 / PId2

AF	Advanced function	AF is used to select advanced function. The value of AF is calculated as below: AF=Ax1 + Bx2 + Cx4 + Dx8 + Ex16 + Fx32 + Gx64 + Hx128 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. C=0, The light bar indicates the output value; C=1, The light bar indicates the process value (for instruments with light bar only). D=0, Loc=808 can access the whole parameter table; D=1, Loc=PASd can access the parameter table. E=0, Normal application on HIAL and LoAL; E=1, HIAL AND LoAL will become to deviation high alarm and Deviation low alarm F=0, Fine control mode, internal control resolution was demonstration's 10 times. When on linear input mode, biggest display value is 3200 units F=1, Wide range display mode, when the value is bigger than 3200 ,chooses this option G=0, When the thermocouple or RTD input is burnt out, PV value will increase and trigger the high limit alarm. G=1, When the thermocouple or RTD input is burnt out, PV value will increase and **NOT** trigger the high limit alarm. After it was sets, High Limit alarm will have 30 sec. delay for trigger in normal usage. H=0, AIBUS communication protocol ,H=1, MODBUS communication protocol Note: AF=0 is recommended.	0～255

PASd	Password	When PASd=0～255 or AF.D=0, set Loc=808 can enter the whole parameter table. When PASd=256 ～ 9999 and AF.D=1, only Loc=PASd can access the whole parameter table. Please setting PASd cautiously, if the password is lost, you can't access the parameter table again.	0～9999
SPL	Low limit of SV	Minimum value that SV is allowed to be.	-999～+3000 unit
SPH	Upper limit of SV	Maximum value that SV is allowed to be.	
SP1	Setpoint 1	When Pno=0 or 1, then SV=SP1	SPL～SPH
SP2	Setpoint 2	When I2 module installed in MIO slot, SP1 and SP2 can be switched by an external switch. If the switch is off, SV=SP1; if the switch is on, SV=SP2.	
SPr	Ramp Slope limit (Only for AI-719P)	Once SPr was set, if PV<SV when program start, the first step of ramp slope will limited by SPr value until the temperature reach the first SV , under this limitation, the RUN lamp will keep flashing. For Ramp mode. SPr had effect on first step only. For Soak mode, SPr had effect on each step.	0~3200 ℃/Min

Pno	No. of Program step (Only for AI-719P)	To define the number of program in use. **Pno= 0,** disable the program running mode, then AI-719P will same as AI-719, meanwhile, can set the parameter "SPr" to limit the ramp time. **Pno=1~30**, AI-719P working as normal programmable controller	0~30
PonP	Program run mode after power restart (Only for AI-719P)	**Cont :** Continue to run the program from the original break point. If STOP STATUS was activated before power cut, then it (the program) will keep stop status after power restart. **StoP** : Stop the program after power restart **run1** : Start to run the program from step 1 unless the instrument was in "stop" state before power cut. **dASt** : If these have deviation alarm after power resume, then stop the program, otherwise, continue run the program from the original break point. **HoLd** : Go into HOLD state after power on. If it is in StoP state before power cut, then keep in StoP State after power on.	Cont / StoP / run1 / dASt / HoLd

PAF	Program Running mode (Only for AI-719P)	PAF = Ax1 + Bx2 + Cx4 + Dx8 + Ex16 + Fx32 When A=0, Enable ready (rdy) function A=1, Disenable ready (rdy) function B=0, Ramp mode. B=1, Soak mode, C=0, Time unit in Minute, the range is 0.1~3200. C=1, Time unit in Hour, the range is 0.1~3200 D=0, Disable PV start up function. D=1, Enable PV start up function. E=0, When work as program generator, upper windows display PV. E=1, When work as program generator, upper windows display the current step F=0, Standard operate mode on Hold and Run switching. F=1, Hold and Run switching can operate on panel Please refer to Page 48 for more detail of Ramp mode, Soak mode and PV start up function.	
EP1～ EP8	Field parameter definition	Define 0～8 of the parameters as field parameters.	nonE and all parameter codes

3.3 Additional Remarks of Special Functions

3.3.1 Single-phase phase-shift trigger output

When OPt is set to PHA, installing a K5 or K6 module in OUTP slot can single-phase phase-shift trigger a TRIAC or 2 inverse parallel SCRs. It can continuously adjust heating power by control the conduction angle of thyristor. With non-linear power adjustment according to the characters of sine wave, it can get ideal control. The trigger adopts self-synchronizing technology, so it can also work even when the power supplies of the instrument and the heater are different. Phase-shift trigger has high interference to the electric power, so user should pay attention to the anti-interference ability of other machines in the system. Now the K5 or K6 module can be only used in 50Hz power supply.

3.3.2 position proportion output

AI-719/719P can direct drive the motor to control the valve and supports two modes: valve position feedback signal and no valve position feedback signal. In the proportional output of the no-feedback position (OPt=nFEd), if OPH is less than 100, the valve position will be set automatically when the instrument is powered on, that is, the valve will be closed automatically when the instrument is powered on. The time is the valve stroke time. In this case, the maximum valve opening can be limited via the OPH parameter when the measured valve PV is less than the parameter OEF. If OPH is set as 0, the instrument will automatically set the valve position when the output is 0% and 100%. The valve position will not be set after powering-on, thereby shorting the start-up time. In the proportional output of the feedback position, OPt is set to be equal to FEAt, the instrument will automatically close and then fully open the valve, and the feedback signal is measured to set the valve position. In addition, the valve position will be saved. After automatic setting of the valve position, the instrument will automatically set the parameter OPt as FEd for normal control. If the feedback signal is 2% more than the range, the feedback signal will be considered abnormal, the mode of no valve feedback signal will be automatically enabled for control, and the lower display window will display “FErr” as the error prompt. The feedback signal can be 1K resistance (requiring the module W5 or U5) or 0-5V/1-5V signal (the current 0-20mA/4-20mA can be converted in parallel to the resistance). When the instrument adopts the position proportion in the output, it is recommended to use the instrument panel with the light pillar indicator, such as A2 and E2. The light pillar can indicate the valve opening instead of the output value which is not calculated by the instrument.

3.3.3 Alarm blocking at the beginning of power on

Sometimes the fault alarm may occur at the beginning of power on. In a heating system, at the beginning of power on, its temperature is much lower than the set point. If low limit and deviation low limit are set and the alarm conditions are satisfied, the instrument should alarm, but there is no problem in the system. Contrarily, in an refrigerating system, the unnecessary high limit or deviation high limit alarm may occur at the beginning of power on. Therefore, AI instruments offer the function of alarm blocking at the beginning of power on. When Act is set to rEbA or drbA, the corresponding low or high alarms are blocked until the alarm condition first clears. If the alarm condition is satisfied again, the alarm will work.

3.3.4 Setpoints switch

If an I5 module is installed in MIO slot (or bAud=1 and I2 installed in COMM slot). User can connect external on off switch to realize some control function. Set Et = rest, can switching program run and stop. For AI-719, or AI719P when its Pno=0, set Et = SP1.2, can switching between setpoint 1 and setpoint 2.

3.3.5 Communication function

S or S4 module can be installed at COMM slot to communicate with a computer. The instrument can be controlled by computer. AI instruments can be connected to the computer through RS232 or USB communication port. Every communication port of a computer can connect up to 60 AI instruments, or 80 AI instruments if a repeater is installed. A computer with 2 communication ports can connect up to 160 instruments. Please note that every instrument connecting to the same communication line should be set to a unique communication address. If the number of instrument are enough, 2 or more computers can be used and a local network can be set up.

AIDCS application software, a distributed control system software developed by Yudian, can control and manage 1～160 AI instruments, record the data, generate and print reports. If users want to develop their own distributed control system by themselves, the communication protocol of AI instruments can be free offered. There are many famous distributed control system software support AI instruments.

3.3.6 Temperature re-transmitter / Program generator / Manual current output

Besides AI PID, stand PID control and on-off control, if the output is defined as current output, the instrument can also retransmit PV (process value) or SV (setpoint) into linear current and output from OUTP. The precision of current output is 0.2%FS. Base on that ability, AI-719 can become temperature re-transmitter and AI-719P can become program generator

The corresponding parameters are set as below:

When CtrL=POP, PV is retransmitted to linear current, the instrument works as temperature re-transmitter.

When CtrL=SOP, SV is transmitted and outputted, and the instrument works as manual current output controller(AI-719) or program generator(AI-719P) .

OPt is used to choose output type, generally 4～20mA or 0～20mA output.

Parameter InP, SCL, SCH, and Scb are used for selecting input specification, setting low limit or high limit of PV and adjusting input.

For example, in order to retransmit temperature read from K thermocouple, range 0～400℃, to current 4～20mA, the parameters are set as below: InP=0, ScL=0.0, ScH=400.0, OPt=4~20, and X3 or X5 linear current module is installed in OUTP slot. When the temperature is less than or equal to 0℃, the output is 4mA. When the temperature equals to 400℃, the output is 20mA.

3.3.7 Fine control

Fine control means operation resolution is 10 times higher than display resolution ,e.g. The instrument display 1 ℃， but control resolution is 0.1℃,in this way ,the control accuracy is much higher than display resolution.

Intruments of old version use fine control only when the input signal is a temperature while new version use fine control only when the value is less than 3000 under the condition of linear input signal. (most applications are less than 3000 at industrial applications),in this way the instrument can obtain higher precision and more stable output ,and if need fine control when value more than 3000,can set AF.F=1.

3.3.8 User defined non-linear table

User can define a non-linear table. This table can provide special input specification (Inp should be set to 10), or output power restriction on different temperature sections.

3.3.8.1 Enter non-linear input specification define state

(If Loc=808, first set Loc=0 and exit parameter setting state.) Set parameter Loc = 3698 and then press can enter non-linear table setting.

3.3.8.2 Non-linear table setting:

A00=0, the table is for non-linear input measurement

A00=1, the table is for sectional output power restriction

A01 indicates input type: A01 = Ax1 + Ex16 + Gx64

A01.A indicates input range:

A01.A=0, 20mV(0～80ohm); A01.A=1, 60mV(0～240ohm);

A01.A=2, 100mV(0～400ohm); A01.A=3, 0-1V; A01.A=4, 0-5V

A01.E=0, the value generated from the table should be scaled by parameter Sch and Scl again, and then displayed

A01.E=1, the displayed PV is the value generated from the table.

A01.G indicates the input signal type.

A01.G=0, thermocouple

A01.G=1, RTD

A01.G=3, linear voltage/current

A01.G=0, linear resistance

For example:for a non-temperature, 1～5V voltage signal, A01=4x1 + 0x8 + 2x64 = 132

A02 represents the low limit of the input signal. A03=low limit x 2000 / range. For example, for 1～5V voltage input, A02=1 x 2000 / 5 = 400.0.

A03 represents the length of the input signal range. A03=length x 2000 / range. For example, for 1～5V signal, the length is 5-1=4V, then A03=4 x 2000 / 5 = 1600

A04 shows the interval between points. A04 = A03/ the number of segments. For example, in above example, if there is only 1 segment, then A04=A03=1600.

d00 shows the start point of the non-linear table. It is the output value corresponding to A02. For example, in the above sample, it can be set to 0.

d01 = the output value corresponding to A02+A04.dnn(nn=02～60), dnn = the output value corresponding to A02 + A04 x nn

Through the above table, even complex curve such as extraction, log, or exponent can be defined.

Sectional output power restriction for high temperature stove (A00=1, this special function should be requested when ordering).

For example: a restriction for a MoSi2 heating element can be set as below:

A01=1050; A02=100.0; A03=1500; A04=750.0; d00=120.0; d01=1100, d02=2000

It means: when the temperature is lower than 100℃, the maximum output power is 6% (2000 means 100%, and 120.0/2000=6%); when the temperature is between 100～850℃, the maximum output is 55%; when the temperature is higher than 1600℃, the maximum output is 100%.

4. Further description for the operation of AI-719P series instrument

AI-719P v8.2 program type temperature controller is used in the application where the setpoint should be changed automatically with the time. It provides 50 segments program control which can be set in any slope and the function of jump, run, hold and stop can also be set in the program. Measurement startup function, preparation function and power-cut/power-resume event handling modes also provided.

4.1 Concepts and functions Program

StEP:
The No. of the program Step can be defined from 1 to 50, and the current Step is the program Step being executing.

StEP time:
Total run time of the program step. The unit is minute and the available value range from 1 to 9999.

Running time:
The Time of current Step has run. As the running time reaches the Step time, the program will jump to the next Step automatically.

Jump:
The program can jump to any other steps in the range of 1 to 50 automatically as you programmed in the program Step, and realize cycle control.

Run/Hold:
When program is in the running status, timer works, and set point value changes according to the preset curve. When program is in the holding status, timer stops, and set point remains to make temperature hold also. The holding operation can be programmed into the program step.

Stop:
When the stop operation is activated, the program will stop, running time will be clear, event output switch will reset and the output control will stop output. If run operation is activated when instrument is in the stop status, the program will start-up and run again from the set step no. The stop function can be programmed into the program Step. The stop operation can also be performed manually at any time. (After stop operation is done, the step no. will be set to 1, but user can modify it again). If the program ran the last step of "Pno", program will stop automatically.

Power cut/resume event handling:
There are 5 events handling method selectable for power resume after power cut off. Please refer to parameter PonP.

PV startup and PV preparation function (rdy function) :
At the beginning of starting a program, resuming a program after power cut or continuing to run a program after it is just modified, the PV (process value) are often quite different from the set point. PV startup function and PV preparation function can make PV and set point consistent, and avoid unexpected result. When PV startup function enabled, the instrument will adjust the running time automatically to make the expected set point is the same as the current PV.
For example, the program is set that the temperature will be raised from 25℃ to 625℃ in 600 minutes. But the current PV is 100℃, then the instrument will automatically to run this program start from 75 minutes, that mean changed the temperature raised from 100℃ to 625℃ in 525 minutes (600-75) min.
At the above situation(PV=100, SV=25, first step SV), when PV preparation function is enable, the alarm function will be blocked at that time, and PV will be adjusted to approach SV until the deviation alarm condition is released (PV is between SV-LdAL and SV+HdAL). After deviation alarm was off, the controller starts to run the program again. Preparation function (rdy Function) is helpful to keep the integrity of the program, but it will prolong the program time because the start of the program is postponed.
PV startup function is prior to PV preparation function. If both function are enabled, the system apply PV startup first, if PV startup function works, PV preparation function will not be activated.

Curve fitting:
Curve fitting is adopted as a kind of control technology for AI-719P series instrument. As controlled process often has lag time in system response, by the way of curve fitting the instrument will smooth the turning point of the linear heating-up, cooling-down and constant temperature curves automatically. The degree of the smooth is relevant with the system's lag time t (t=d+CtI) ; the longer of the lag time, the curve will more smooth. On the opposite the smooth function will be weaker. Generally the shorter of the process lag time (such as temperature inertia), the better of the program control on effect. By the way of the curve fitting to deal with the program curves, will avoid overshoot. Note: The characteristic of the curve fitting will force the program control to generate fixed negative deviation during the linear heating-up and fixed positive deviation during the linear cooling-down, the deviation is direct proportional to the lag time and the speed of heating-up (cooling-down). This phenomenon is normal.

4.2. Programming and operation (For AI-719P only)

4.2.1 Ramp Mode(PAF : B=0)

Programming of instrument has uniform format of temperature-time-temperature, which means temperature "A"(SP 1), passed Time "A"(t01), then reached Temperature "B"(SP 2). The unit of temperature set is ℃ and the unit of time set is minute. The following example includes 5 steps, which is linear temperature heating up, constant temperature, linear temperature cooling down, jump cycling, ready, Hold..

StEP1: **SP 1=100 , t 1=30.0** Start linear temperature heating up from 100℃, and the time needed 30 minutes to reach SP 2(400 degree).

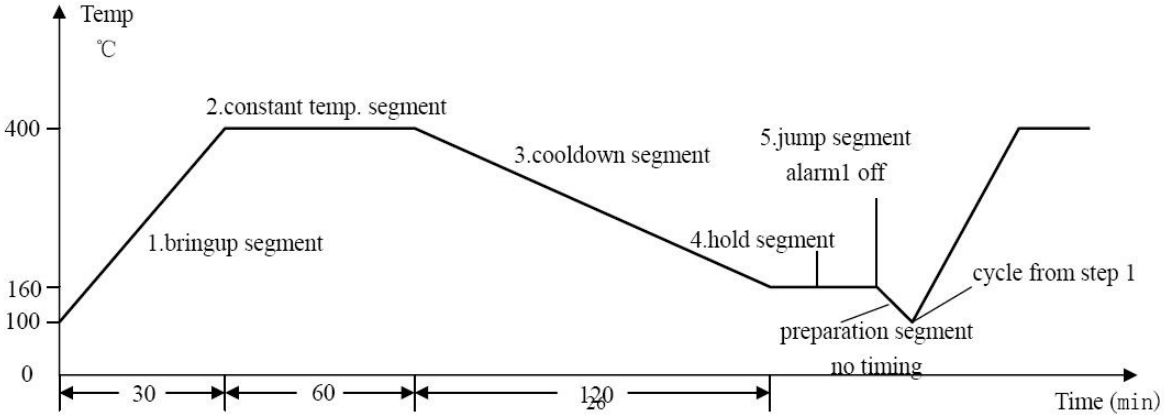
StEP2: **SP 2=400 , t 2=60.0** Temperature raised to 400℃, slope of raising curve is 10℃/minute, The program take 60 minutes to raise temperature to SP3 (400 degree). It means keep the same temperature in 60 minutes.

StEP3: **SP 3=400 , t 3=120.0** This is the step for temperature cooling down, slope of cooling curve is 2℃/minute, and the time needed is 120 minutes to reach SP4 (160degree).

StEP4: **SP 4=160 , t 4=0.0** When temperature reached 160 degree, the program get in Hold state. If need go to next step, it needed operator to executed the "run" for next step.

StEP5: **SP 5=160 , t05=-1.0** Jump to StEP1 to start from beginning.

In this example, it is assumed that the deviation high alarm is set to 5℃. Because the temperature of StEP 5 is 160℃, and the temperature of StEP1 is 100℃, when program jumps from StEP 5 to StEP 1, the program will change to preparation state at first(if preparation mode "rdy" was enabled), i.e., Control the temperature until the deviation between setpoint and PV is less than deviation high alarm value. After temperature is controlled to 105℃, the program will be started from StEP 1, and run the above steps again. The temperature control drawing was shown below.


Temp
℃
400
160
100
0
2.constant temp. segment
3.cooldown segment
5.jump segment
alarm1 off
1.bringup segment
4.hold segment
cycle from step 1
preparation segment
no timing
30
60
120
Time (min)

4.2.2 Soak mode(PAF : B=1)

Suitable for the process which does not need to establish the temperature slope, can simplify the programming and more effective. Each step also can set parameter “SPr” to define temperature raise slope, if “SPr=0” raising speed will set to maximum. Because cannot know the actual time which spend on temperature raising, user can enable “rdy” function to ensure the correct soak time.

4.2.3 Time setting

Set “t-xx” = 0.1～3200 (min)

Set the time of xx StEP. (Time units can be change to Hour by parameter “PAF”.)

Set “t-xx” = 0.0

The program hold on StEP xx, program will hold running and hold counting time.

Set “t-xx” = -121.0

The program stops, and switches to stop status.

Set “t-xx” = -0.1～-122.0

Negative value of this range represents a jump operation which will jump to step xx and event output. Range -1~-120 is for step jumping application. The step jumping cannot greater than “Pno”(No. of Program step).

Decimal point use for control the event output from AL1 and AL2. (Modular), Note, if parameter AOP was assigned alarm action will trigger from AL1 and AL2, the event output also will cause alarm from AL1 and AL2.

When set

-XXX.1, AL1 activate, AL2 release

-XXX.2, AL1 release, AL2 activate

-XXX.3, AL1 and AL2 activate

-XXX.4, AL1 and AL2 release

Example:
Example 1 : t -5 = -1.1 ; means when the program arrived step 5, AL1 activate, AL2 release and will jump to step 1
continues running
Example 2 : t-6 = -0.3 ; means when the program arrived step 6, AL1 and AL2 activate and continuous next step.
Note: The program will be held if it jump from a control segment to another control segment (an Hold action will be inserted between two control sections), external run/Hold operation is needed to release the Hold status. It is not allowed that the jump section jump to itself (for example: t -6= -6), otherwise, the Hold status cannot be released.

4.2.4 Program arrangement of multi-curve operation

AI-719P has the advanced function of flexible program arrangement. Normally, when the program stops, the StEP will be automatically set to1. Thus if StEP is not change to other value, a program will start from step1. If multiple curves are defined, the control can jump to different curve by setting step 1 as jump segment.

For example: There are three curves with the length of 3 steps represent three groups of process parameter, they are separately arranged on StEP2-StEP4, StEP5-StEP7, StEP8-StEP10. Settings are as follows:
t- 1=-2.0 Execute the program of curve 1 (StEP2-StEP4)
t- 1=-5.0 Execute the program of curve 2 (StEP5-StEP7)
t- 1=-8.0 Execute the program of curve 3 (StEP8-StEP10)
Note: Can choose the curves by setting the value of StEP “t-1“ set to -2.0, -5.0 or -8.0 before the program startup.