AI-8x9**Series Artificial Intelligence Industrial Controller User's Manual**

(V9.1)

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CONTENTS

1 Summary

1.1 Main Features

● The new AI artificial intelligence algorithm can accurately control even the large lag system, and is more adaptable to PID parameters.

● In addition to the classic AT self-tuning, it has the AAT advanced and quick self-tuning, which can analyze the heating curve to calculate the PID parameters upon power on and heat-up, and does not need to oscillate back and forth like the traditional AT, which greatly saves the debugging time.

● 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 0.05℃.

● High-precision low-temperature drift measurement technology is employed, which adopts 22/24BIT high-resolution A/D converter customized by Yudian as well as 50Hz/60Hz interference suppression function.

● Global switching power supply 100~240VAC is adopted, which provides comprehensive power protection. Even if 380VAC is misconnected for a long time, it will not burn out; 24VDC power supply can also be selected, with a variety of external sizes to choose from.

● It adopts energy-saving and environment-friendly design with "fever" level energy-saving components. When there is no output and alarm, the power consumption of the whole machine is only about 0.2W, which greatly reduces the temperature rise of the instrument itself and improves product reliability and stability.

● Advanced modular construction is adopted to provide rich output specifications, which can widely meet the demands of various applications, with quick delivery and convenient maintenance

● It is allowed to edit operation and field parameters, and can set password to form "customized" instrument.

● Multiple communication protocols are supported, including AIBUS protocol independently developed by Yudian and MODBUS protocol, etc.; through the multi-functional communication controller, various network connections including TCP can be realized.

● Its design has passed the 6KV group pulse anti-jamming test and meets the requirements of electromagnetic compatibility (EMC) under harsh industrial conditions.

● The digital tube is upgraded to a new generation of self-luminous LED display technology, without light leakage, but with higher luminous efficiency, brighter colors, low power consumption, and different LED color matching modes.

● Instantaneous power failure protection for grid under-voltage, the starting voltage is as low as about 50VAC, and the continuous working time is about 1 second after the power grid is instantaneously off.

● The temperature ranges as widely as -10~+60℃, high-precision crystal oscillator is used, and the actual aging test temperature is as high as 100℃.

● With multiple sets of input and output, the instrument can provide a full solution to power supply and photoelectric isolation.

● When Pno=0, the internal program control is fully compatible with the set points. When Pno=1, only the set value and timing control need to be set.

● The automatic/manual non-disturbance switching function can be set to be used as a hand-held communicator.

● With external set value control and process value / set value retransmission as 4~20mA or 0~20mA output function.

● With internal 50-point table/poly-line processing function, it can be used for multi-point correction of process value input and high-temperature furnace output to follow the process value limit and other functions.

● External event input function supports set value switching, PID parameter switching and manual/automatic non-disturbance switching.

● Besides the upper limit, lower limit, positive deviation, negative deviation and other alarm mode functions, its alarm output slot can be set freely.

● A variety of thermocouple cold junction compensation can be selected: in addition to the common internal compensation mode, high-precision external CU50 and freezing point compensation are supported.

● When the sensor is turned off, the output percentage can be defined, and the manual setting or the system autonomous limit can be selected.

● Various panel mounting and rail mounting options are available: including 48*96, 96*48, 96*96, 160*80, 80*160 and other panel mounting and D7 rail mounting modules.

⚠ ATTENTION

This manual is for ARTIFICIAL INTELLIGENCE INDUSTRIALCONTROLLER AI-8*9 Version 9.1. Some functions described in this manual may not applicable in other versions. The display will show instrument model and firmware version upon power on. User should pay attention to the difference between different versions. Please read this manual carefully in order to use the instrument correctly and make it to its full use.

Please correctly set parameters according to input / output speculation and function.Only correctly wired instruments with parameters correctly set can be put into use.

1.2 Ordering Code Definition

1.2.1 AI-8*9 Panel-mounted/Rail-mounted Instrument

When Cc>0 is set, AI-8*9 series cascade AI temperature controller/regulator can achieve cascade control or dual input selection, which requires the input signal specifications of the two channels to be the same; The panel consists of 9 parts:

AI－899	A	J1	N	X3	L3	N	S4	－	24VDC
①	②	③	④	⑤	⑥	⑦	⑧		⑨

This means the instrument: ①basic model AI-899; ②A type (96 × 96mm); ③J1 module installed at input (M1) ; ④ no module installed at the auxiliary input (MIO); ⑤a linear current output module installed at main output (OUTP); ⑥L3 installed at alarm ALM; ⑦ no module installed at auxiliary output (AUX); ⑧ S4 with photoelectric isolation RS485 interface installed at communication (COMM); ⑨24VDC power supply; meanings of the 9 parts in the instrument model are as follows:

① basic models

AI-899 (accuracy 0.05/0.1, 10-year free warranty, Cascade AI controller/regulator)
AI-889 (accuracy 0.1 , 10-year free warranty, Cascade AI controller/regulator)
AI-869 (accuracy 0.15, 8-year free warranty, Cascade AI controller/regulator)
AI-859 (accuracy 0.2, 5-year free warranty, Cascade AI controller/regulator)

② **panel size specifications**

Socket Module	Panel Size
A	Panel type, 96×96mm(W*H), hole size 92×92mm
A2	Panel type, 96×96mm (W*H), with light bar
B	Panel type, 160×80mm (W*H), opening size 152×76mm
C	Panel type, 80×160mm (W*H), opening size 76×152mm
C3	Panel type, 80×160mm (W*H), with light bar
D7	DIN rail type, built-in display, pluggable terminals, width 22.5mm
E	Panel type, 48×96mm (W*H), hole size 45×92mm
E5	DIN rail type, width 45mm, no display window by itself, external E8 display
E2	Panel type, 48×96mm (W*H), with light bar
F	Panel type, 96×48mm (W*H), hole size 92×45mm

③ **Modules at input (M1)**: Select one of J1, J2, J3, J31, J4 and other modules for installation

④ **Modules at auxiliary input (MIO)**: I2, K3, V and other modules, N means no modules installed, the same below.

⑤ **Module at main output (OUTP)**: L1, L2, L4, W1, W2, G, K1, K3, X3, X5 and other modules

⑥ **Modules at alarm (ALM)**: L0, L2, L3, L4, W1, W2, G and other modules.

⑦ **Modules at auxiliary output (AUX)**: L0, L1, L2, L3, L4, W1, W2, G, K1, X3, X5 and other modules.

⑧ **Modules at communication (COMM)**: S, S1, S4, X3, V and other modules.

⑨ **Power supply**:Being blank means 100~240VAC, 24VDC means 20-32VDC or AC.

1.3 Used Modules

1.3.1 Module Slot

AI-8 * 9 series instruments are equipped with 6 optional module slots (M1 is added) (3 of which are D7 rail type, namely OUTP, AUX and COMM, and the input module is solidified); Different types of outputs and functions can be realized by installing different modules.

Modular Slot		Function Description	Optional Modules
Input	M1	For AI-8 * 9 series input	J1\J2\J3\J31\J4 etc.
Auxiliary Input	MIO	For extended input or event input or feed output or extended output	I2\V24\V12 etc.
Main Output	OUTP	For ON-OFF output or PID regulation output or retransmission output	L1\G\X3\K1\K50\K3 etc.
Alarm	ALM	For upper and lower limit/deviation alarm output or feed output	L0\L3\V10\V24 etc.
Auxiliary Output	AUX	For the second output of heating and cooling or alarm output or RS232 communication	L0\L1\L3\G\X3\K1\R etc.
Communication	COMM	For RS485 communication or retransmission output or event input	S\S1\S4\X3\X5\I2 etc.

1.3.2 Common Modules

Name	Function Description
N（or /）	No module installed
L0	Large-capacity large-size relay, normally open(NO) + normally closed(NC) relay output module; Capacity: 30VDC/2A, 250VAC/2A, suitable for alarm.
L1	Large capacity and large size relay. NO relay output module; Capacity: 30VDC/2A, 250VAC/2A
L2	Small capacity and small size relay. NO+NC relay output module; Capacity: 30VDC/1A, 250VAC/1A, suitable for alarm
L3	Dual channel, large capacity and large size relay. NO relay output module; Capacity: 30VDC/2A, 250VAC/2A
L4	Large capacity but small size relay. NO+NC relay output module; Capacity: 30VDC/2A, 250VAC/2A
W 1、W 2	TRIAC non-contact output module, W1 is NO, W2 is NC; Capacity: 100~240VAC/0.2A, burn-proof, without welding
G	Solid-state relay (SSR) voltage output module; 12VDC/30mA
K50/K60	Single channel 220VAC/380VAC, burn-proof thyristor phase-shift trigger output module

K1/K3	Single channel/3-channel burn-proof thyristor zero-crossing trigger output module; Each channel triggers one loop of a TRIAC or a pair of inverse parallel SCR with current of 5~500A; without welding
X3	Photoelectric programmable linear current output module
X5	Photoelectric programmable linear current output module with own photoelectric isolated power supply.
S	Photoelectric RS485 communication interface module.
S1	Photoelectric RS485 communication interface module. (Uses internal 24V isolated power)
S4	Photoelectric RS485 communication interface module with own photoelectric isolated power supply.
R	Photoelectric RS232C communication/ printing interface module (if printing is needed, please specify).
V24 / V12 / V10 / V5	Isolated 24V/12V/10V/5V DC voltage output with maximum current of 50mA for power supply of external transmitter or circuit.
I2	Switch / frequency signal input interface for external switch or frequency signal.
J1	With two thermocouple inputs, support voltage input below 100mV

J2	Two two-wire thermistor inputs
J3	Two voltage inputs, support 0~5V and 1~5V
J31	Two voltage inputs, support 0~10V
J4	Two current inputs, support 4~20mA, 0~20mA

Note: please refer to the manual or call technical support for other modules not listed.

1.3.3 Module Installation and Replacement

Module installation and corresponding parameter setting is done by factory. If there is faulty modules to be replaced or functions to be changed, users can replace by themselves. Users can pull the controller board out of the housing, using a small flat-tip screwdriver to insert into the opening between the original module and the slot, removing the existing module and replacing a new one. Changing a module type often require users to modify the corresponding parameters.

The welded module is solidified on the internal circuit board. Please confirm the requirements before ordering to avoid wrong module selection. It is recommended to return to the factory to replace the module if the function is changed.

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 (24V/12V/10V voltage output), I2

(frequency/on-off input, with 12V isolated voltage output). The 12V power commonly supplies power for output or communication module. Generally, the relay contact output and TRIAC no contact discrete output are self-isolated from the other circuit or does not require isolated power. Therefore, only the electric isolation between the communication interface and the current output should be considered. S (RS485 communication interface), R (RS232 communication interface) and X3 (linear current output) all draws from the internal 12V power supply. If more than one of the above modules are installed, they will be not electrically isolated because they share the same power supply. To avoid interference, S4 (RS485 communication interface) or X5 (linear current output) is designed. They have their own isolated power supply, without drawing from instrument internal power.

For example, if an X3 module is installed in main output (OUTP) slot, S or X3 should be installed in communication (COMM) slot. Then the X3 and S or X3 modules cannot be isolated, a S4 or X5 module should be installed.

For relay contact point and thyristor no contact point output, they are isolated from other circuits already. Isolation for SSR voltage output (G) generally is not required because solid –state relay itself is isolated.

1.3.5 Further descriptions about module applications

Voltage output module: The voltage output modules like V24, V12, V10 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/W2 are newly developed non-contact switch module with advanced “burn-proof” technology and zero-crossing conduction. It can replace the relay contact switch to control AC contactor actuator or electric servo motor. Compared to the relay contact output module, W1/W2 have longer life span and able to lower the

interference spark. This improves the stability and reliability of the system. Since the driving component is thyristor, it is suitable to control100~240VAC but no DC. Since output terminals are connected in series with protection components, the allowed continuous current for control is up to 0.2A with allowed maximum instantaneous current up to 2A.This driving power can directly control AC contactor of 220VAC with current below 80A. For the load 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 size limit and also bringing large amount of electromagnetic interference. It is important to choose a suitable relay module. To control equipment with 100~220VAC supply, such as AC contactor and electromagnetic valve, W1 module is recommended. To control DC or AC above 50VAC, relay module L1, L4, etc can only be chosen. L2 module is small without size limitation and both of its normal open and normal close terminals have varistor spark absorption. But the capacity is small therefore It is suitable for alarm output. L1 and L3 are large-volume and large-capacity relay modules. In the instrument with a width of 48mm (including E, F, E5 and other sizes), this kind of modules cannot be installed on the main or side board at the same time, Otherwise the modules will collide to one another. If either main or side board is L1 or L3 installed, another board cannot have L1 or L3 installed at the same time. L3 module provides dual relay outputs. It can be used to support two loops of alarm, for example, AL1+AL2.

1.4 Technical Specification

- **Input Specification: (One instrument is compatible to the following)**

Thermocouple: K, S, R, E, J, T, B, N, WRe3-WRe25, WRe5-WRe26, etc(J1 for M1)

Resistance temperature detector: Cu50, Pt100, Ni120(J2 for M1)

Linear voltage: 0~5V, 1~5V, 0~1V, 0~100mV, 0~20mV, -5~+5V, -20~+20mV etc.(J3 for M1, J1 for mV)

Linear current: 0~10mA, 0~20mA, 4~20mA etc.(J4 for M1)

Extended specification: Apart from the above-mentioned Input specification, an additional type can be provided upon request.

● **Instrument Input 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(-80.00~+300.00℃)

Linear Input: -9990~+32000 defined by user

● **Measurement accuracy**: level 0.05~0.1/0.1/0.15/0.2(Note: The thermocouple input should be externally compensated with a Cu50 copper resistor, and an extra ±1°C compensation error will be added during internal compensation; level 0.05 refers to input specifications of AI-898, including PT100, thermocouple of S and B type, and mV input supporting level 0.05)

● **Measurement temperature drif**t: ≤25PPm/℃ (level 0.05~0.1); ≤35PPm/℃ (level 0.1~0.15); ≤75PPm/℃ (level 0.2)

● **Control period** : 0.1~300.0 seconds selectable

● **Regulation mode**:

On-off control mode (dead band adjustable)

AI-PID with fuzzy logic PID regulating and auto tuning with advance artificial intelligence algorithm.

Standard PID regulating

Cascade regulation

- **Output specification (Modularized)**

Relay output (NO+NC): 250VAC/2A or 30VDC/2A

TRIAC no contact discrete output (NO or NC): 100~240VAC/0.2A (continuous), 2A (20mS instantaneous, repeat period≥5s)

SSR Voltage output: 12VDC/30mA (To drive solid-sate relay SSR).

Thyristor zero-crossing trigger output: To trigger TRIAC of 5~500A, a pair of inverse paralleled SCRs or SCR power module.

Linear current output: 0~20mA or 4~20mA customized. (Maximum output voltage of energy-saving module ≥ 5.5V; Output voltage of high-voltage module ≥ 10.5V)

- **Alarm function**: 4 types of alarm, high limit, low limit, deviation high limit and deviation low limit with alarm blocking at the beginning of power on.
- **Electromagnetic compatibility (EMC)**: ±6KV/5KHz according to IEC61000-4-4 (Electrical Fast Transient); 6KV according to IEC61000-4-5 (Electrical Surge) and under the interference of 10V/m high-frequency electromagnetic field, the instrument does not crash, the I/O malfunctions will not emerge either, and the fluctuation of the process value does not exceed ±5% of the range.
- **Isolation withstanding voltage**: Among power, relay contact or signal terminals ≥2300VDC. Among isolated electroweak terminals ≥600V
- **Power supply**: 100~240VAC/DC, -15%, +10% / 50~60Hz; or 24VDC, -15%, +10%.

- **Power consumption**: ≤0.3W (including CPU, measurement, display and communication, excluding any output or external power consumption)
- **Operating ambient**: Temperature -10~60℃. Humidity ≤90%RH

1.5 Energy-saving and environment-friendly Design

The AI-8*9 series adopts an energy-saving and environment-friendly design, which is reflected in its extremely low temperature drift and power consumption. High-quality key components, which pass pair test, with low temperature drift is used. Low temperature drift can achieve better energy-saving effects in various applications. 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.

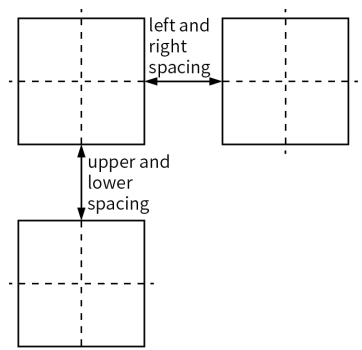
Compared with conventional temperature controller, the instrument with low temperature drift has less change in the measured temperature under the influence of ambient temperature, which can provide more stable product quality and less energy consumption. Thanks to low temperature drift, high precision 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-8 series instrument can be reduced to be within ±0.3~1℃, 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 3~4℃. The lower the average temperature of the industrial furnace has, the less the power consumption will be. 0.3%~1% of energy will be saved only relying on reduced temperature shift instrument. And the product quality will become more stable.

2 Installation and Wiring

2.1 Installation

2.1.1 Panel Mounting



① The distance between the installation holes should take different sizes and installation brackets into consideration. If necessary, the instruments should be installed side by side closely. It is recommended that the left and right spacing of A/C/E is ≥5mm, and the upper and lower spacing is ≥30mm; the left and right spacing of B/F is ≥30mm, and the upper and lower spacing is ≥8mm.

② Insert the instrument into the panel mounting hole, press the mounting bracket from the opening side of the housing, and temporarily fix the main body.

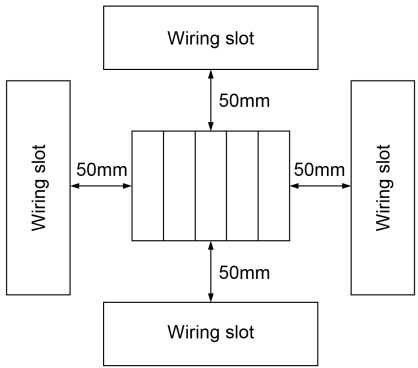
③ When tightening the mounting bracket and wiring terminals, please set the tightening torque to 0.39~0.58N·m.

2.1.2 DIN-rail Module

① Install the module on the 35mm DIN rail.

② Rail module installed vertically, with recommended distance at least 50mm.

③ When wiring the terminals, please set the tightening torque to 0.39 ~ 0.58N·m



2.2 Wiring

2.2.1 Precautions

① In order to avoid interference, please separate the lines of signal and the power supply.

② Please use shielded wire (cross-sectional area 0.5mm2 ~ 1.25mm2) for the cable, and ground the shielding layer at one end. The stripping length of the wire should be 6 ~ 8mm.

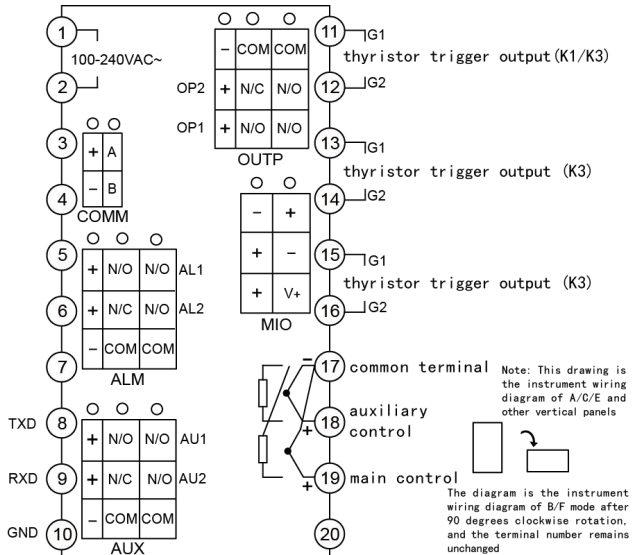
③ Please use crimp terminals for terminal wiring, and use wiring materials and crimp tools suitable for crimp terminals. For crimp terminals, use M3.0 terminals.

2.2.2 Wiring Diagram of Panel Mounted Instrument

Note: Due to technical upgrades or special orders, etc., if the random wiring diagram of is inconsistent with this manual, please refer to the random wiring diagram.

■ Wiring Diagram of Instrument

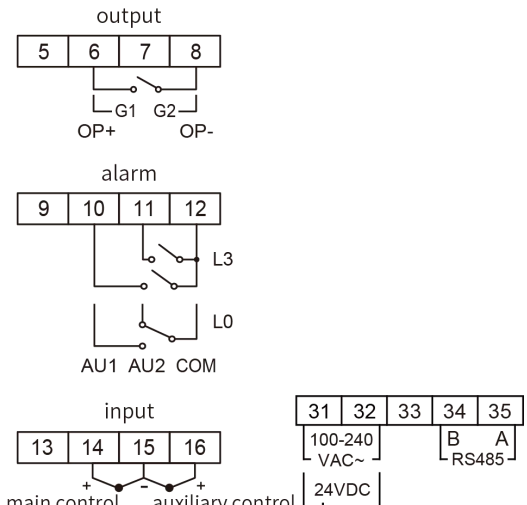
① When input through thermocouple or DC linear voltage or DC linear current, terminal 17 as common negative pole, terminal 19 as main positive pole, and terminal 18 as auxiliary positive pole. Input through thermal resistance only supports the two-wire connection. Input through main control is connected to terminals 17 and 19, and input through auxiliary control is connected to terminals 17 and 18.



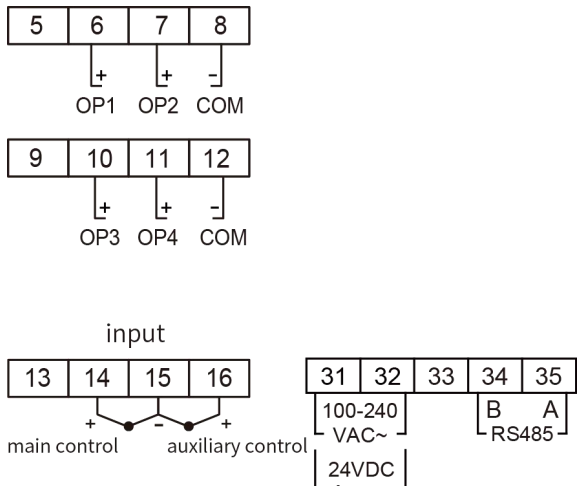
② When the main output OUTP from relays such as L1, terminals 11 and 13 are normally open(dry nodes). Output from G, X3, etc., connect terminal 13+ and 11 -. From G1, connect terminal 11, and from G2, connect 12.

2.2.3 Wiring Diagram of DIN Rail Module

■ **The wiring diagram of D7**

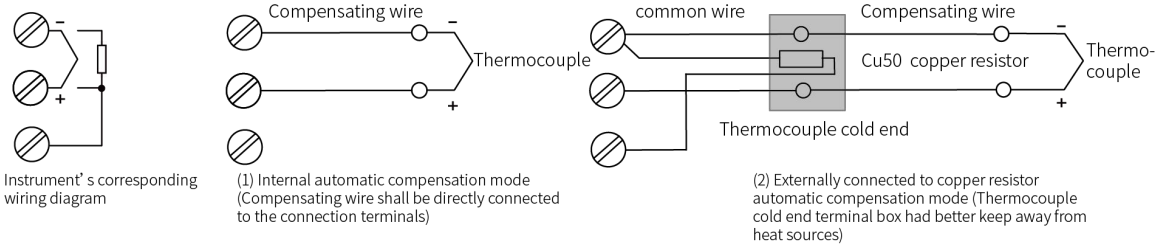


■ **Four-channel solid-state wiring diagram**



2.2.4 Thermocouple Cold Junction Compensation Mode

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:

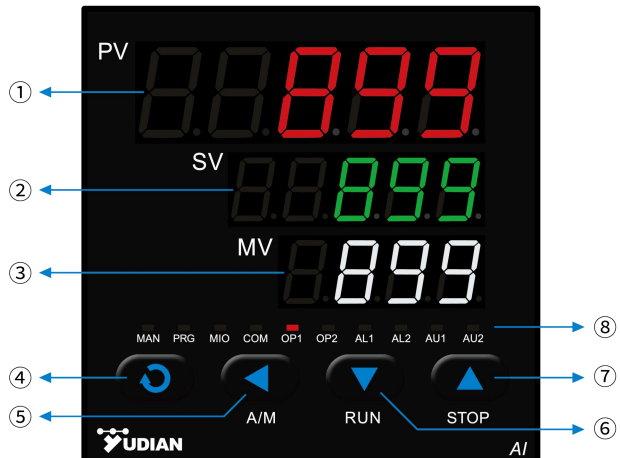


Note: The external compensation terminals of AI-8*9 series are input common negative terminals (COM) and CJC terminals (Dimension A/E for terminal 20, Dimension D7 for terminal 13)

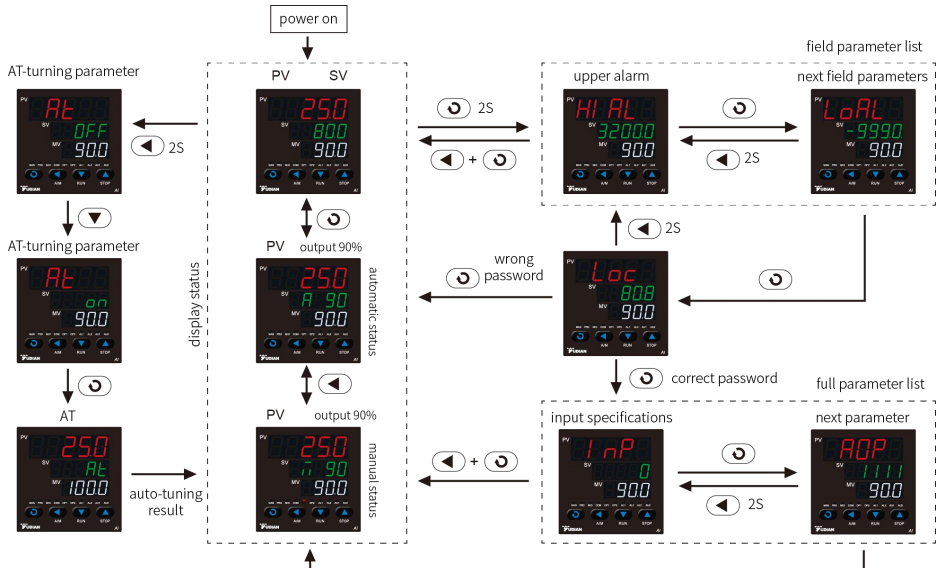
3 Display and Operation

3.1 Panel Description

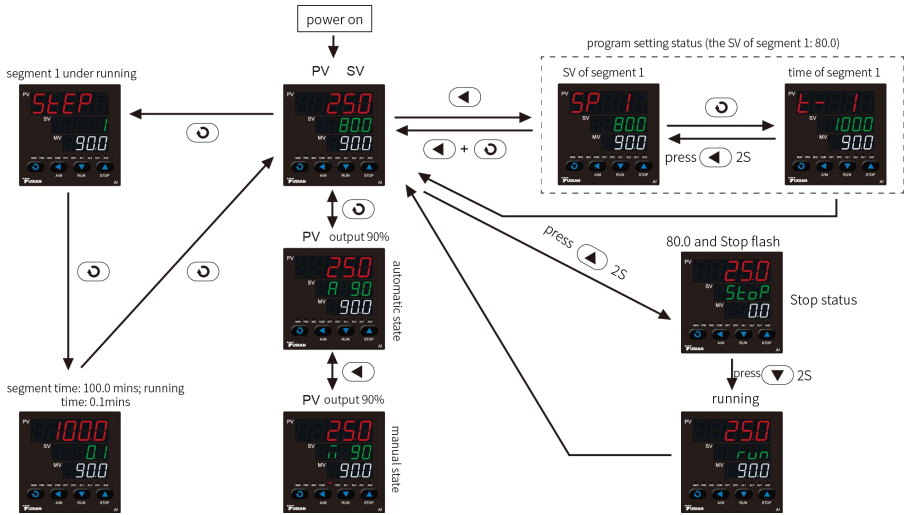
① Upper display window: Displays PV, parameter code, etc.
② Lower display window: Displays SV, parameter value, or alarm message
③ Setup key: For accessing parameter list and conforming parameter modification.
④ Data shift key (cursor pointer)
⑤ Data decrease key (RUN/HOLD button)
⑥ Data increase key (STOP button)
⑦ 10 LED indicators. MAN is not applicable in this series. PRG turns on when program is running. MIO, OP1, OP2, AL1, AL2, AU1 and AU2 turns on when the corresponding module are giving output. COMM turns on when the instrument is communicating with upper device.



3.2 Parameter Setting Flowchart



3.3 Program Setting Flowchart



Upon power on, the PV window displays the process value of the main thermocouple, and the SV window displays the set value of the main control; Press key ⟲ once to switch the interface, the PV window displays the process value of the auxiliary thermocouple, and the SV window displays the output percentage MV of the main control.

3.4 Operating Instructions

3.4.1 Parameter Setting

In basic display status, press ⟲ and hold for about 2 seconds can access Field Parameter List. Press ◁、▽ or △ can modify a parameter. Press ▽ to decrease the data, press △ to increase the data, the decimal point of the modified data will flash (like a cursor). Press and hold the key to quickly increase/decrease the value, and the speed will automatically increase as the decimal point moves to the right. Or press ◁ to directly move the position (cursor) of the modified data, which makes the operation more efficient. Press ⟲ to save the modified parameter and display the next parameter, keep pressing ⟲ to quickly go down; press and hold ◁ for more than 2 seconds to return to the previous parameter; press and hold ◁ first and then press ⟲ again to exit the parameter setting directly; if there is no key operation, it will automatically return to the basic display status after about 25 seconds.

3.4.2 Short-cut operation

All function in AI-8*9 can be accessed through changing parameters. For common operation such as set point editing, changing the status of program RUN/STOP/HOLD, short-cut key is provided. These short-cut can be prohibited to avoid any incorrect operation.

Set Value Setting: When fixed-point control mode(Pno=0) is adopted, in the basic display status where the lower display window shows the set value (If the lower display window displays the output value, press ⟲ to switch to the set value display status, the same below), press ◁ to edit the current set value, and then press ◁, ▽ and △ to directly edit the set value.

Program setting: When program control mode(Pno≥1) is adopted, in the basic display status where the lower display window shows the set value, press ◁ to enter the program setting, the set value of the current running segment is displayed first, and press ⟲ to display the next data, each program is arranged in the order of "set value-time-set value". Programs can be edited even while the program is running.

Run the program: Press and hold ▽ for about 2 seconds until the lower display window shows the "run" message. AI-8 series will start the program from STOP status. If parameter “PAF.F =1” and program status is RUN, this operation will HOLD the program. The timer will be paused. Perform RUN operation again will resume the program.

STOP the program: Press and hold △ for about 2 seconds until the lower display window shows the

"StOP" message. The instrument output will be stopped. AI-8 series will stop the program and restore the current StEP number to 1.

Automatic/manual switching (A/M): When the lower display window shows the output value (if the lower display window shows the set value, press ⟲ to switch to the output display status), press the A/M (◁) to make the instrument switch between automatic and manual without disturbance. Under the manual status and the output value is showed in the lower display window, directly press △ or ▽ to increase and decrease the manual output value. By setting the A-M parameters, the instrument can be fixed in the automatic status and not allowed to be switched to the manual status with the panels, so as to prevent entering the manual status by mistake.

Auto Tuning: Press ◁ for 2 seconds, At parameter will appear. Press △ to change the value of At from OFF to on, then press ⟲ to activate the auto-tuning process. During auto tuning, the lower display blinks with At. After two fluctuating cycles by ON-OFF control, the instrument will obtain the optimal PID control parameter value. If you want to quit from auto tuning, press and hold the ◁ for about 2 seconds until the At parameter appear again. Change At from on to OFF, press ⟲ to confirm. If the instrument is running the program, the program timer will be paused to avoid changing SV. If the controller was applied on heating/cooling dual output system, those two set of PID parameters are required to be calculated separately. When the controller was performing cooling control from AUX, enable auto tuning to obtain P2, I2, d2.

Manual auto-tuning: Since positional regulation is adopted for auto-tuning, its output will be at the position defined by OPL and OPH. 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-8 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 instead of that defined by OPL and OPH. This function can avoid great change of valve and improve the precise of auto-tuning. In addition, when the controlled physical value responds quickly, the manual self-tuning method can obtain more accurate self-tuning results. Note: before manual auto-tuning, the manual output value should be limited in the range of 10% ~ 90%, and the process value and the set value should be basically consistent and stable, otherwise optimal parameters can not be obtained.

Note 1: The advanced artificial intelligence algorithm APID is able to avoid overshooting problem over standard PID algorithm and achieve precise control. Both APID and PID can be calculated based on auto-tuning.

Note 2: Different set point will result in different PID values from auto-tuning. Please input the set value SV to an value which is often used or mean value. For those furnaces with good heat preservation, the set value can be set at the highest applicable temperature, it is prohibited to edit SV during auto-tuning. Depending on the system, the auto-tuning time may vary from seconds to hours.

Note 3: Parameter CHYS has influence on the accuracy of auto-tuning. In general, the smaller the value of CHYS, the higher precision of auto-tuning will be. There is a chance that the CHYS value is too small so as to work as on-off control. Then the resulting PID values will be completely misled. CHYS=2.0 is recommended.

Note 4: 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.

Note 5: In the auto-tuning or manual status, no matter how large the control period (CtI) of the instrument was originally set, it is temporarily limited to no more than 3 seconds to improve the setting accuracy and improve the response speed of the instrument during manual operation.

3.4.3 Instructions for E5 Rail Mounted Instruments

AI-8*9 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 E85 keypad with display to show and set the parameters. E85 supports hot plug, which is handheld and can also be installed on the DIN rail. The LED indicator 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 at certain frequency. The meaning for lighting signal is explained as below.

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

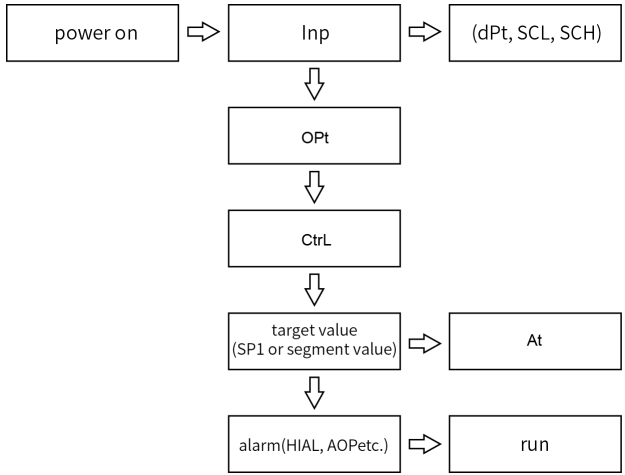
Flashing quickly in period of 0.6s-No communication but there is warnings such as an alarm.

Flashing quickly in period of 0.3s-No communication and 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.

4 Parameter Description

4.1Typical Setting Process and Common Parameters



①Please refer to the full parameter list for the parameters in the figure. For other functions, please refer to the common functions.

②There is no need to set input range when the thermocouple or thermal resistance is selected for input, and it is needed to be set only when the analog signal is input or the retransmission is required.

③Auto-tuning is only needed when APID or PID is selected. It must be run when the instrument works normally.

④After the setting, if the instrument is in stop or hold status, it needs to run manually or receive running command from the host computer.

4.2 Parameter Lock and Custom Parameter Table

4.2.1Parameter Lock (Loc)

Parameter lock (Loc) provides different operation privilege and access control to the parameter list. The explanation of Loc function was shown as below:

Loc=0, allowed to edit field parameters and to directly edit the set value in the basic display status;

Loc=1, forbidden to edit field parameters, but allowed to directly edit the set value in the basic display status;

Loc=2~3, allowed to edit field parameters, but forbidden to directly edit the set value in the basic display status;

Loc=4~255, only Loc allowed to be edited, and all shortcut operations prohibited;

Set Loc=password (the password can be a number between 256~9999, the initial password is 808), and press  to confirm and to access and edit the full parameter list. Once the full parameter list is entered, all parameters except read-only parameters are authorized to be edited.

Editing restrictions can be set for the communication function of Loc parameter, please refer to the communication protocol for details; the manual/automatic function and the AT function are independently set and controlled.

4.2.2 User-defined Parameter List

The parameter list of AI-8*9 can be programmed to define the function, which means the parameter list can be customized. In order to protect important parameters from being arbitrarily modified, we name the parameters that need to be displayed or edited in the field as field parameters. The field parameter list is a subset of the full parameter list and can be defined by the user, and can be directly called out for the user to edit, while the full parameter list must be called out with the password.

Parameters EP1~EP8 allow users to define 1~8 field parameters. If the field parameters are less than 8, the first parameter that is not used should be defined as nonE. For example: there are 3 parameters such as HIAL, HdAL and At in the full parameter list, then the parameter EP can be set as follows: EP1=HIAL, EP2=HdAL, EP3=At, EP4=nonE.

4.3 Full Parameter List

The parameters can be divided to 8 groups, including alarm, control, input, output, communication, system, set point/program step and field parameter:

Code	Name	Description	Setting Range
Addr	Communication address	Define communication address, with range 0~80; in the same communication line, different instrument should be set to different address.	0~80

bAud	Baud rate / COMM mode selection	Define the communication baud rate. The range of baud rate is 0~28800bit/s(28.8K). When COMM slot is not used communication, bAud value defines its function. bAud=1, as an external switching input, same function as MIO slot. When the MIO slot is used, the I2 module can be installed in the COMM slot. bAud=3, COMM slot used to transmit and output the process value of 0~20mA; bAud=4, COMM slot used to transmit and output the process value of 4~20mA; bAud=8, COMM slot used to transmit and output the set value of 0~20mA; bAud=12, COMM slot used to transmit and output the set value of 4~20mA; Note: Some old instruments do not support the retransmitting function.	~28.8K

<table>
<tr><td>AFC</td><td>Communication mode</td><td colspan="4">Select communication mode, its calculation method is as follow:
AFC=A*1+D*8
A=0, standard MODBUS; A=1, AIBUS; A=2, MODBUS compatible mode; A=4, compatible with S6 module.
D=0, no calibration; D=1, even calibration.
Note: AFC supports 03H (read parameters and data) and 06H (write a single parameter) under MODBUS. When AFC=0 or 4, the 03H can read up to 20 words at a time; When AFC=2, 03H reads 4 words. For more details, Please refer to the communication protocol description.</td><td>0~12</td></tr>
<tr><td>InP</td><td>Input specification Code</td><td>InP</td><td>Input spec.</td><td>InP</td><td>Input spec.</td><td>0~39</td></tr>
<tr><td></td><td></td><td>0</td><td>K</td><td>20</td><td>Cu50</td><td></td></tr>
<tr><td></td><td></td><td>1</td><td>S</td><td>21</td><td>Pt100</td><td></td></tr>
<tr><td></td><td></td><td>2</td><td>R</td><td>22</td><td>Pt100 (-80~+300.00℃)</td><td></td></tr>
<tr><td></td><td></td><td>3</td><td>T</td><td>25</td><td>0~75mV voltage input</td><td></td></tr>
<tr><td></td><td></td><td>4</td><td>E</td><td>26</td><td>0~80ohm resistor input</td><td></td></tr>
<tr><td></td><td></td><td>5</td><td>J</td><td>27</td><td>0~400ohm resistor input</td><td></td></tr>
<tr><td></td><td></td><td>6</td><td>B</td><td>28</td><td>0~20mV voltage input</td><td></td></tr>
<tr><td></td><td></td><td>7</td><td>N</td><td>29</td><td>0~100mV voltage input; 0-</td><td></td></tr>
</table>

				5V/0-10V(J3/J31); 0-20mA(J4)	
		8	WRe3-WRe25	30	0~60mV voltage input
		9	WRe5-WRe26	31	0~1V
		10	Extended input specification	32	0.2~1V
				33	1~5V voltage input
				34	0~5V voltage input
				35	-20~+20mV
		17	K（0~300.00℃）	36	-100~+100mV
		18	J（0~300.00℃）	37	-5V~+5V
		19	Ni120	39	20~100mV voltage input; 1-5V(J3); 4-20mA(J4)
		Note：While InP=10, the non-linear table can be self-defined or input by factory under a paid service.			

<table>
<tr>
<td>AOP</td>
<td>Alarm output allocation</td>
<td>
<table>
<tr><th>Alarm / Output to</th><th>LdAL (x1000)</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, alarms assigned to AU1 and AU2 does not take in effect.
Note 2: Installing L3 dual relay output module in ALM or AUX, AL2 or AU2 can be used
</td>
<td>0~4444</td>
</tr>
</table>

OPt	Main output type	SSr: output SSr drive voltage or thyristor zero crossing trigger signal. rELy: output relay contact switch 0-20: 0~20mA linear current output. 4-20: 4~20mA linear current output. PHA1: Single-phase phase-shift output. In this status, AUX cannot be used as the cold output terminal of the regulating output. SSr4: 4-channel solid-state synchronous output	
At	Auto tuning	oFF: Auto tuning was off. on: Active auto turning of PID and CtI parameter, automatically return to FoFF after self tuning FoFF : Auto tuning was off, cannot activate again by pressing key from panel AAt, fast auto-tuning, automatically returns to OFF after self-tuning.	
A-M	Automatic/ Manual Control Switch	MAn: Manual Control. User manually adjusts the output (OUTP). Auto: Automatic Control. Output (OUTP) depends on the calculations mode set by CtrL. FSv: compatible with manual/automatic function, prohibited from entering manual/automatic switching interface FAut: Fixed Automatic Control. This mode forbids front panel short-cut key switching back to manual control.	

Srun	Running status	run, running status, indicator PRG turns on. Stop, stop status, the lower display flashes StoP, and the indicator PRG turns off. HoLd, keep running status. The instrument is under program control (Pno>0), here the timing will be suspended. At the same time, the lower display will flash HoLd, so will the indicator PRG.	
Pno	Numbers of program steps	Define the number of effective program steps. When Pno=0 is set, the instrument is in constant temperature mode; When Pno=1 is set, it is a single program mode. Only one set value and one holding time need to be set, and the holding time will end and enter the stop status; When Pno=2~50 is set, normal program is adopted for operation.	0~50

PonP	automatic operation after power restarts	Cont, continue to stop if it is stopped before power failure; otherwise, continue to execute at the original termination after power restarts. StoP, enter the stop status no matter what happens after power restarts. Run 1, Continue to stop if it is stopped before power failure, otherwise, it will automatically start running from the first step after power on. dASt, if there is no deviation alarm after power restarts, the program continues to run; If there are any deviation alarm, it will stop the program. HoLd(Pno≥1), If the instrument is powered off during operation, the instrument will enter the suspend state no matter what happens after power on. However, if the instrument is stopped before power failure, it will remain stopped after power on.	
Et	Event input type((Install I2 module at MIO or COMM)	nonE: Disable event input function ruSt: RUN/STOP function. With MIO connected in a short moment, RUN mode is activated. Press and hold for more than 2s, the program STOP. SP1.2: During fixed point control(Pno=0), this switches between set point 1 and set point 2. When MIO is open, SV=SP1. When MIO is	

		closed, SV=SP2. PId2: In case of unidirectional control (non heating/cooling dual output control), if MIO is turned off, use P, I, d and CtI parameters to regulate; If MIO is turned on, use P2, I2, d2 and CtI2 parameters to regulate. EAct: Use an external switch to switch heating/cooling. When the MIO switch is turned off, the P, I, d and CtI parameters are used to regulate heating; when the MIO switch is turned on, the P2, I2, d2 and CtI2 parameters are used to regulate cooling. Erun: Use an external switch to switch RUN/STOP. When MIO is turned off, the instrument STOP. When MIO is turned on, the instrument RUN. EMAn: Use an external switch to switch between manual and automatic function, The instrument is in automatic status when the switch is off, and in manual status when the switch is on. Note: Some models do not have this parameter.	

CtrL	Control mode	onoF: on-off control(ON-OFF), for situation not requiring high precision. APID: advanced artificial intelligence PID control. (Recommended). nPID: standard PID algorithm with anti integral-saturation function. PoP: Direct PV retransmission, working as a temperature re-transmitter. SoP: Direct SV retransmission, working as a program generator.	
OPL	Output low limit	0~100%: OPL is the minimum output of OUTP in single directional control system. -1~- 110%: the instrument becomes a bidirectional output system with heating/cooling output function. Note: Some models have no bidirectional output function, and the minimum OPL is 0.	-110~ +110%
OPH	Output upper limit	When PV<OEF, OPH limits the maximum of OUTP; When PV>OEF, the maximum of OUTP is 100%. OPH should be greater than OPL.	0~110 %

Aut	Cooling output type	The AUX output type is defined only when AUX is used as an auxiliary output in the heating/cooling two-way regulation. SSr, Output SSR driving voltage or time proportional signal triggered by SCR zero crossing. rELy, Output relay contact switch. 0-20, 0~20mA linear current output. 4-20, 4-20mA linear current output. Note: If the heating or cooling output signal is 4-20mA, When there is an output at one terminal, the signal at the other terminal will return to zero, and the output is 0mA instead of 4mA	1~3200 unit
CHYS	Control Hysteresis	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 unit

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.	0~3200 s
P	Proportional band	Define the proportional band regulated by APID and PID, and the unit is the same as the PV value, rather than the percentage of the range.	1~3200 unit
I	Integral time	Defines the integral time regulated by PID, in seconds, when I=0, the integral action is disabled.	0~9999 s
d	Differential time	Defines the differential time adjusted by PID, in 0.1 seconds. When d=0, the differential action is disabled.	0~3200 s
Ctl	Control circle	When SSR, thyristor or current output is used, it is generally set to 0.5-3.0 seconds. It is recommended to set between 15-40 seconds when relay output is adopted; Ctl is usually set to about 1/5~1/10 of the differential time (basically equal to the lag time of the system).	0.2~30 0.0s

P2	Proportional band of cold output	Define the cold output proportional band regulated by APID and PID, and the unit is the same as the PV value, rather than the percentage of the range.	1~3200 unit
I2	Integral time of cold output	Define the integral time of cold output regulated by PID, in seconds, and the integral action is disabled when I=0.	0~9999 s
D2	Differential time of cold output	Define the differential time of cold output regulated by PID, in 0.1 seconds. When d=0, the differential action is disabled.	0~3200 s
CtI2	Control circle of cold output	When SSR, thyristor or current output is used, it is generally set to 0.5-3.0 seconds. When the output is a relay switch, the actual CtI will be limited to more than 3 seconds, it is generally recommended 20~40 seconds.	0.2~30 0.0s
dPt	Display Resolution	Four formats are selectable: 0, 0.0, 0.00 and 0.000. For thermocouple or RTD input, only 0 or 0.0 are selectable.	
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.	-9990~+4000 unit
ScL	Signal scale low limit	Define scale low limit of input. It is also the low limit of retransmission output and light bar display.	-9990~+

ScH	Signal scale high limit	Define scale high limit of input. It is also the high limit of retransmission output and light bar display.	32000 unit
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.	0~40
Fru	Selection of power frequency and temperature scale	50C: 50Hz, display ℃., 50F: 50Hz, display ℉ 60C: 60Hz, display ℃., 60F: 60Hz, display ℉. Input has max. anti-interference ability to 50Hz or 60Hz frequency when parameter set;	
SPSL	Low limit of SV	Display the temperature difference between the main control and the auxiliary control at constant temperature, and the instrument will automatically confirm this parameter.	-9990~+32000 unit
SPSH	Upper limit of SV	Spare	
AF	Advanced function	AF is used to select advanced function. The value of AF is calculated as below: AF=A*1+B*2+C*4+D*8+E*16+F*32+G*64	0~255

		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. B=0, Alarm and control hysteresis work as unilateral hysteresis; B=1, As bilateral hysteresis. C=0, the resolution of output value displayed in the third row is 0.1%; C=1, the resolution of the output value displayed in the third row is 1%. D=0, Loc=808 can access the parameter table; D=1, Loc=PASd can access the parameter table. E=0, HIAL and LoAL work as high and low limit alarms respectively; E=1, HIAL and LoAL work as deviation high and low limit alarms respectively. F=0, Fine control; F=1, Wide range display mode, when the value is required to be larger than 3200, it is recommended to choose this mode. G=0, When the thermocouple or RTD input is burnt out, PV value will increase and trigger the high limit alarm(set value of the upper limit alarm should be less than the upper limit of signal range). 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 set, high limit alarm(HIAL) will have 15s delay to trigger in normal usage. H=0, HIAL and LOAL can alarm independently; H=1, HIAL and LOAL become interval alarm, and will alarm only when LOAL>PV>HIAL is met. The alarm code is HIAL, and HIAL is also used for output. Note: For non-professional users, it is recommended to set AF=32. When AF. D=1, first long press the circle to enter the field parameter table, and then long press the shift key to switch to the LOC parameter.	

AF2	Advanced function 2	AF2 is used to select the second group of advanced functions, and its calculation method is as follows: AF2=A*1+B*2+C*4+D*8+E*16+F*32+G*64 A=0, spare B=0, spare C=0, normal input; C=1, adopt linear input signal to process square root. D=0, spare E=0, output 0 when the sensor is disconnected; E=1, output Ero parameter when the sensor is disconnected. F=0, automatically sets Ero; F=1, manually set Ero. Automatically defining Ero is one of AI artificial intelligence controls, that is, when the process value is consistent with the set value, the instrument will automatically remember the latest average output value for the reference of PID regulation to improve the control effect. For safety, it is recommended to set the maximum Ero value as 70% of the output power; If a higher Ero value is required, it can be manually set as the safest common output. G=0, spare Note: AI-8*9 series cannot be set with externally given functions	0~255
PAF	Program operation	PAF is used to select program control, and its calculation method is as follows:	0~255

	mode (Pno≥1)	PAF=A*1+B*2+C*4+D*8+E*16+F*32+G*64+H*128 A=0, the preparation function (rdy) is disabled; A=1, the preparation function is enabled. The preparation function needs to use the deviation upper limit alarm (temperature drop), deviation lower limit alarm (temperature rise) and alarm return difference together. For example, the preparation function is effective when the temperature is raised, and LdAL=- 3.0 and AHYS=2.0 are set, then when the PV value is within the range of (set PV= -1), the next section or thermostatic timer will be started if the conditions are met. B=0, ramp mode; B=1, soak mode (constant temperature mode), each step of the program defines the set value and holding time, rdy function is used to limit the conditions to enter the next step, and SPr/SPrL parameter is used to regulate the rising/cooling rate; in addition, even if B=0 is set, if the command in the last step of the program is not STOP, the constant temperature mode will still be executed, and it will automatically end when the time is up. C=0, in minutes; C=1, in hours.	

		D=0, without PV startup function; D=1, with PV startup function. E=0, PV showed in the upper display window when it works as program generator; E=1, StEP number showed in the upper display window when it works as program generator. F=0, standard operation mode; F=1, HoLd status when the program RUN. G=0, in minutes; G=1, in seconds. H=0, standard operation mode; H=1, each step has preparation function (rdy) in ramp mode.	
SPr	Rate limiting to heating	The heating rate can be limited in ℃/min. This function is not used in ramp mode. When item C of PAF=1, the units of SPR and SPRL become ℃/10min.	0~3200 ℃/ min
SPrL	Rate limiting to cooling	The cooling rate can be limited in ℃/min. This function is not used in ramp mode. If there is no cooling output, when the natural cooling rate is lower than SPrL, the cooling ramp cannot be guaranteed, and the natural cooling rate will be used. When item C of PAF=1, the units of SPR and SPRL become ℃/10min.	0~3200 ℃/ min

Ero	Output for out of range.	When the control method is PID or APID, Ero defines the output value(usually caused by sensor failure or disconnection) when the input value is out of range. AF2 parameter is used to define the Ero output mode	-110 ~110%
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. Soft start is needed to lower the impulse current of induction load, Ctl can be set to 0.5second, and OPrt 5 seconds.	0~3600 s
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 (%)	-999.0~ +3200.0℃
HIAL	High limit alarm	Alarm on when PV>HIAL; Alarm off when PV<HIAL-AHYS	-9990~+ 32000 unit
LoAL	Low limit alarm	Alarm on when PV<LoAL; Alarm off when PV>LoAL+AHYS	

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, alarm will be disabled.	
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. FOFF, energy saving/confidential display mode; In this mode, the instrument SV window will display the communication address, instead of the process value and the set value.	
SPL	Low limit of SV	Minimum value that SV is allowed to be.	-9990~+32000 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 Pno=0 or 1, I2 can be installed at the MIO to switch SV=SP2 with an external switch.	

PASd	Password	When PASd=0 ¯ 255 or AF.D=0, set Loc=808 to enter the full parameter table. When PASd=256 ¯ 9999 and AF.D=1, set Loc=PASd to access the full parameter table. Note: Only expert users can set PASd. It is recommended to use a unified password to avoid forgetting	0~9999
Strt	Valve rotation stroke time	Strt is used to define the stroke time of valve rotation when the instrument is under position proportional control output	10~240 s
OPH1	Output upper limit	Output upper limit 1	
OPH2	Output upper limit	Output upper limit 2	
OPH3	Output upper limit	Output upper limit 3	
OPH4	Output upper limit	Output upper limit 4	

Cc	Selection of cascade and dual input modes	Cc=0, common control mode of single input Cc=1~200, cascade control mode, input 1 is main control, and input 2 is auxiliary control; If the input specifications of the two channels are consistent, the output of the main control is the set value of the auxiliary control, and the instrument will automatically output the controlling load after the calculation. The smaller the lag time of the auxiliary control is compared with that of the main control, the larger the allowable Cc parameter value can be. If Cc is set too large, it may cause oscillation. Cc=201, hot backup mode in dual input Cc=202, take the lower measurement value in the dual inputs as the value of the main control. Cc=203, take the higher measurement value in the dual inputs as the value of the main control.	
EP1—EP8	Field parameter definition	Define 1—8 field parameters for those common used parameters when the Loc lock is applied. If there is none or less than 8 field parameters, please set as nonE.	

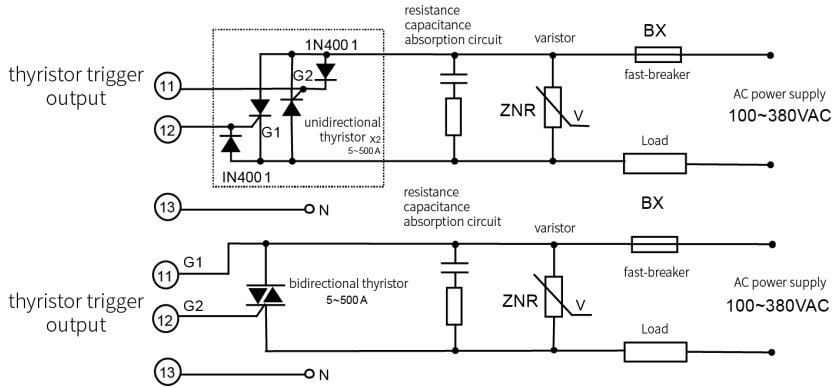
5 Common Function Description

5.1 SCR Trigger Output

5.1.1 Single-phase Phase-shift Trigger Output

Name	Setting	Description
OPt	PHA1	SCR single-phase phase-shift trigger output, SCR is 5-500A, if a larger-size SCR will be used, please specify when ordering.

It can continuously regulate heating power by controlling the conduction angle of the SCR (2 unidirectional inverse parallel or 1 bidirectional SCR), and according to the characteristics of the sine wave, the nonlinear correction of the power is carried out to achieve the ideal control effect. The trigger uses self-synchronizing technology, which allows the powers of instrument and heater to be different. Phase-shift triggering will bring high-frequency interference to the power grid. It is recommended to add RC resistance-capacitance circuits. When applying, pay attention to whether the anti-interference of other electrical appliances can meet the requirements.



Note 1: RC absorption and varistor must be added when phase-shift trigger is used to improve possible harmonic interference.

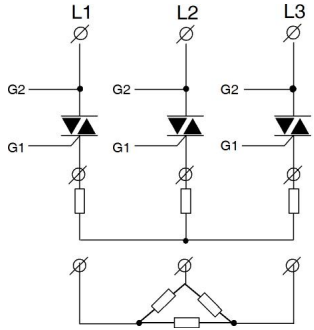
Note 2: It is recommended to use a SCR power module. One power module contains two unidirectional SCRs, as shown by the dotted line in the figure.

Note 3: When using the K60 module, the load power supply is 380VAC; when using the K50 module, the load power is reduced to 200~240VAC.

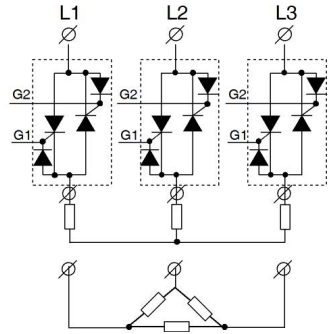
5.1.2 Single-phase/Three-phase Zero-crossing Trigger Output

Name	Setting	Description
OPt	SSr	SCR single-phase/three-phase zero-cross trigger output, SCR is 5-500A, if a larger-size SCR will be used, please specify when ordering.

The output power is adjusted by adjusting the ON-OFF time ratio, and the cycle is usually 0.5-4.0 seconds. Select the appropriate varistor according to the load voltage to protect the SCR, the output wiring of the K1 module is the same as the single-phase phase-shift trigger output, and the three-phase zero-crossing wiring is shown in the following figure:



K3 three-phase three-wire star and delta wiring diagram (TRIAC)



K3 three-phase three-wire fully controlled power module star and delta wiring diagram (single-phase SCR anti-

5.2 External Input

If I2 module is installed on MIO(or set bAud=1, and I2/I5 module is installed on COMM), an external switch can be connected to regulate stop switching, dual set value switching, manual/automatic switching, etc.

Name	Setting	Description
Et	RuSt, SP1.2 etc.	Set different options to realize the function switching controlled by external switches

5.3 Quick Tuning of AAt

Traditional auto-tuning of periodic oscillation takes 2 cycles to set PID parameters and a longer debugging time. AAt is that when the instrument is powered on and in heating output status under full power, the PID parameters can be calculated by analyzing the temperature rise curve, and set in advance without periodic oscillation. In most cases, fine control can be achieved at the first heating, greatly shortening the commissioning time. If the AAt has not been completed automatically before the instrument exits the full power output status, which means the AAt fails, the self-tuning will be terminated, and the PID parameters will not be edited.

Name	Setting	Description
At	AAt	The quick setting starts after power on

5.4 Soft Startup

This function needs to be activated when the equipment needs to gradually increase output as time goes upon power on or startup. If PV< OEF upon power on or stop, the maximum allowable output of the main output OUTP will rise to the output percentage set by OPH. If PV>OEF, the rising time of the output is no more than 5 seconds.

Name	Setting	Description
OPrt	0~3600s	The soft starting time is 0 by default. To reduce the impact current of inductive load, Ctl=0.5 s and OPrt=5 s can be set

5.5 Dual Output of Heating and Cooling

When the OPL parameter is set to - 1~- 110% and Ctrl is set to APId/nPId, the instrument will become a bidirectional output system, with two opposite PID control outputs, the main output OUTP and the auxiliary output AUX. The main output uses parameters P, I, d, ctl, while the auxiliary output uses parameters P2, I2, d2, ctl2. Under bidirectional output, OPL is used to tell the maximum limit to cooling output. When OPL= -100%, there is no limit to cooling output, -110% can make the maximum range of current output (4~20mA) exceed 10% or more, which is suitable for special occasions; under SSR or relay outputs, the maximum limit to cooling output shall not be greater than 100%.

Name	Setting	Description
OPt	SSr etc.	Set signal type for the main output
Aut	SSr etc.	Set signal type for auxiliary output
OPL	-1~-110	As the maximum output percentage of auxiliary output
OPH	-1~-110	As the maximum output percentage of main output

5.6 Over-range Output Definition

In case of "orAL" alarm due to over range or abnormal sensor signal, the instrument will automatically close the output, which may even cause danger in some occasions. For example, the instrument controlled by the cooling water valve will close the output due to abnormal measurement signal, which may cause overheating or burning of the equipment. When the input signal "orAL" alarms, after setting the over range output, the instrument can work according to the preset output percentage or automatically set the appropriate output to avoid the above situations.

Name	Setting	Description
AF2	16 or 48	Set whether to activate the over range output function, and set the Ero output in manual or automatic mode
Ero	0	Set the output of the over-range, in the manual mode or in the automatic mode

5.7 Regulation to Heating / Cooling Rate

When the equipment cannot be heated or cooled rapidly due to material and other factors, the function can be limited by setting the heating / cooling rate; When the set value or program startup (soak mode) changes, if PV is inconsistent with SV, limit the heating / cooling to the set value or program segment value according to the selected heating / cooling rate. The PRG light will flash when the heating / cooling rate is limited. If there is no cooling output and the natural cooling rate<SPrL, making the cooling slope fail to be guaranteed, the system will cool down at the natural cooling rate.

Name	Setting	Description
SPr	0~3200	Set limit to heating rate, in ℃/min
SPrL	0~3200	Set limit to cooling rate, in ℃/min

5.8 Selection under Power-on Running Status

After the equipment is powered on or recovered from accidental power failure, the instrument can select the video tutorial

Name	Setting	Description
PonP	Cont / StoP etc.	Select the running status once power on again

5.9 Selection of Power Frequency and Temperature Unit

The instrument can select the power frequency, so that the input signal has the maximum anti-interference ability under the selected power frequency. The Celsius and Fahrenheit temperature values can be selected.

Name	Setting	Description
Fru	50C\50F\60C\60F	Select power frequency and temperature unit

5.10 Alarm Blocking upon Power-on

When the instrument is just powered on, some unnecessary alarms often occur. For example, when the electric furnace (heating control) is just powered on, the actual temperature is usually far lower than the set temperature. If the user sets the lower limit alarm or the lower limit deviation alarm, the instrument will alarm as soon as it is powered on, but in fact, the control system may not have problems. On the contrary, in the cooling control (positive action control), just powering on may cause the upper limit alarm or deviation upper limit alarm. Therefore, the instrument provides alarm exemption upon power-on, so that the instrument will not alarm immediately even if it meets the corresponding alarm conditions after power on; After the alarm is canceled, the corresponding alarm will be generated if the alarm condition is met again.

Name	Setting	Description
Act	rEbA or drbA	Set rEbA as the power-on exemption lower limit alarm and drbA as power-on exemption upper limit alarm

5.11 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 RS232C/RS485 converter or USB / RS485 converter. Every communication port of a computer can connect up to 60 AI instruments. With RS485 repeater, up to 80 AI instruments can be connected. If large quantity of instrument is required, 2 or above computers can be used with a local network formed. Please note that every instrument connecting to the same communication line should be set to a unique communication address.

AIDCS application software, a distributed control system software developed by Yudian, can control and manage 1~200 AI instruments, record the data, generate and print reports under the Chinese Windows operating system. 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 distributed control system software support AI instruments.

Name	Value	Description
AFC	0~12	Set communication mode, select MODBUS-RTU or AIBUS, etc
Addr	0~80	Set communication address
bAud	0~28.8K	Set communication baud rate

5.12 Temperature Re-transmitter/Program Generator

Apart from APID / nPID control and ON-OFF control, the instrument can retransmit PV (processed value) or SV (set value) from OUTP or COMM terminals. AI-8*9 becomes a temperature re-transmitter when the output is defined as current output, while the program function starts, AI-8*9 becomes a program generator. The precision of current output is 0.3%FS.

5.12.1 Retransmitting output at OUPT terminal

Name	Setting	Description
CtrL	POP or SOP	Retransmit PV or SV
SCL	0	Set the lower limit value of input signal and that of retransmission
SCH	1000	Set the upper limit value of input signal and that of retransmission
OPt	0~20 / 4~20	Set signal type for retransmission

For example, the instrument is required to have the K-type thermocouple retransmitting function, with temperature 0~400 ℃, output 4~20mA. The parameters are set as follows: InP=0, SCL=0.0, SCH=400.0, OPt=4~20, OPL=0, OPH=100. For the defined transmitter, when Temp≤0 ℃, the output of X3 or X5 installed at OUTP is 4mA; when Temp≥400 ℃, the output is 20mA; when the temperature is between 0 ℃ and 400 ℃, the output changes continuously between 4 and 20mA.

5.12.2 Retransmitting output at COMM terminal(Note: Only one function at the COMM can be selected, such as transmission, communication or event input)

Name	Setting	Description
bAud	3 or 4 or 8 or 12	Retransmit PV or SV and set 0~20 or 4~20mA
SCL	0	Set the lower limit value of input signal and that of retransmission
SCH	1000	Set the upper limit value of input signal and that of retransmission

5.13 Fine Control

Under fine control, the PID operation resolution is 10 times higher than the display resolution. For example, the temperature signal of the instrument is displayed at 1 ℃, but the internal PID is still operated and controlled according to the resolution of 0.1 ℃, which can achieve a much higher control accuracy than the display resolution. The previous AI series instruments only used fine control for temperature signals. When the new version of the instrument was in linear input, as long as the displayed value was less than 3000 words (most industrial applications were no more than 3000 words), the fine mode was defaulted to obtain higher control accuracy and more stable output. When the displayed value was greater than 3000, the high-resolution mode can be set.

Name	Setting	Description
AF	AF.F＝0 or1	F=0, fine control mode; F=1, high resolution display mode

5.14 Selection of Cascade Control Mode and Dual Input Mode

Cascade control mode refers to that the system connects two regulators in series, and the output value of one regulator is used as the set value of the other regulator. It is mainly used in the following situations, such as large lag and time constant of the control object, strong and frequent interference, large load change, and high control quality, such as equipment like diffusion furnace, reactor, etc. In the dual input mode, the process value of one of the two channels can be selected as the process value of the main control according to conditions, and the output can be controlled and edited according to the process value of this channel.

Name	Setting	Description
Cc	1~200	Cascade control mode: the smaller the lag time of auxiliary control is compared with that of main control, the larger the Cc can be set
	201	Dual input with hot spare
	202	In dual input mode, take the lower value of the two channels as PV of the main control.
	203	In dual input mode, take the higher value of the two channels as PV of the main control.

5.15 User-defined Input Specifications(Cc=0)

When the parameter InP=10 is set, the instrument input specification is a user-defined input type, and non-linear tables can be edited. Setting method: Set Loc parameter to 3698 to enter the table setting state. The parameter A 00 definition table is used for: 0 for input nonlinear measurement or multi segment linear correction of input signal, 1 for nonlinear power control of high temperature furnace; Parameters include A01~A04 and d00~d59 (the values of A02~A04 and d00~d59 have decimal places. If dPt is set to 0.0, the values of A02~d59 should be divided by 10), respectively set as follows:

A 00: 0

A 01: Define the input type, whose values are defined as follows:

A 01=A*1+E*16+G*64

A indicates input signal range: 0, 0~20mV (0-80 Ω); 1, 0~60mV (0-240 Ω); 2, 0~100mV (0-400 Ω); 4，0~5V； 10, 0~20mA or 0~10V (I4 or I31 module is installed at MIO position).

E indicates input signal display: 0, indicating that the table output value needs to be calibrated again by the SCH/SCL parameter when the linear input signal is used. 1, indicating that the table output value is the display value.

G indicates the type of input signal (determine whether the input signal is temperature type or non temperature type): 0, thermocouple; 1. Thermal resistance; 2. Linear voltage (current); 3. Linear resistance.

For example, if the signal is 1-5V voltage input and not temperature type, set A01=4*1+0*16+2*64=132

A 02: Define the lower limit of the input signal, equal to the lower limit of the signal * K/range, e.g. 1-5V signal input, A02=1*25000/5=5000 can be set.

K is the signal coefficient, where the coefficient is 20000 when A01. A is 0, 25000 when A01. A is 2, 4 and 10, and 30000 when A01. A is 1.

A 03: Define the input signal range, equal to the signal range × K/range, for example, in 1-5V input, if the range is 5-1V=4V, A03=4*25000/5=20000 should be set.

A 04: Define the table spacing of input signals, A04=A03/number of curve segments. If there is only one segment, A04 is equal to A03; If it is divided into two sections, A04=A03/2.

d 00: represents the starting point value of the curve table, which corresponds to the output value when the input signal is A02.

d 01: represents the value of the first segment of the curve table, which corresponds to the output value when the input signal is A02+A04, for example, it can be set as 20000 in 1-5V input (full scale).

d 02-d59: indicates the values of the 2nd to 59th segments of the curve table. All applications can correct very complex curves, such as square root, logarithmic and exponential curves.

5.16 Multi-step Linear Correction to Input Signal(Cc=0)

When the input specification InP is set to plus 64, the instrument has the input multi segment linear correction function. Setting method: Set Loc parameter to 3698 to enter the table setting state (if Loc=808, set Loc to 0 first, exit the parameter setting state, and then enter the parameter state again to set Loc to 3698). The settings are as follows:

A00：0；

A01: Input signal and display setting:

A 01=A*1+E*16+G*64

A indicates signal range: A=0, 0~20mV (0-80 Ω); A=1, 0~60mV (0-240 Ω); A=2, 0~100mV (0-400 Ω).

E indicates signal display: E=0, no effect; E=1, the values set in the table d00~d59 are the displayed values.

G indicates signal type: G=0, thermocouple; G=1, thermal resistance.

For example, if the signal is thermocouple input and temperature type, set A01=2*1+1*16+0*64=18

A02: Starting temperature

A03: measuring range=highest value measured - A02

A04: Temperature interval of each section=A03/number of sections

d00~d59: temperature setting value of each section

For example, the input range of K thermocouple is 0 to 300 degrees, one decimal place, correction every 100 degrees. Then set parameters A00=0, A01=18, A02=0.0, A03=300.0, A04=100.0, d00=0.0, d01=100.0, d02=200.0, d03=300.0. Just set the corresponding temperature point slightly higher or lower than the value displayed on the instrument, for example, the instrument shows 200.0 degrees, and the calibration device measures 202.0, then change d02=200.0 to d02=202.0.

Note: The corrected value is the value of each point, and the point-to-point transition is automatic and linear. When this function is enabled, the instrument can only be displayed within the temperature range set by the table. When the actual temperature exceeds the table range, the instrument will display the orAL overrun alarm.

5.17 Nonlinear Power Control to High Temperature Furnace

For high-temperature furnaces with non-linear load, the resistance will change dramatically with the temperature change. Take the silicon-molybdenum bar furnace as an example, its room temperature is about 6% when the resistance is only 1600 degrees. If the output power of the instrument is not limited and transformed, it will lead to two problems. First, when the instrument starts at low temperature, the current of the electric furnace is too large and exceeds the maximum allowable load of the power grid, thyristor and transformer, which causes damage to thyristor, electric furnace and transformer or even causes power grid tripping. In addition, when the instrument has the same output, the power of the electric furnace in the low temperature zone and the high temperature zone will differ by more than 10 times at most, which means that the proportional band P in the PID parameter needs to change by more than 10 times at different temperatures to enable accurate temperature control in the low temperature and high temperature zones. However, the method of limiting parameter OPH can only limit the output power and cannot achieve proportional band transformation. If accurate temperature control is required in high and low temperature areas, multiple sets of PIDs need to be set, which is not only complex to use, but also ineffective. The user-defined output limit transformation function simultaneously solves the function of limiting output and transforming the proportional band P. This function limits and transforms the instrument output according to the measured temperature. It not only limits the power in the low temperature zone, but also automatically corrects the parameters of the proportional band at different temperatures. The power limit and the change of the proportional band are both continuous broken line mode, which is better than the grouping mode. The power limit only reduces the actual output of the instrument proportionally, while the display range of the instrument output is still 0~100%. For example, when it is used for silicon molybdenum bar furnace, it can be set as follows (customers can also edit the data according to their own needs):

A00=1，A 01=1050，A02=100.0；A03=1500；A04=750.0，d00=120.0；d01=1100，d02=2000

A00=1，a01=1050，A02=100.0A03＝1500A04=750.0，d00=120.0d01=1100，d02=2000

When parameter A00=1 and A01=1050 are set, the instrument enables the user-defined output limit transformation function. A02 represents the initial temperature of the output limit, A03 represents the temperature range of the output limit, and A04 represents the segment length of the nonlinear data temperature segment. In this example, 1500/750.0=2 represents two segments. The more segments, the more complex and refined the curve can be. D00 represents the maximum output power when it is lower than A02, and its unit is 100% × (1/2000), d00=120.0 means 6%, d01 means 55%, and d02 means 100%. The meaning of this curve is that when the temperature is below 100 ℃, the output limit is 6%; when the temperature is between 100 ℃ and 850 ℃, the power limit is 6% and smoothly transits to 55%; when the temperature is between 850 ℃ and 1600 ℃, the power limit is 55% and 100%; when the temperature is above 1600 ℃, the power limit is not limited to 100%.

Note: The range of d value is 0~59, which is equivalent to the maximum power limit of 60 segments. This function cannot be used with the input multi segment linear correction function at the same time. If it is used at the same time, special specification input is required. Please contact the seller to negotiate the solidification into the instrument, but there may be a one-time additional payment.

6 Program Control（Pno≥1）

The AI-8*9 program type instrument is used in situations where it is needed to automatically change the set value to control according to a certain time rule. It not only has the function of 50 steps programming, which can set the rise and fall slope of any set value, but also has programmable/operable commands such as jump, run, pause and stop, which can edit the program during controlling; in addition, it has functions like power failure processing, process value startup and preparation, which makes program more efficient and perfect.

6.1 Functions and Concepts

Program step: The number of the program Step can be defined from 1 to 50. The current Step is the program Step being executing.

Program time: refers to the total running time set for the program step, in minute or hour, with effective values ranging from 0.1 to 3200.

Running time: refers to the running time of the current step. When the running time reaches the set period, the program automatically moves to the next period.

Jump: the program step can be programmed to automatically jump to any step to achieve circle-control. Or it can also be achieved by editing the value of StEP.

Run (run/HoLd): When the program is in the running status, the time shall be timed, and the changes of the set value follow the prearranged program curve. When it is changed to suspend status (suspended), the timing function stops and the set value remains unchanged. The suspend operation (HoLd) can be programmed in the program step.

StoP: it will stop the program running. Here the running time is cleared and the timing as well as the output is stopped. In this situation, if the instrument is required to run, start the step number set by StEP. Autostop is allowed to be programmed into steps and the StEP value of the run step is set. Or stop the operation artificially at any time (StEP is set to 1, which can be modified by the user). If the program step has run through the last step defined in the Pno parameter, it stops automatically.

Power cut/ resume event handling: it refers to the power on or the accidental power failure during operation. A variety of solutions can be found by setting PonP parameters.

PV preparation function (rdy): When the program is running and the power is cut off/started unexpectedly but the operation needs to continue, if the process value is different from the set value (if the program allows starting with the process value, start with the process value; and if the process value works well, the preparation function is unnecessary, and only when the process value does not meet the requirements for starting can the preparation function be used for processing), and when PV-SV>deviation alarm value (HdAL and LdAL), the instrument will not immediately give a positive (or negative) deviation alarm. On the contrary, it will adjust the process value until its error is less than the deviation alarm value. Here the timing will be suspended, and the deviation alarm signal will not be output. The program will not be started again until the positive and negative deviations meet the requirements. The preparation function can also be used to set the program step with unpredictable rise/drop time, which can be achieved by setting PAF parameters; It can ensure the integrity of the whole program curve, but it is possible to increase the total running time due to the preparation time. The preparation function and process value startup can be used to solve the uncertainty of program operation caused by the inconsistency between the process value and the set value during startup, so as to obtain efficient, complete and satisfactory results.

PV Startup: When the program is started and the power is cut off/started unexpectedly but the operation needs to continue, the actual process value is often different from the set value set by the computer, which is sometimes unexpected and unpredictable. For example, set a heating section from 25 ℃ to 625 ℃ after 600 minutes, and the temperature will rise by 1 ℃ every minute. It is assumed that when starting from the starting position of this program step, if the process value is just 25 ℃, the program can run successfully as originally planned, but if the system temperature has not been reduced at the time of starting, for example, 100 ℃, then the program cannot run successfully as originally planned. Thus the startup function of the process value can be realized by automatically adjusting the running time of the instrument to make them consistent; In the above case, if the measuring temperature is 100 ℃ when starting the operation, the instrument will automatically set the running time to 75 minutes, so that the program can be started directly from the position of 100 ℃.

Curve fitting: it is a controlling technology adopted by the instrument. Because the control objects usually lag behind time, the instrument automatically smoothes the linear rise, drop and constant temperature curves at the break point. The smoothness is related to the system's lag time t (t=differential time d+control period Ctl). The greater t is, the greater the smoothness is, and vice versa. The smaller the lag time (such as thermal inertia) of the control object, the better the control effect. The overshoot can be avoided by processing the program curve according to the way of the curve fitting.

Note: The characteristic of curve fitting makes the program control generate a fixed negative deviation during linear temperature rise and a fixed positive deviation during linear temperature drop. The value of the deviation is proportional to the lag time (t) and the rate of temperature rise (fall). It is a normal phenomenon.

6.2 Program Arrangement

6.2.1 Ramp Mode

When the parameter PAF.B=0, the program arrangement is set in the 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 is the same as PV (processed value). The unit of time can be minute or hour. In ramp mode, when the program pointer reaches the last step number defined in Pno parameter, the instrument will hold the time (t) at the temperature (SPx) then ends the program, unless the SPx value is a command for stop or jump. The following example includes 5 steps, which is linear temperature heating up, constant temperature, linear temperature cooling down, jump cycling, ready, Hold.

Step 1: SP 1=100 , t 1=30.0; Start linear temperature heating up from 100℃. Time required is 30 minutes. Rate of temperature increase is 10℃/minute.

Step 2: SP 2=400 , t 2=60.0; Temperature 400℃ is kept for 60 minutes.

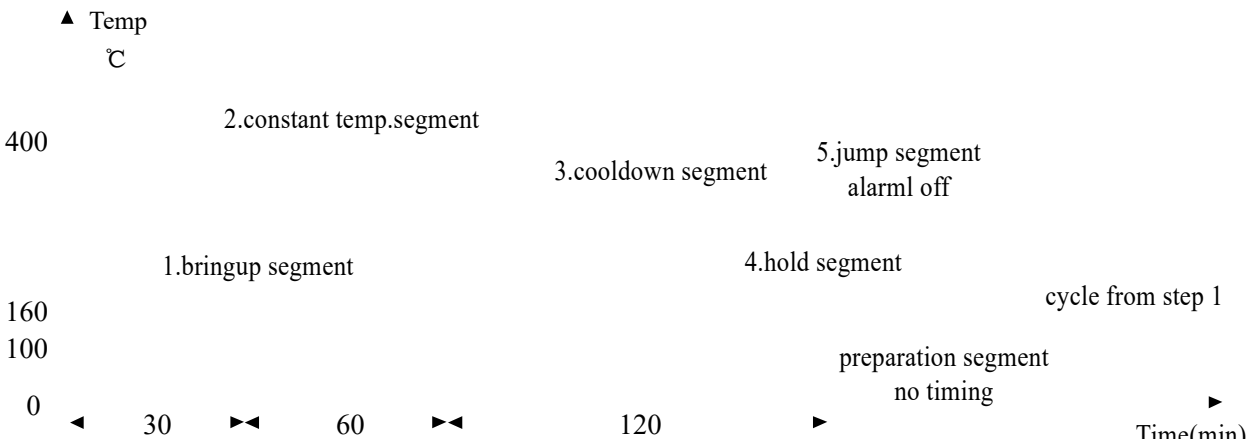
Step 3: SP 3=400 , t 3=120.0; Temperature cooling at a rate of cooling is 2℃/minute. Time needed is 120 minutes to reach SP4

Step 4: SP 4=160 , t 4=0.0; When temperature reached 160 degree, the program paused (HoLd status). User has to execute “run” to proceed to next steps.

Step 5: SP 5=160 , t 5=-1.0; Jump to Step 1 to start from beginning in a loop.

In the example above, When the program jump from step 5 to step 1, the temperature is 160℃ which is not equal

to the value of step 1 as 100℃. The step 5 is a command step as well. Assuming that the deviation high alarm is set to 5℃, before the program jumping from step 5 to step 1, it will activate PV Preparation/Ready function (if PV Preparation/Ready “rdy” was enabled) to regulate the temperature until the deviation between PV and SV is less than deviation high alarm value, i.e. 105℃. Then the program will be started from Step 1 again. The temperature control curve is illustrated below.

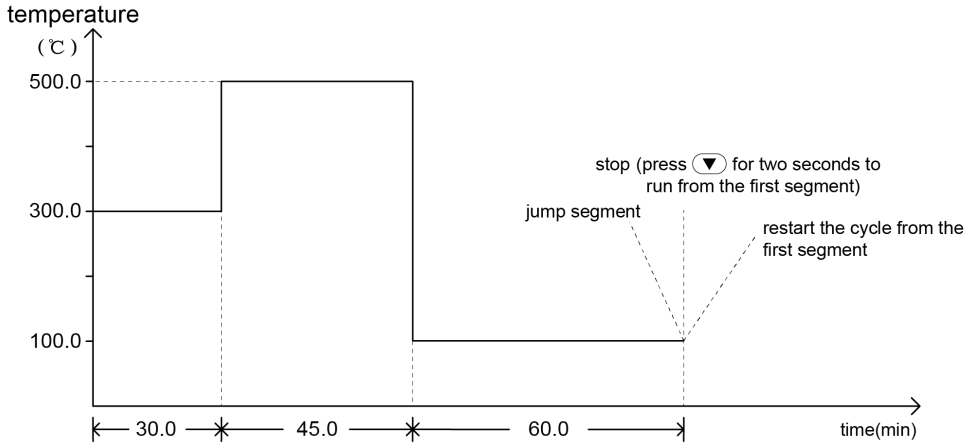


The advantage of applying “temperature-time-temperature” arrangement is to provide a wide window of setting rate of increasing and decreasing temperature. The format of increasing and decreasing temperature steps keep the same format, for easy to learn. There is a high flexibly to set the curve, enabling possibility to input continuous increasing curves (e.g. using different rate of increasing curve to achieve functional heating) or continuous temperature holding steps

6.2.2 Soak Mode

When the parameter PAF.B=1, soak mode is selected. This is suitable for the process which does not need to establish the temperature slope, simplifying the programming and using the quantity of steps more effectively. Each step contain the meaning of “temperature ~ holding time at that temperature”. Parameter “SPr” defines the rate of temperature change among steps. If “SPr=0”, the rate will set to maximum. Since the time of temperature increasing and it occupies the holding time, PV preparation/Ready function “rdy” is advised to be used to ensure to obtain the correct soak time (holding time).

Step 1: SP 1=300.0 t 1=30.0; Temperature at 300 ℃ for 30 minutes
Step 2: SP 2=500.0 t 2=45.0; Temperature at 500 ℃ for 45 minutes
Step 3: SP 3=100.0 t 3=60.0; Temperature at 100 ℃ for 60 minutes
Step 4: SP 4=160.0 t 4=-121.0; The program enters the stop status.


temperature
(℃)
500.0
300.0
100.0
stop (press ▼ for two seconds to
run from the first segment)
jump segment
restart the cycle from the
first segment
30.0
45.0
60.0
time(min)

6.2.3 Time Setting

Each step of program includes set value and time. The range of the set value is limited by SPL and SPH, which is - 999~+3200 ℃, indicating the temperature (℃) or linear unit to be controlled; In addition to the running time, time has special significance, as follows:

Set “t-xx” = 0.1¯3200 (min)

Set the time of Step xx. (Time unit can be change to hour by parameter “PAF”.)

Set “t-xx” = 0.0

The program pauses (HoLd) on Step xx. The program will be paused and timer pauses counting.

Set “t-xx” = -121.0

The program stops(StoP), and go into stop status.

Set “t-xx” = -0.1¯-122.0

Negative value in time value represents a command (a jump operation + event output). The integral part “-1~-120” refers to the step number to jumped to. Step number greater than Pno (Number of program step) with non-zero decimal space does nothing but proceed to next step. Decimal place refers to programming of event output at AL1 and AL2. – XXX.0 indicates the event is none but step jumping only. Please note that if parameter AOP assigns alarm action at AL1 or AL2, no matter event outputs or ordinary alarms will cause alarms from AL1 and AL2. The definition of -XXX.1 ~ -XXX.4 are as below

-XXX.1, AL1 activated, AL2 released

-XXX.2, AL1 released, AL2 activated
-XXX.3, AL1 activated, AL2 activated
-XXX.4, AL1 released, AL2 release

Example 1: t- 5 = -1.1; When the program pointer arrives step 5, AL1 is activated. AL2 is released. The program jumps to step 1 to keep running.

Example 2: t- 6 = -0.3; When the program arrives step 6, AL1 and AL2 are activated. The program proceeds to the next step (Step 7).

Note: Only when the “run” operation is executed or jumping during the power is just on, the program will continues to jump. If the program jump to a step setting itself is a jump step as well, the program will be paused (HoLd status. The system will automatically insert HoLd between two jump step). External run/Hold operation is needed to release this HoLd status. Please be reminded if the jumping destination is the step number itself(i.e. t- 6= -6), the HoLd status is not able to be released. This is a meaningless step.

6.2.4 Program arrangement of multi-curve operation

AI-8*9 has the advanced function of flexible program arrangement. Normally, when the program stops (StoP), the StEP will be automatically set to 1. If multiple curves are defined in all the steps available, the control method can be done by setting different jump steps in step 1, as a starting point. For example, there are three curves with the length of 3 steps represent three groups of process parameter. They are separately arranged on Step 2~Step 4, Step 5 ~ Step 7 and Step 8 ~ Step 10. By changing the step number:

t- 1=-2.0 Execute the program of curve 1 (Step 2 ~ Step 4)

t- 1=-5.0 Execute the program of curve 2 (Step 5 ~ Step 7)

t- 1=-8.0 Execute the program of curve 3 (Step 8 ~ Step 10)

When the manufacturing methodology is required to be changed, the curves can be loaded by setting the “t-1“ as -2.0, -5.0 or -8.0. This jump selection step can also be omitted. The corresponding StEP number can be chosen before the program starts.

7 Display/Alarm Symbols and FAQs

7.1 Display/Alarm Symbols

The instrument starts the basic display status upon power on. At this time, the upper and lower display windows show the process value (PV) and the set value (SV) respectively. The SV display window can also alternately show symbols or the status, as shown in the following list:

Name	Description	Solution
At	Auto-tuning status	Wait for the tuning to come to an end, or manually change the At parameter to OFF
AAt	Fast self-tuning status	Wait for the tuning to come to an end, or manually change the At parameter to OFF

StoP	Stop status	Press ▽ for two seconds to run the instrument, if fails, please check whether communication, event input or other factors that restrict its the running.
run	Running status	This symbol is displayed once when it runs successful and no need to be handled
HoLd	Suspend status	Press ▽ for two seconds to run the instrument. If fails, please check whether communication, program step settings or other factors that restrict its running.
rdy	Ready state	After the measured signal meets the required setting, it will automatically continue running, or cancel ready status by editing the PAF parameters
A 50	Automatic output status with the number representing the output percentage	Click ↺ to switch to SV status or click ◁ to switch to the manual output status
M 50	Manual output status with the number representing the output percentage	Upon the MAN light on, click ◁ to switch to the automatic output status, then click △ and ▽ to edit the output percentage

orAL	Over-range of the input measurement signal	Check whether the input specifications and parameters are set correctly, whether the input wiring is correct, and whether the input signal is normal
HIAL	Occurrence of an upper limit alarm	When PV< HIAL-AHYS, or set the HIAL=32000 to turn off the alarm
LoAL	Occurrence of a lower limit alarm	When PV>LoAL+AHYS, or set LoAL=-9990 to turn off the alarm
HdAL	Occurrence of a deviation upper limit alarm	When PV-SV< HdAL-AHYS, or set HdAL=32000 to turn off the alarm
LdAL	Occurrence of a deviation lower limit alarm	When PV-SV>LdAL+AHYS, or set LdAL=-9990 to turn off the alarm
EErr	An error is detected within the system, such as parameter loss, etc.	Need to be returned to the factory for repair

Note: If necessary, turn off the character flashing during upper, lower limit and deviation alarms to avoid excessive flashing (set the ADIS parameter to oFF).

7.2 FAQs

7.2.1 How to set self-tuning?

When the process value PV is room temperature, set the set value SV to about 60% of the common temperature (directly set signals like pressure or flow to commonly-used set values), then press ◁ and hold for two seconds to call up the parameter At, change the parameter value from OFF to ON, and click ↺ to start self-tuning. After the self-tuning signal At automatically stops flashing, it can work normally.

7.2.2 How to enter the internal parameter list?

Press ↺ and hold for two seconds to enter the parameter list, and then press ↺ briefly to refer to the next parameter. If the parameters are locked, please find the password lock LOC and set it(Default value=808. or set the correct password if it is edited), then press ↺ briefly to refer to all the parameters.

7.2.3 How to judge whether the instrument has output?

First, check whether the panel indicator light OP1 is on, If it is not on, check whether the instrument operates normally, then check whether the instrument parameters are set correctly; If it is on, it indicates that the instrument output status is normal. A multi-meter can be used to check whether the output signal is normal. If it is normal but the back-end actuator does not work, it is necessary to check other equipment or line faults along the output line. If there is no output signal, it can be judged that the output module is abnormal.

7.2.4 Panel flashes orAL?

When the panel flashes orAL, it indicates that there is no input signal. First, check whether the sensor model corresponds to the input specification parameter InP, and then check whether the input terminal wiring is correct. If there is no problem for the above mentioned, judge whether the input signal of the sensor is correct, otherwise, the sensor may be damaged.

7.2.5 How to enter the program step settings?

After the instrument is powered on, click  on the initial display to enter the program step menu, then click  to display the next data. Each program is arranged in the order of "given value-time-given value". Welcome to find more details about the program step setting in the manual's program control chapter.

7.2.6 How to set alarm parameters?

First, set the alarm parameters to the required values (for example, if 200 degrees is set for the upper limit alarm, change the HIAL value to 200), then enter the internal parameters to find the parameters AOP to define the alarm output terminals(for example, If the upper limit alarm outputs from AL1, set the digit of AOP to 1. For specific definitions, please refer to the AOP parameter introduction in the manual).

7.2.7 How to set bidirectional output for heating and cooling?

Enter the internal parameter list to find the OPL parameter (output lower limit), change the OPL to -1%~-110%, the instrument becomes a bidirectional PID output system, the main output OUTP is used for heating control, while the auxiliary output AUX is used for refrigeration control.

7.2.8 How to switch manual/ automatic output?

Click  once on the initial interface, and the SV will switch from the set value to the output value state. Click  again to make the instrument switch between automatic and manual without disturbance. A is the automatic state, and M is the manual state.