AI-8 Artificial Intelligence High-performance Multi-functional Industrial Regulator User’s Manual

(V9.3)

CONTENTS

Friendly Reminder

1. The user of this product must have sufficient knowledge of electrical systems and ensure that this product is not used in situations that may pose a danger to personal safety or property. Before using this product for the first time, please read the entire user manual carefully to ensure proper use.
2. If the features do not match those described in this manual, please confirm your model version and download the corresponding manual from the official website, or contact the technical support hotline for assistance.
3. Unauthorized modification or disassembly of the module casing may result in unexpected errors or hazards. Please do not use unused terminals.
4. During installation, avoid areas with high voltage, high-frequency noise, or high current to prevent interference.
5. Please make sure to disconnect the power supply before wiring or replacing modules. Sensor inputs and loads should be wired separately.
6. When using a thermocouple input, be sure to use compensation wires that match the thermocouple specifications and connect them directly to the input terminals.
7. When using a three-wire RTD input, ensure that all three wires are of equal length and impedance to avoid introducing additional measurement errors.
8. It is recommended to use shielded wire for analog signal input/output, and the shield layer should be grounded.
9. Before powering on, please ensure that the power supply, input, and output wiring are correct; otherwise, serious damage may occur. Do not touch the module terminals or perform maintenance after powering on, as this may result in electric shock.
10. This product is a high-precision instrument. Do not subject it to any kind of strong pressure or force, as this may damage the internal components and affect normal operation.

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 function, it has the AAT advanced and fast self-tuning function, which can analyze the heating curve to calculate the PID parameters when the equipment is powered on and heat up, and does not need to oscillate back and forth like the traditional AT, which greatly saves the equipment debugging time.

● The input can freely choose thermocouple, thermal resistance, voltage, current and expand the input and self-defined nonlinear correction table. The measurement accuracy of some input types can reach 0.05 level.

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

● Its power supply of the controller adopts the global switching power supply in the range of 100~240VAC, which provides comprehensive power protection function. Even if 380VAC is misconnected for a long time, it will not burn out; 24VDC power supply can also be selected, and it has a variety of external sizes to choose from.

● It attaches great importance to the design concept of energy saving and environmental protection, and selects "fever" grade 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.

● It adopts advanced modular structure, provides rich output specifications, and can widely meet the needs of various application occasions, fast delivery and easy maintenance.

● It allows editing operation authority and field parameter table, and can set password to form "customized" instrument.

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

● Its strong anti-jamming design has passed the 6KV group pulse anti-jamming test, what's more, its anti-jamming performance 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, with no light leakage or viewing angle problems, higher luminous efficiency, brighter colors, and greatly reduced power consumption, and different LED color matching modes can be selected.

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

● The designed temperature range is as wide as -10~+60 degrees, and high-precision crystal oscillator is used, and the actual aging test temperature is as high as 100 degrees.

● When the instrument has multiple sets of input and output, it can provide a complete solution of power supply and photoelectric isolation.

● When the parameter Pno is set to 0, the built-in program control function is fully compatible with the fixed-point operation mode. When it is set to 1, only the given value and timing control time need to be set. AI-8*8 series can support up to 50 programs control function.

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

● With external given value control function (only AI-8*8 series) and measured value / given value transmission as 4~20mA or 0~20mA output function.

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

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

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

● A variety of thermocouple cold junction compensation modes can be selected: in addition to the common internal compensation mode, high-precision external Pt100 and freezing point compensation modes are supported.

● When the sensor is disconnected, 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*48, 72*72, 48*96, 96*48, 96*96, 160*80, 80*160 and other panel mounting and E7、 D71 rail mounting modules.

1.2 Ordering Code Definition

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

The panel-mounted panel model of the AI-8 series artificial intelligence temperature controller/regulator consists of 9 parts:

AI－858	A	N	X3	L3	N	S2	－	24VDC	－	F2
①	②	③	④	⑤	⑥	⑦		⑧		⑨

This means the instrument: ①the basic model is AI-858; ②the panel size is A type (96×96mm); ③the auxiliary input (MIO) has no module installed; ④the main output (OUTP) is installed with a linear current output module; ⑤Alarm ALM is installed with L3 dual relay contact output module; ⑥Auxiliary output (AUX) has no module installed; ⑦⑦ Communication Interface (COMM): Equipped with an optically isolated RS485 communication interface S2; ⑧The power supply of the instrument is 24VDC power supply; ⑨The expansion input specification is F2 type (radiation type high temperature thermometer); the following are the meanings of the 9 parts in the instrument model:

① Indicates the basic model of the instrument

AI-888 (level 0.1 accuracy, 10-year free warranty, full-featured artificial intelligence controller/regulator)

For high-precision instrument 888, the suffix J0 (indicating RTD) or J1 (indicating TC) is added to the model number to distinguish the input type. Note: J1 input has an internal PT100 soldered for improved accuracy, but this results in it only accepting thermocouple input. (The J0/J1 note is placed after the dimensions.)

AI-868 (level 0.15 accuracy, 5-year free warranty, full-featured artificial intelligence controller/regulator)

AI-858 (level 0.2 accuracy, 5-year free warranty, full-featured artificial intelligence controller/regulator)

AI-838 (level 0.25 accuracy, 3-year free warranty, full-featured artificial intelligence controller/regulator)

AI-828 (level 0.3 accuracy, 2 years free warranty, full-featured artificial intelligence controller/regulator)

AI-826 (level 0.3 accuracy, 2 years free warranty, artificial intelligence controller/regulator)

Note: Compared with the 8*8 series, the 8*6 series lacks the valve forward/ reverse function and the external given function, and the program segment can be set to 1 segment at most.

② Indicates instrument panel size specifications

Socket Module	Welding Module	Panel Size
A	--	Panel type, 96×96mm(W*H), hole size 92×92mm
A9	--	Panel type, 96×96mm (W*H), double-row 5-digit display + third-row 4-digit display
B	--	Panel type, 160×80mm (W*H), opening size 152×76mm
C3	--	Panel type, 80×160mm (W*H), opening size 76×152mm
D	--	Panel type, 72×72mm (W*H), hole size 68×68mm
--	D61	Panel type, 48×48mm (W*H), opening size $45^{+0.5}$×$45^{+0.5}$mm
--	D71	DIN rail type, built-in display, pluggable terminals, installation width 22.5mm
E	--	Panel type, 48×96mm (W*H), hole size 45×92mm
E3	--	Panel type, 48×96mm (W*H), three rows of 4-digit display
E7	--	DIN rail type, built-in display, pluggable terminals, installation width 22.5mm
E9	--	Panel type, 48×96mm (W*H), double-row 5-digit display + third-row 4-digit display
E5	--	DIN rail type, width 48mm, no display window by itself, external E85 display
F	--	Panel type, 96×48mm (W*H), hole size 92×45mm

③ **Indicates the module specifications installed by the instrument auxiliary input (MIO):** I2、I5、I45、K3、V and other modules can be installed, N means not installed, the same below.

④ **Indicates the module specifications installed on the main output (OUTP) of the instrument:** L1,L5,W1,W5,G,K1,K3,X3,X51,X56 and other modules can be installed. 8*6 series do not support OUTP to install L5 module to realize the valve forward and reverse.

⑤ **Indicates the module specifications installed by the instrument alarm (ALM):**L0,L21,L3,W1,W5,G and other modules can be installed.

⑥ **Indicates the module specifications of the instrument auxiliary output (AUX) installation:** L0, L1,L21,L3,W1,W5,G,K1,X3,X51,X56 and other modules can be installed.

⑦ **Indicates the module specifications installed by the instrument communication (COMM):** S,S2,V,X3 and other modules can be installed.

⑧ **Indicates the power supply of the instrument:** if not written, it means using 100~240VAC power supply, 24VDC means using 20-32VDC power supply.

⑨ **Indicates the extended scale specification of the instrument** (if not, do not write it), AI-8 series has stored the commonly used thermocouple and thermal resistance input specifications (see the technical specifications later for details), but if the specifications other than the above are used Input signal, users are allowed to expand an input specification.

Note 1: This instrument is a maintenance-free instrument that adopts automatic zero adjustment and digital calibration technology. If the measurement is out of tolerance, the problem can be solved by cleaning and drying the inside of the instrument. If drying and cleaning cannot restore the accuracy, this instrument is regarded as a faulty instrument and sent back to the factory for maintenance;

Note 2: The instrument provides free warranty during the warranty period. For any instrument that needs to be repaired, be sure to write down the fault phenomenon and reason and contact information to ensure that the correct and comprehensive repair can be obtained.

1.3 Using Modules

1.3.1 Function Definition of Module Socket

AI-8 series instruments have 5 (MIO\OUTP\ALM\AUX\COMM) optional function module sockets (For E7 rail-mounted type, there are 2 terminals: OUTP, AUX; the communication module is fixed installation; For D, D61 panel-mounted types, there are 3 terminals: OUTP, AUX, and COMM/ALM; For D71 rail-mounted type, there are 4 terminals: MIO, OUTP, AUX, ALM; the communication module is fixed installation); by installing different modules, different types of output specifications and functional requirements can be achieved.

Modular Socket		Function Description	Optional Modules
Auxiliary Input	MIO	Functions as extended input or event input or feed output or extended output	I45\I2\V24\V12 etc.
Main Output	OUTP	Functions as ON-OFF output or PID adjustment output or transmission output	L1\L5\G\X3\X51\K1\K50\K3 etc.
Alarm	ALM	Functions as upper and lower limit/deviation alarm output or power feed output	L21\L3\V10\V24 etc.

Auxiliary Output	AUX	Functions as the second output of heating and cooling or alarm output or RS232 communication	L1\L21\L3\G\X3\K1\R etc.
Communication Interface	COMM	Functions as RS485 communication or transmission output or event input	S\S2\X3\I2 etc.

1.3.2 Models Common Module

Name	Function Description
N（or /）	No module installed
L0	Large capacity Large volume relay normally open + normally closed contact switch output module, module capacity: 30VDC/1A, 250VAC/1A, suitable for alarming.
L1	Large-capacity large-volume relay normally open contact switch output module, module capacity: 30VDC/2A, 250VAC/2A.
L21	Small capacity small volume relay normally open + normally closed contact switch output module, module capacity: 30VDC/1A, 250VAC/1A, suitable for alarming.
L3	Two-way large-capacity large-volume relay normally open contact switch output module, capacity: 30VDC/2A, 250VAC/2A.
L5	Two-way large-capacity large-volume relay normally open contact switch output module, capacity: 30VDC/2A, 250VAC/2A.
W 1、W 5	SCR non-contact output module, W1 is single-channel normally open type, W5 is dual-channel normally open type capacity: 100~240VAC/0.2A, "not burn out" feature, no welding type module
G	Solid state relay driving voltage output module, 12VDC /30mA.
G5	Two-way solid state relay drive voltage output module, two-way 12VDC /30mA.
G51	Dual-channel isolated NPN output, can be externally connected to 5~24VDC to drive SSR or intermediate relay for driving valve motor. Maximum external voltage 24VDC, maximum drive current per channel 100mA.
K50/K60	One-way 220VAC/380VAC "not-burn-out" one-way SCR phase-shift trigger output module.
K1/K3	One-way/ three-way "not-burn-out" SCR zero-crossing trigger output module, each can trigger 5~500A bidirectional or two anti-parallel one-way SCR. K3 Solderless Modules.
X2	Photoelectrically isolated programmable linear current output module.(Occupies the second group 12V isolated power supply)
X3	Photoelectrically isolated programmable linear current output module.(Occupies the first group 12V isolated power supply)
X305	Optically Isolated HighPrecision Linear Voltage Output Module (0.2class output accuracy, Occupies the first group 12V isolated power supply), output voltage range 0-5V/1-5V.
X31	Optically Isolated HighPrecision Linear Voltage Output Module (0.2class output accuracy, Occupies the first group 12V isolated power supply), output voltage range 0-10V.
X5	High-precision linear current output module with built-in isolated power supply and optical isolation (0.2% output accuracy, does not occupy the instrument's internal isolated power supply), energy-saving type, maximum output voltage 5.5V.

X51	Optically isolated programmable linear current output module with built-in isolation power supply. Load capacity 500 ohms, compatible with dual 12V transformer.
X56	Opto-isolated programmable linear current output module with built-in isolation power supply (X56 is a soldered module).
S	Photoelectrically isolated RS485 communication interface module (Occupies the first group 12V isolated power supply).
S2	Photoelectrically isolated RS485 communication interface module (Occupies the second group 12V isolated power supply).
R	Photoelectrically isolated RS232C communication/printing interface module (if printing function is required, please specify).
V24 / V12 / V10	Isolated 24V/12V/10V/5V DC voltage output, available for external transmitters or other circuits, with a maximum current of 50mA.
I2/I5	Switch/frequency signal input interface, which can be used for external switch contact or frequency signal input.
I45	Analog 4~20mA/0~20mA input interface, including 24VDC/25mA power output for the use of two-wire transmitter.(Occupies the second group 12V power supply)

Note: please check the selection manual or call technical support for other modules not listed.

1.3.3 Module Installation and Replacement

The module can be installed before the instrument is delivered, and the corresponding parameters can be set correctly according to the user's requirements when ordering. If the module is damaged or the function needs to be changed, the user can also replace the module by himself. When replacing the module, you can pull out the instrument movement, use a small flat-blade screwdriver to carefully pry open the seam between the original module and the socket on the motherboard, remove the original module, and then install the new module according to the label. If the module type is changed, it is also necessary to change the setting of the corresponding parameters.

The welded module is solidified on the internal circuit board of the instrument. Please confirm the functional requirements before ordering to avoid wrong module selection.

1.3.4 Electrical Isolation of Modules

The instrument internally has two groups of 12V power supplies isolated from the main circuit for module use. Modules occupying the first group 12V power supply: X3, X31, X305, S, R, S6. Modules occupying the second group 12V power supply: X2, S2, I45. (Except for the special case where D61 size can be equipped with X3S) Generally, only one module using the same power supply group can be present in a single instrument. When three or more modules requiring power supply are needed, the X3/X2 can be replaced with the module X51 which has an isolated loop.

1.3.5 Application Instruction for Certain Modules

Voltage Output Modules: power output modules such as V24, V10 and V12 usually provide power for external sensors and transmitter feedback resistors. This module can be installed on any module socket, but in order to make the wiring specification, it is recommended to orderly install the modules in the positions of MIO, AUX and COMM according to whether the module positions are free.

Non-contact Switch Module: W1/W5 is a new type of non-contact switch module designed by applying advanced "not-burn-out" protection technology and zero-crossing technology. It can replace the relay contact switch output commonly used in the past to control the AC contactor or the servo motor of the electric actuator. Compared with the relay contact output module, it has the advantages of long life and can greatly reduce the interference spark of the equipment. In addition, it can greatly improve the reliability of the system. The driving element of the non-contact switch is SCR, thus it is only suitable for controlling the AC power supply of 100-240VAC specification, and cannot be used to control the DC power supply. Since the output terminal is connected in series with a protection device, the maximum continuous control current is 0.2A, and the instantaneous current is allowed to reach 2A. This driving capacity can directly control the AC contactor below 220AC and 80A, but for larger loads, it is necessary to add an intermediate relay.

Relay Module: The relay module is a very widely used output module in industrial control, but it is also the only module with service life problems and height restrictions among various modules. In addition, the action of the relay often brings a lot of electromagnetic interference, so it is important to correctly choose the relay modules. W1 module is recommended to use to control the output of mechanical switches such as contractors and solenoid valves powered by 220VAC, yet to control DC or AC power below 50VAC, only relay modules can be used, and modules such as L1 can be used. 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 board or side plate at the same time, otherwise they will meet together. Therefore, when the L1 or L3 is installed on one side, the output module should be installed on the other side instead of the L1 or L3 module again. L3 is the only two-way relay module, which can be used for 2-way alarm output, such as AL1+AL2, etc. External solid state relays (SSRs) such as G5 (SSR voltage) can also be used to drive the load if mechanical contacts are not preferred or cannot be installed due to height constraints.

1.4 Technical Specifications

Power Supply	100~240VAC/DC，-15%，+10% / 50~60Hz；24VDC，-15%，+10%
Power Consumption	≤0.2W (when only displaying with no output or external power feed consumption); Maximum total power consumption ≤3W
Input specifications	Thermocouple：K、S、R、E、J、T、B、N、WRe3-WRe25、WRe5-WRe26 etc
	Thermal resistance：Cu50、Pt100、Ni120etc
	Linear voltage：0~5V、1~5V、0-10V、0~1V、0~75mV、0~20mV、-5~+5V、-20mV~+20mV etc
	Linear current (requires external shunt resistor or install I45 module)：0~10mA、0~20mA、4~20mA(D61 size requires note for J4 input)etc
	Extended Specifications: On the basis of retaining the above input specifications, users are allowed to customize an additional input specificatio
Measurement accuracy	888：level 0.1；868：level 0.15；858：level 0.2
	838：level 0.25；828/826：level 0.3
Measurement temperature drift	≤50PPm/℃（level 0.1~0.15）；≤100PPm/℃（level 0.2~0.3）
Control cycle	adjustable from 0.1 to 300.0 seconds
Adjustment method	AI artificial intelligence adjustment, advanced control algorithm including fuzzy logic PID adjustment and parameter self-tuning function
	Standard PID tuning
	Position adjustment method (adjustable hysteresis)

	Manual control mode
Output Type	**Relay contact switch output (normally open + normally closed)**: 250VAC/2A or 30VDC/2A
	Valve motor position proportional output: Controls valve motor forward/reverse rotation, with or without valve position feedback (stroke time greater than 10 seconds)
	Linear current output: 0~10mA or 4~20mA can be defined (maximum output voltage of energy-saving modules ≥ 5.5V; high-voltage output voltage ≥ 10.5V)
	Linear voltage output: 0~5V, 0~10V
	SSR voltage output:12VDC/30mA
	SCR trigger output: Capable of triggering bidirectional SCRs from 5~500A, two anti-parallel connected unidirectional SCRs, or SCR power modules
Alarm function	There are 4 modes, such as upper limit, lower limit, upper limit deviation, lower limit deviation, etc., which can output up to 4 channels, and has the function of power-on exemption alarm selection
Communication Method	COMM/AUX position communication terminals or RS485 bus communication terminals at the bottom of D71 size; Supports MODBUS-RTU protocol (no parity or even parity) / AIBUS protocol; Baud rate adjustable from 0-28800 bit/s;
	Communication terminals can be connected to our company's TCP-MODBUS and EtherCAT communication controllers, supporting relevant communication protocols;
Electromagnetic compatibility	IEC61000-4-4 (electrical fast transient burst) ±6KV/5KHz, IEC61000-4-5 (surge) 6KV, 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 measured value does not exceed ±5% of the range.
Isolation withstand voltage	the voltage between power supply terminals and signal terminals is ≥2300V; while the voltage between the isolated weak current signal terminals is ≥600V
Using environment	temperature -10~60℃; humidity ≤90%RH

Sensor measurement range:

Input Type	Measurement Range	Input Type	Measurement Range
0 K	-200~+1300℃	9 WRe5-WRe26	0~2300℃
1 S	-50~+1700℃	12 F2 High-temperature radiometer	450~2000℃
2 R	-50~+1700℃	13 T	0~300.00℃
3 T	-200~+350℃	17 K	0~300.00℃
4 E	0~800℃	18 J	0~300.00℃
5 J	0~1000℃	19 Ni120	-50~+270.00℃
6 B	200~1800℃	20 Cu50	-50~+150℃
7 N	0~1300℃	21 Pt100	-200~+800℃
8 WRe3-WRe25	0~2300℃	22 Pt100	-200.00~+300.00℃
Linear input	-9990~+32000, user-defined		

1.5 Energy-saving and Environmental Protection Design

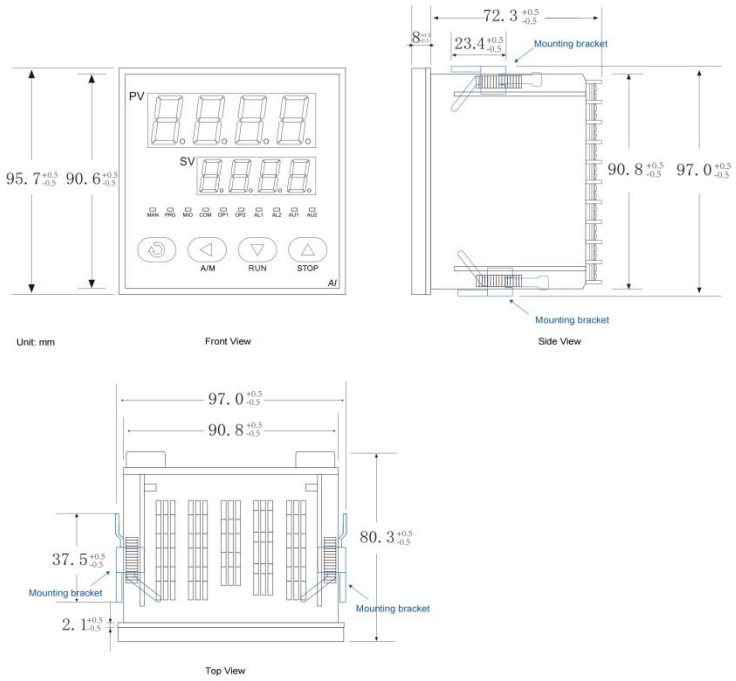
The AI-8 series adopts an energy-saving and environmentally friendly design, which is reflected in its extremely low temperature drift and its own extremely low power consumption. In order to achieve this, high-quality components are used, and low-temperature drift products are selected for key components and have been tested in pairs. Low temperature drift values can achieve better energy-saving effects in various applications. Yudian even pays attention to the power consumption of the instrument itself. For example, the use of LED displays with higher luminous efficiency can effectively reduce the driving current under the same brightness, reduce its own power consumption, and improve the reliability and performance of the product itself.

Compared with ordinary temperature control instruments, the low temperature drift instrument has less change in the measured value of temperature due to the influence of ambient temperature. which can not only make the customer's product quality more stable, but also effectively reduce energy consumption. This turns out to make the high-precision instruments more energy-efficient than the instruments with lower precision due to their low temperature drift, for example, assuming that the sintering temperature range of a ceramic material is around 1000~1010℃, and assuming that the temperature drift of an ordinary instrument on the market is about ±5℃ (caused by the change of ambient temperature in winter, summer and morning and evening), therefore, it is necessary to set the instrument at 1005°C (the temperature range is 1000~1010°C) to maintain normal production under different ambient temperature changes. While the temperature drift of AI-8 series instruments can be reduced to within ±0.3~1°C. In this case, setting the temperature at 1001°C (temperature range of 1000~1002°C) can stabilize production, so that the average temperature of the kiln can be reduced by 3 ~4°C, and the lower the average temperature of an industrial furnace, the less power it consumes. In most application scenarios, 0.3%~1% energy can be saved by reducing the temperature drift of the instrument and optimizing the debugging, and the product quality can be more stable.

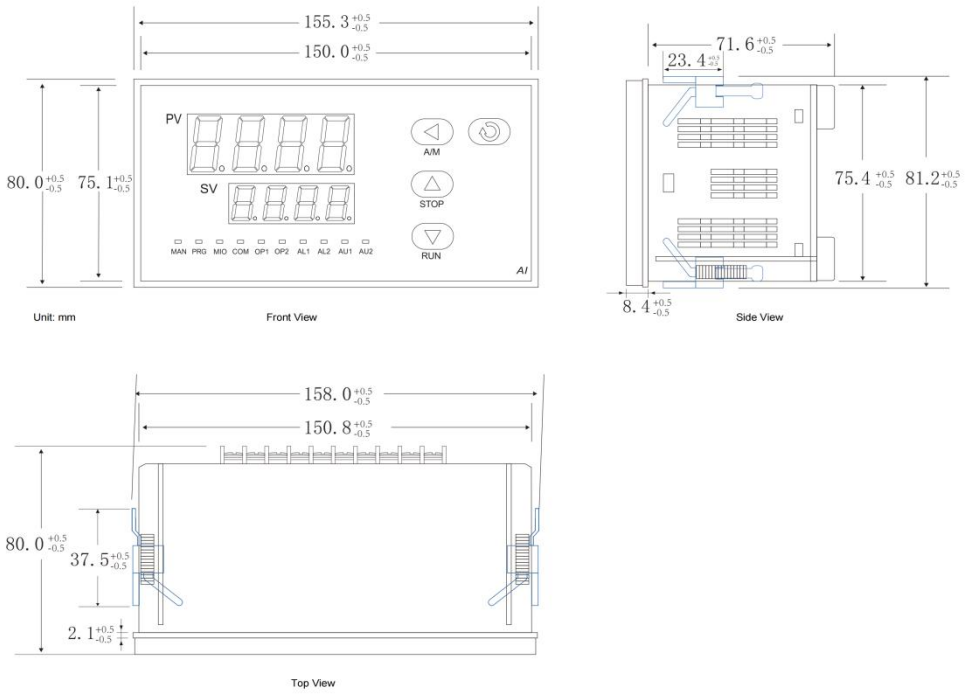
2 Installation and Wiring

2.1 Physical Dimensions

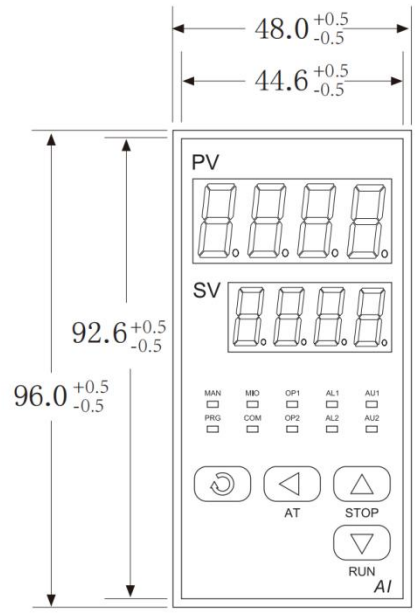
Size A



Size B/C (Rotate 90 degrees for C dimension)

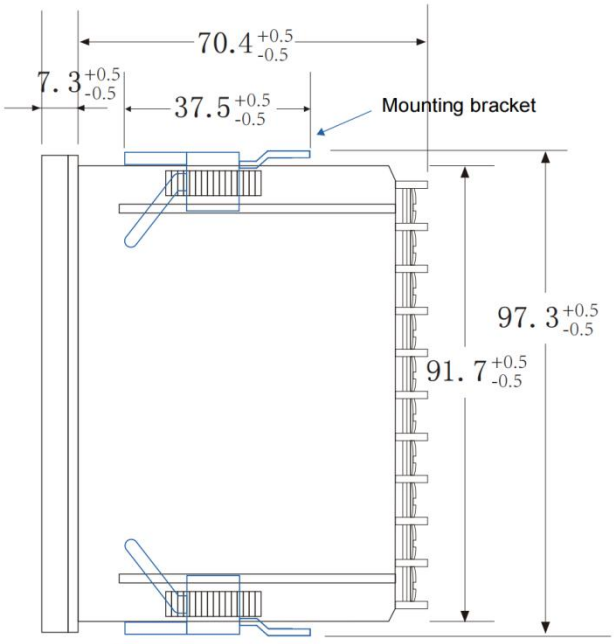


Size E / F (Rotate 90 degrees for F dimension)



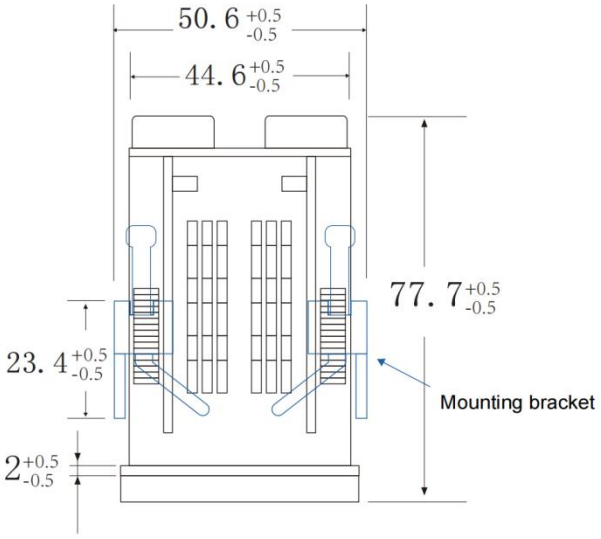
Unit: mm

Front View



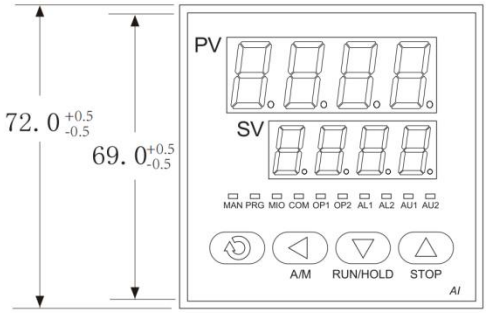
Mounting bracket

Side View



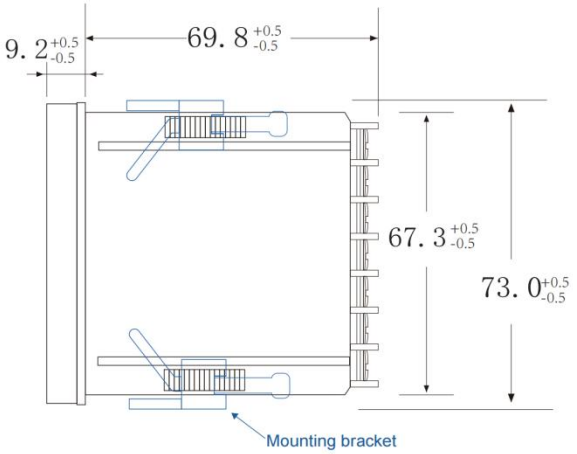
Top View

Size D

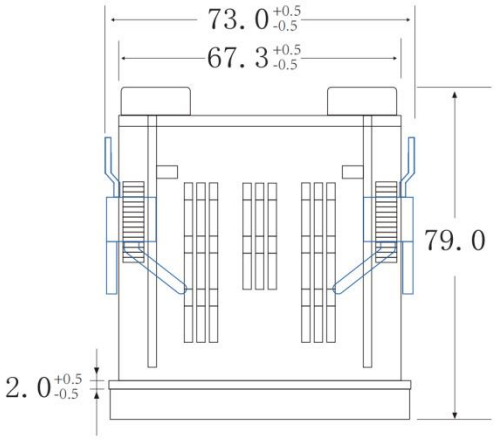


Unit: mm

Front View

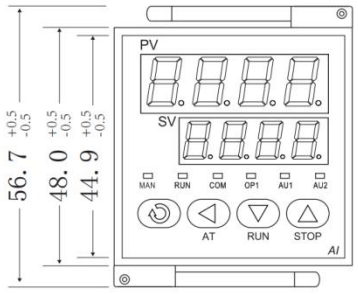


Side View

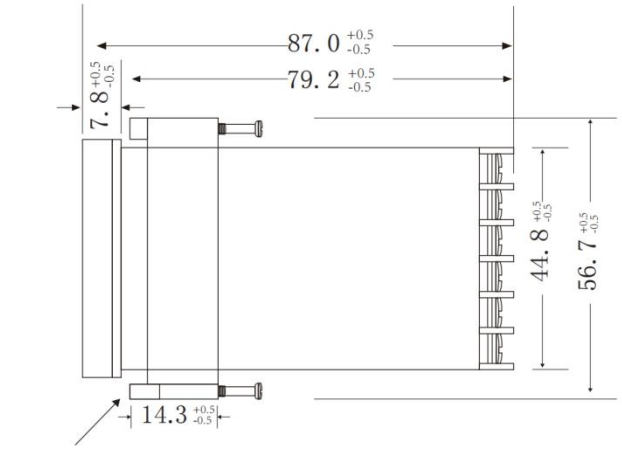


Top View

Size D61



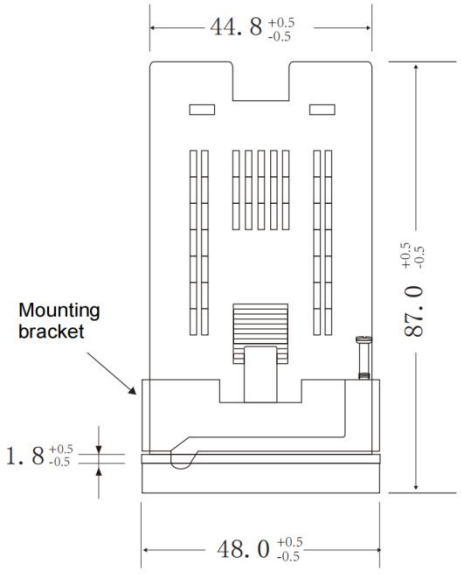
Front View



Mounting bracket

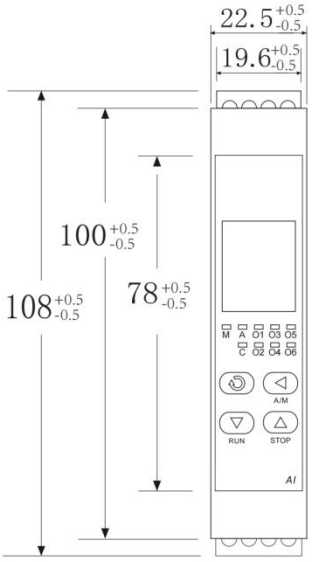
Side View

Unit: mm



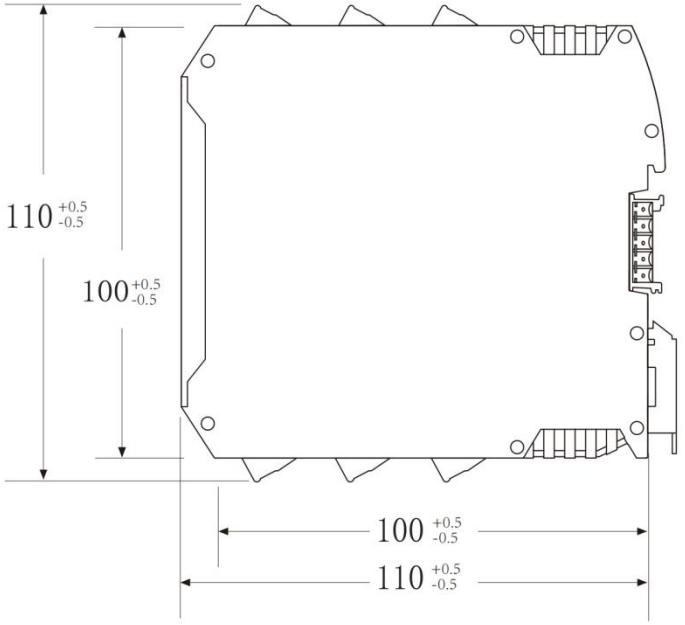
Top View

Size D71 / E7

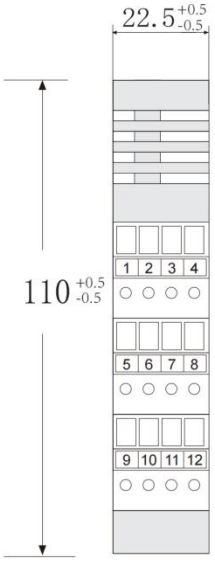


Unit: mm

Front View

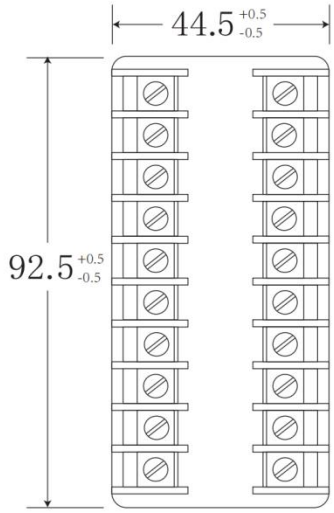


Side View

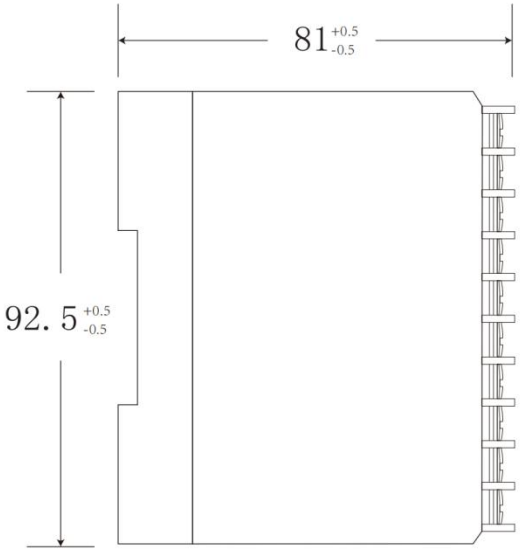


Top View

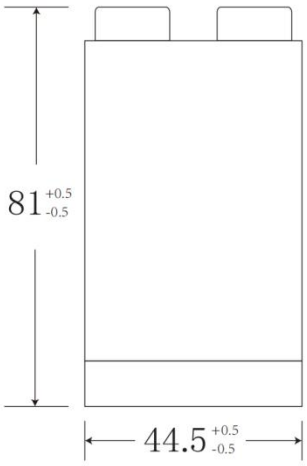
Size E5



Unit: mm Front View



Side View



Top View

2.1.1 Panel-mounted Installation Method

①The distance between the installation holes of the instrument should be set at an appropriate distance according to different sizes and installation brackets. If necessary, the instruments can be installed side by side closely. It is recommended that the left and right spacing of A/D/D61/C/E size is ≥8mm, and the upper and lower spacing is ≥30mm; the left and right spacing of B/F size is ≥30mm, and the upper and lower spacing is ≥8mm.

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

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

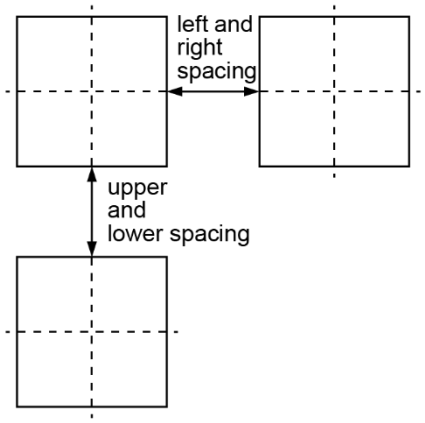


Figure 1

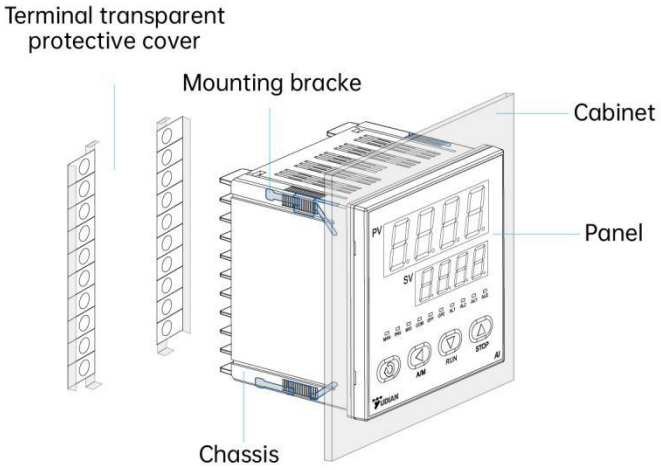


Figure 2

2.1.22.1.2 Rail-mounted Module Installation Method

①Install the module on the 35mm DIN rail.

② If there are other heat-generating devices near the instrument, such as power controllers or solid-state relays,
they should be arranged above the instrument or on the side farther from the input terminals; As shown in the several installation methods in the figure above,
the input terminals are at the position indicated by the arrow. Please keep them as far away from heat sources as possible to ensure heat dissipation (Figure 1).

③ The rail module should be installed vertically. For ease of maintenance, a minimum clearance of 50 mm on all sides (top, bottom, left, and right) should be allowed

④ It is recommended to use pin-type terminals with a copper tube length of at least 10mm for wiring. Recommended pin-type terminal models are E0510 and E7510. The structure of the pin-type terminal is shown in the figure, with the following requirements: F ≥ 10mm, D ≤ 1.5mm, W ≤ 3mm.

⑤ When wiring the power supply and communication terminals, please set the tightening torque to 0.2 N·m.

⑥ Installation should be avoided in environments where temperature and humidity exceed specified limits, where there are corrosive gases, where mechanical vibrations are beyond specified ranges, or in outdoor locations.

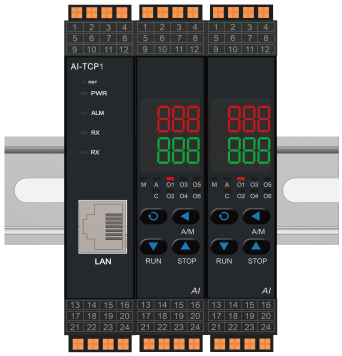


Figure 1

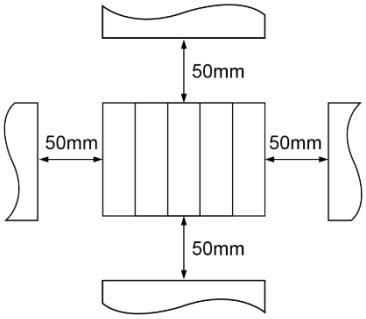


Figure 2

2.2 Terminal Definitions

2.2.1 Wiring Precautions

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

② Please use shielded wire (cross-sectional area 0.5mm^2 ~ 1.25mm^2) 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.For E7\D71 rail-mounted modules, it is recommended to use needle-type terminals with copper tube length of 10mm or more for wiring (Figure 2).

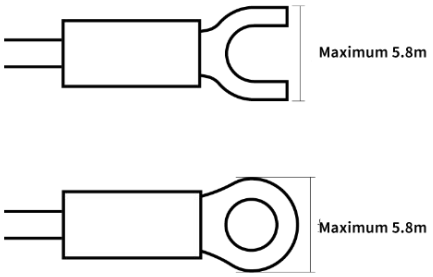


Figure 1

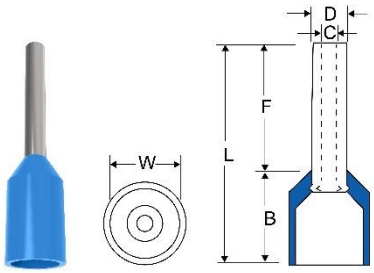
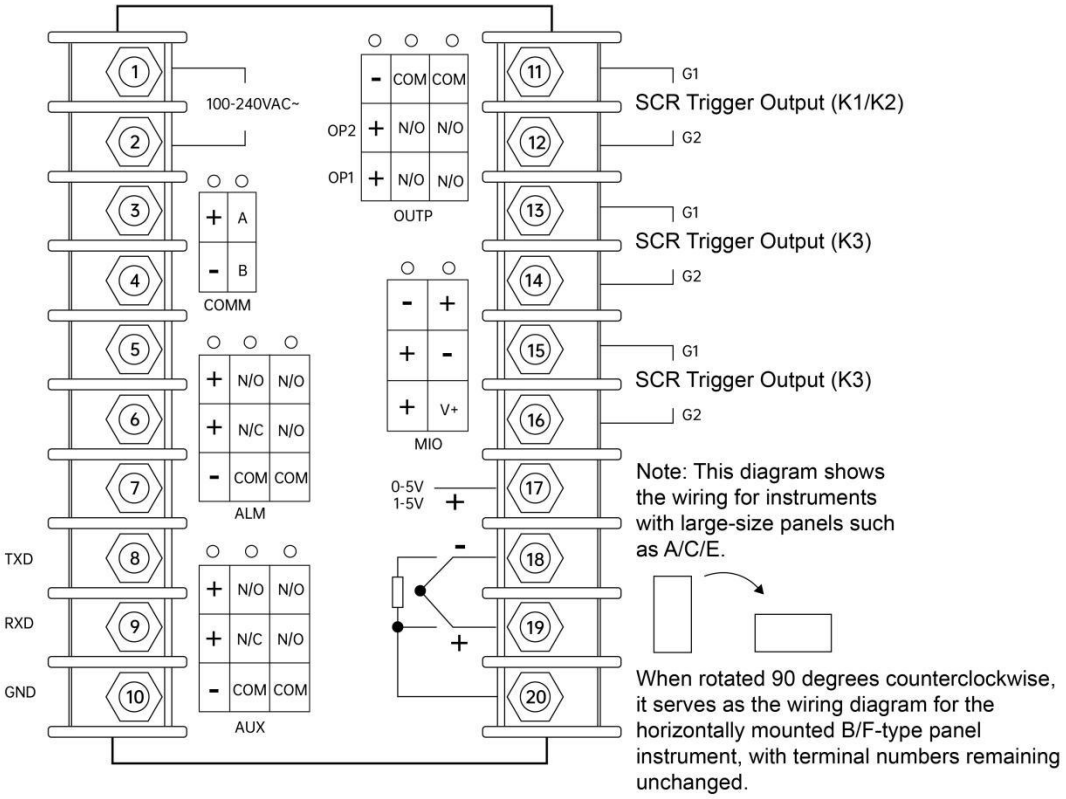


Figure 2

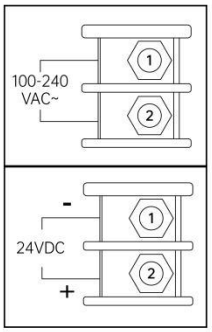
2.2.2 盘装式仪表接线图

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

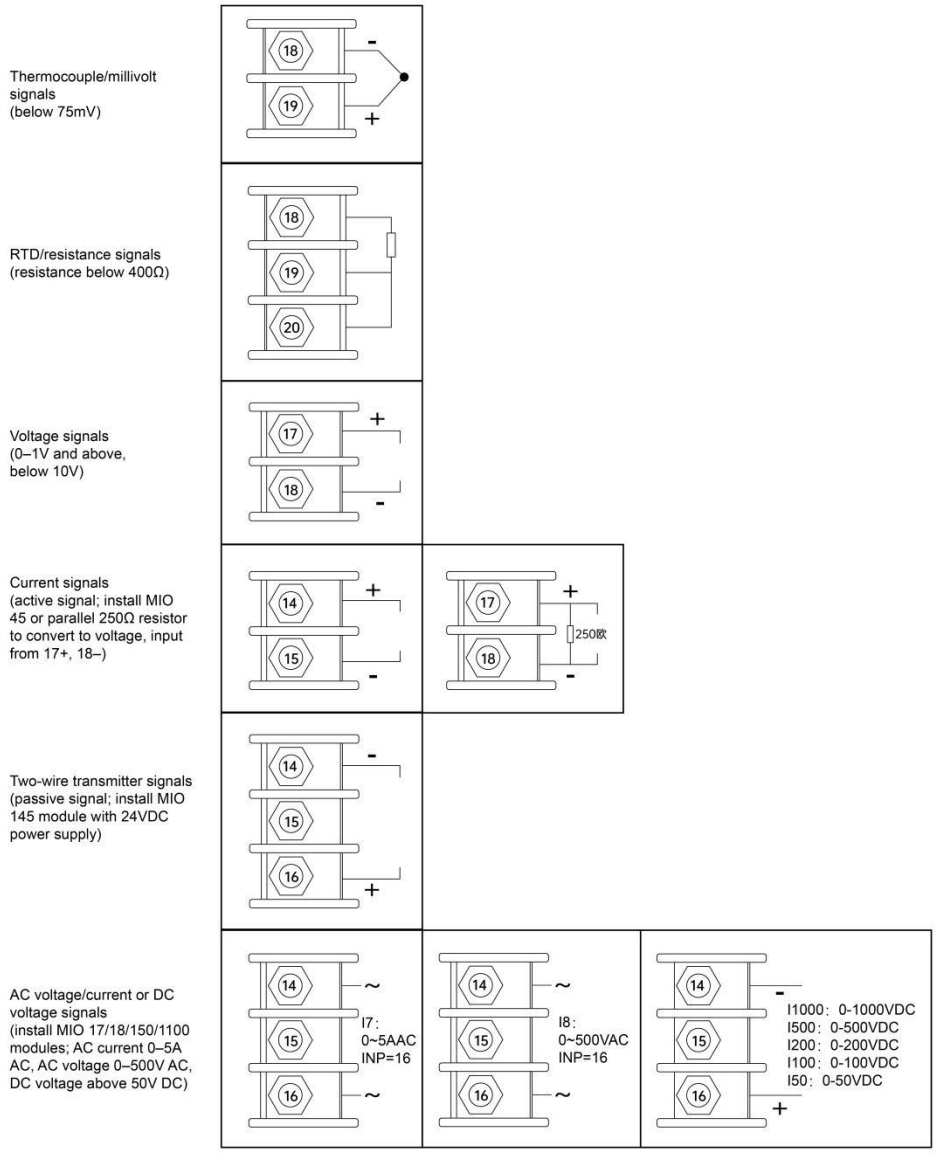
2.2.2.1 Terminal Arrangement Diagram for A/B/C/E/F/E5/E51 Sizes


1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
100-240VAC~
COMM
A
B
ALM
N/O
N/C
COM
AUX
TXD
RXD
GND
OP2
OP1
OUTP
MIO
V+
0-5V
1-5V
G1
G2
SCR Trigger Output (K1/K2)
SCR Trigger Output (K3)
SCR Trigger Output (K3)
Note: This diagram shows the wiring for instruments with large-size panels such as A/C/E.
When rotated 90 degrees counterclockwise, it serves as the wiring diagram for the horizontally mounted B/F-type panel instrument, with terminal numbers remaining unchanged.

- Power terminals (①②)

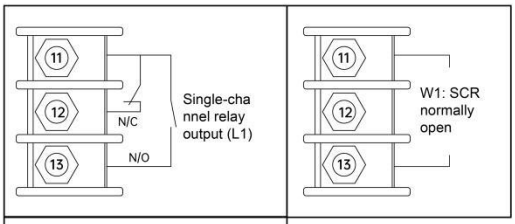


- Sensor input terminals (including MIO auxiliary input positions) (⑭⑮⑯⑰⑱⑲⑳)

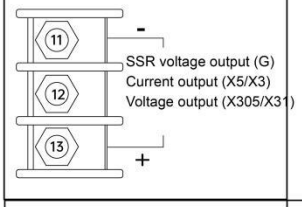


● Control output terminals (OUTP position)
(⑪⑫⑬⑭⑮⑯)

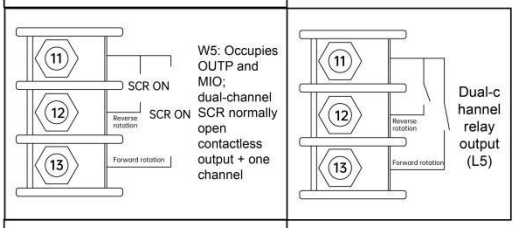
Relay Output (install L1 or W1 module; W1 is normally open contact)



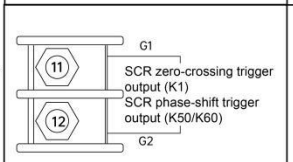
Solid-state SSR/current/voltage output (install G, X series modules)



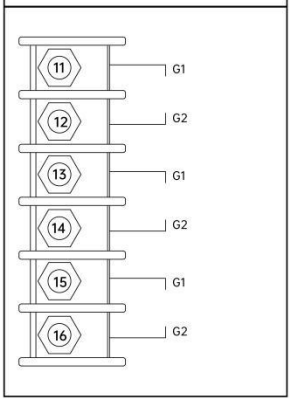
Valve position proportional output (install L3\L5\W5 modules; W5 occupies OUTP and MIO positions)



SCR single-phase trigger output (install K1\K50\K60 modules)

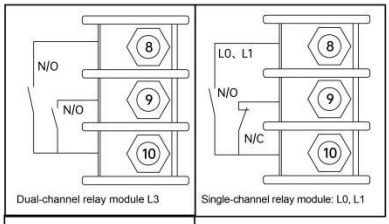


Three-phase SCR zero-crossing trigger output (install K3 module; occupies OUTP and MIO positions)

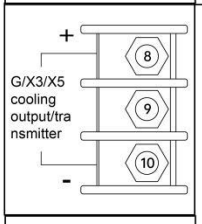


● Auxiliary output terminals (AUX position)
(⑧⑨⑩)

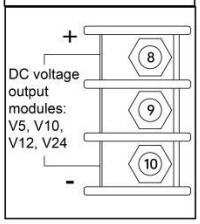
Relay output (for alarm; install L0 or L3 module; L3 is dual-channel normally open contact)



Solid-state SSR/current/voltage output (install G, X series modules; for heating/cooling dual output, used as cooling output, or install X series module for AI-8x8 as transmitter output)

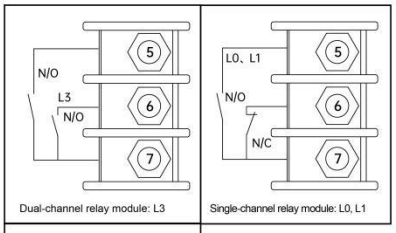


DC power supply output (install V series modules for external device power supply)

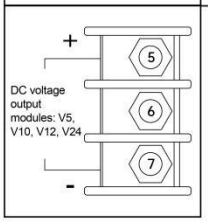


● Alarm output terminals (ALM position)
(⑤⑥⑦)

Relay Output (for alarm; install L0 or L3 module; L3 is dual-channel normally open contact)

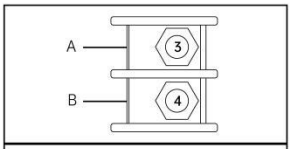


DC power supply output (install V series modules for external device power supply)

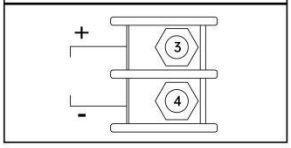


● Communication terminals (COMM position)
(③④)

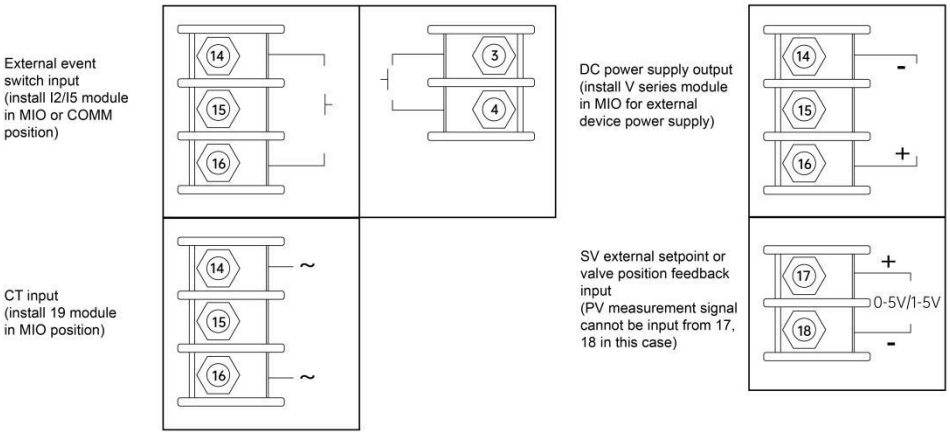
RS485 communication (install S series module))



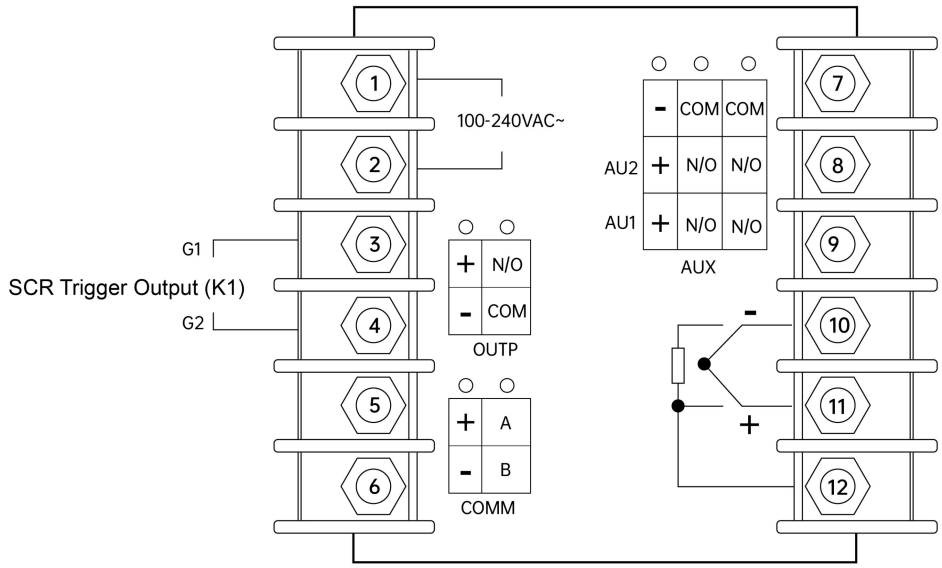
Current/voltage output (install X series module for transmitter output)



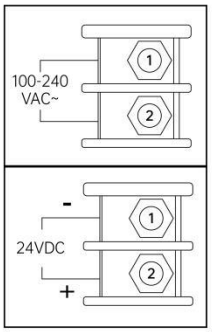
● Other usage wiring terminals
(③④⑭⑮⑯⑰⑱)



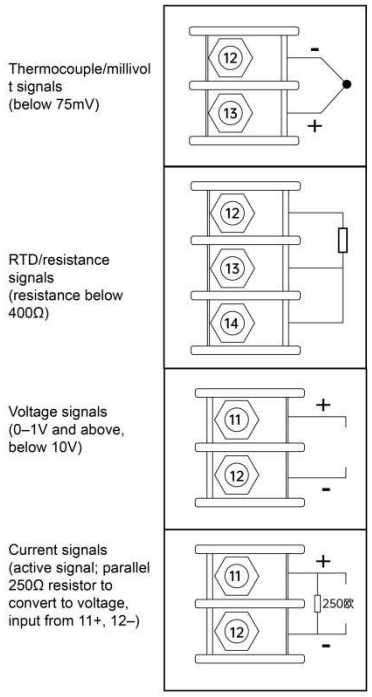
2.2.2.2 Terminal Arrangement Diagram for D Size:



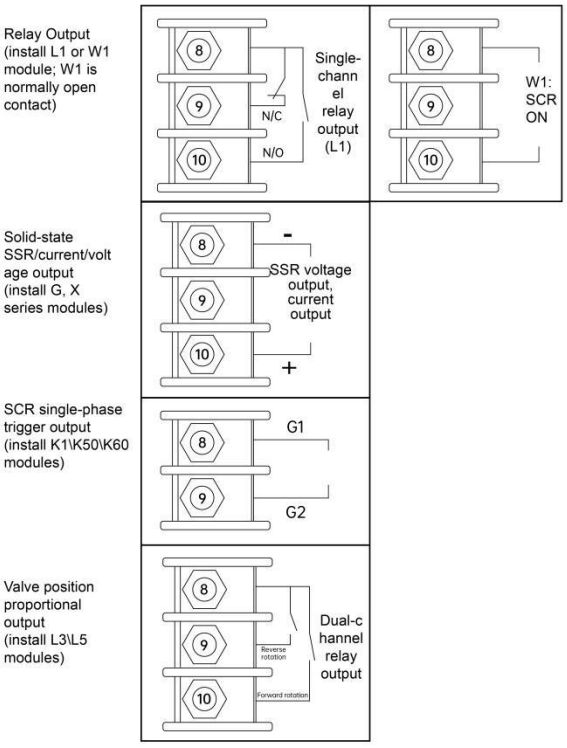
● Power terminals
(①②)



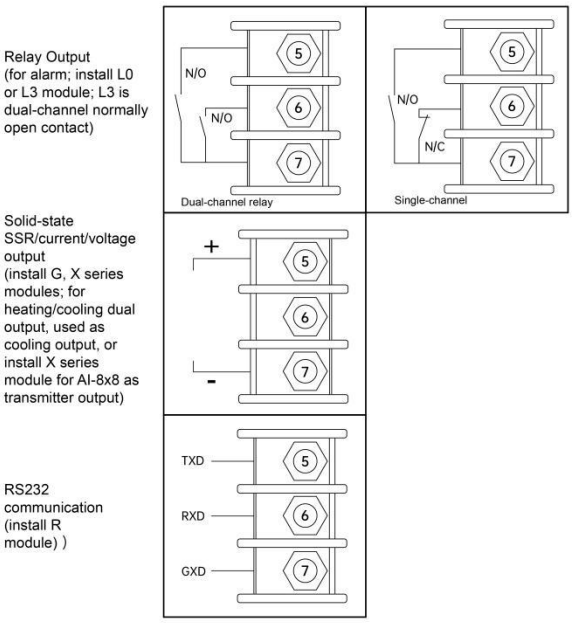
● Sensor input terminals
(⑪⑫⑬⑭)



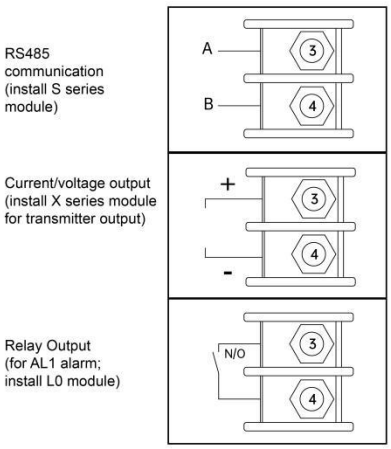
● Control output terminals (OUTP position)
(⑧⑨⑩)



● Auxiliary output terminals (AUX position)
(⑤⑥⑦)

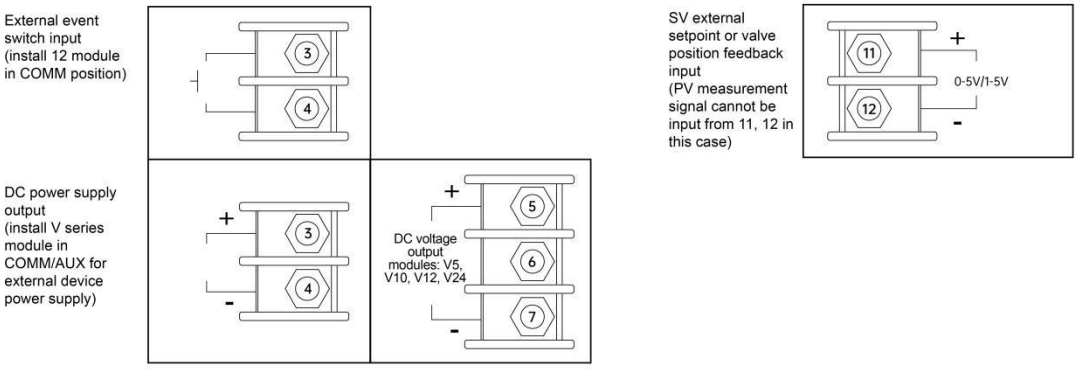


● Communication terminals (COMM/ALM position)
(③④)

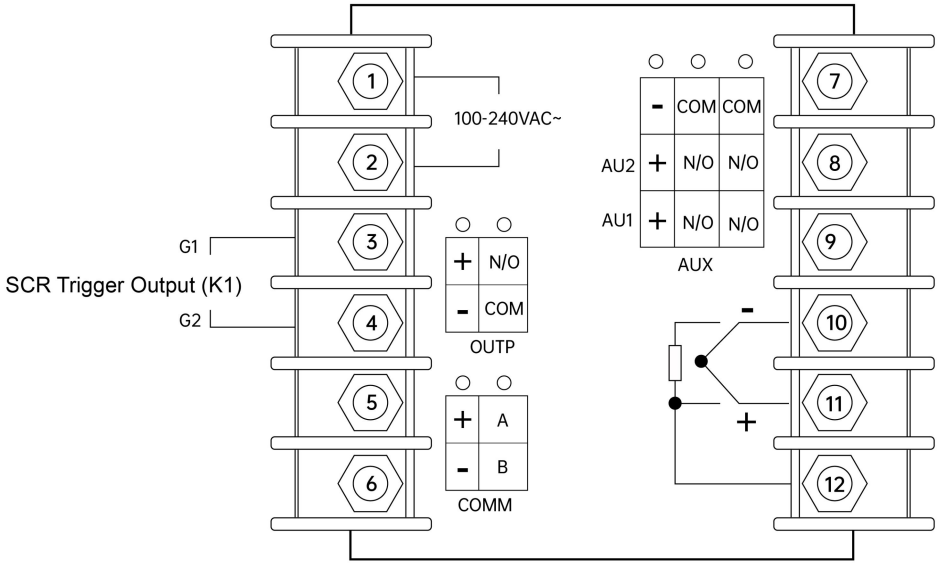


● Other usage

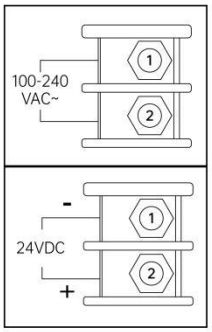
(③④⑤⑥⑦⑪⑫)



2.2.2.3 Terminal Arrangement Diagram for D61 Size:



● Power terminals (①②)

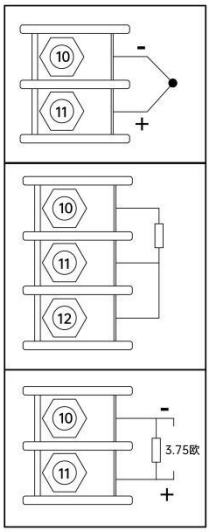


● Sensor input terminals (⑩⑪⑫)

Thermocouple/millivolt signals (below 75mV)

RTD/resistance signals (resistance below 400Ω)

Current signals (active signal; parallel 3.75Ω resistor to convert to voltage, input from 11+, 10–)

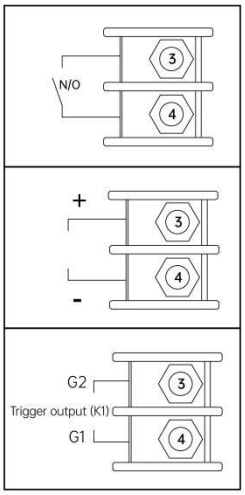


● Control output terminals (OUTP position) (③④)

Relay Output (install L1 module)

Solid-state SSR/current/voltage output (install G, X series modules))

SCR single-phase trigger output (install K1\K50\K60 modules)

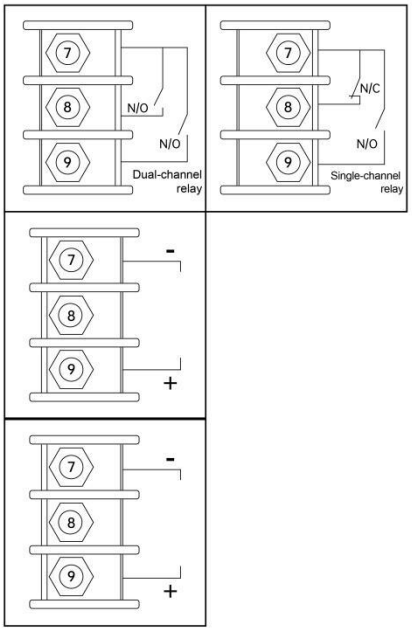


● Auxiliary output terminals (AUX position)

Relay Output (for alarm; install L0 or L3 module; L3 is dual-channel normally open contact)

Solid-state SSR/current/voltage output (install G, X series modules; for heating/cooling dual output, used as cooling output, or install X series module for AI-8x8 as transmitter output)

DC power supply output (install V5V10 module in AUX for external device power supply)

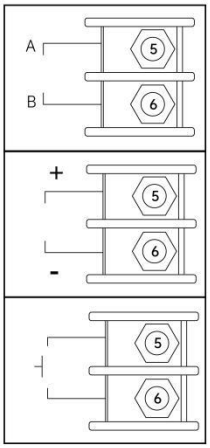


● Communication terminals (COMM position)

RS485 communication (install S series module)

Current/voltage output (install X series module for transmitter output)

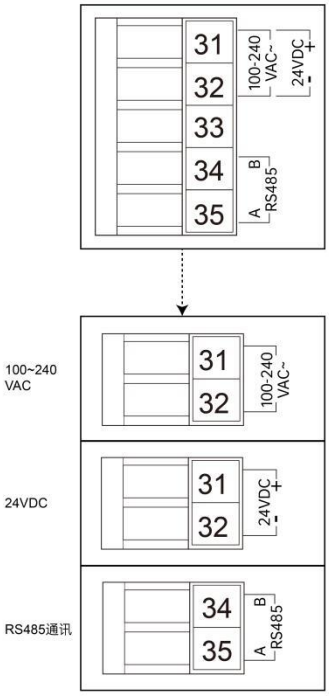
External event switch input (install 12 module in COMM position)



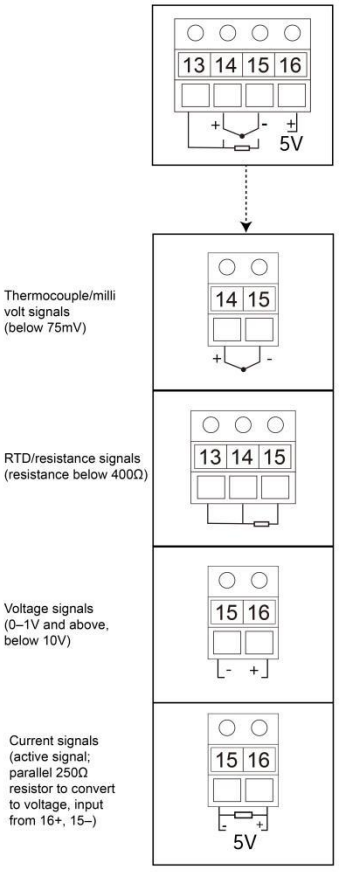
2.2.3 Rail-mounted Module Wiring Diagram

2.2.3.1 D71 Type Wiring Diagram as follows:

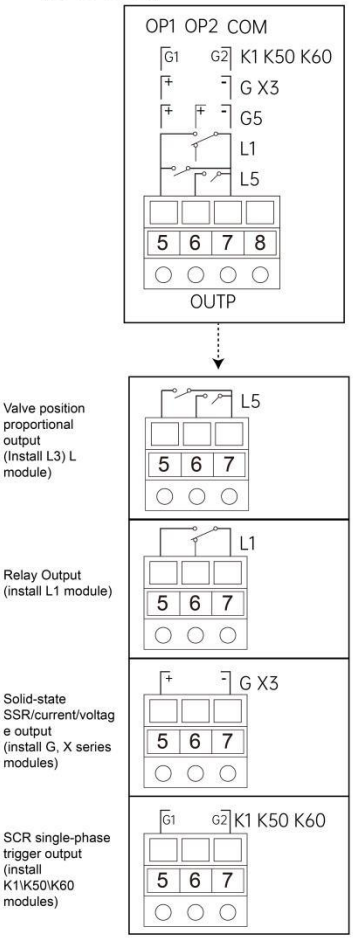
● Power and communication terminals
(㉛ ㉜ ㉝ ㉞ ㉟)



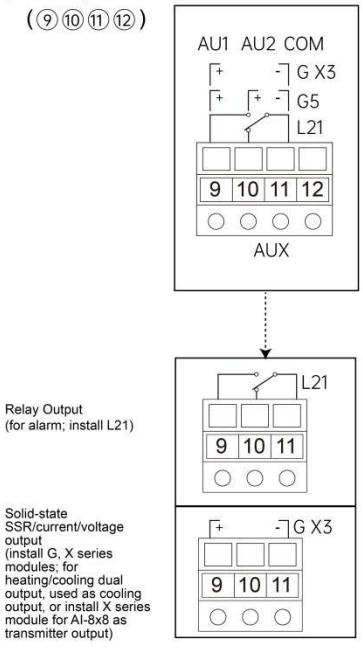
● Sensor input terminals
(⑬ ⑭ ⑮ ⑯)



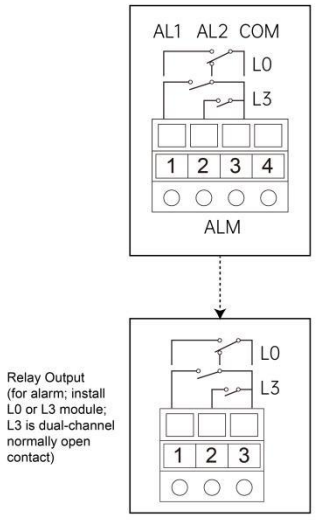
● Control output terminals (OUTP position)
(⑤ ⑥ ⑦ ⑧)



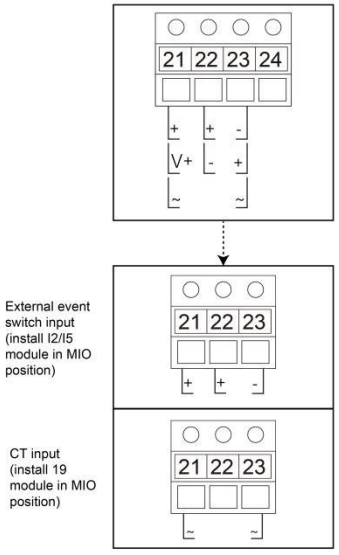
● Auxiliary output terminals (AUX position)
(⑨ ⑩ ⑪ ⑫)



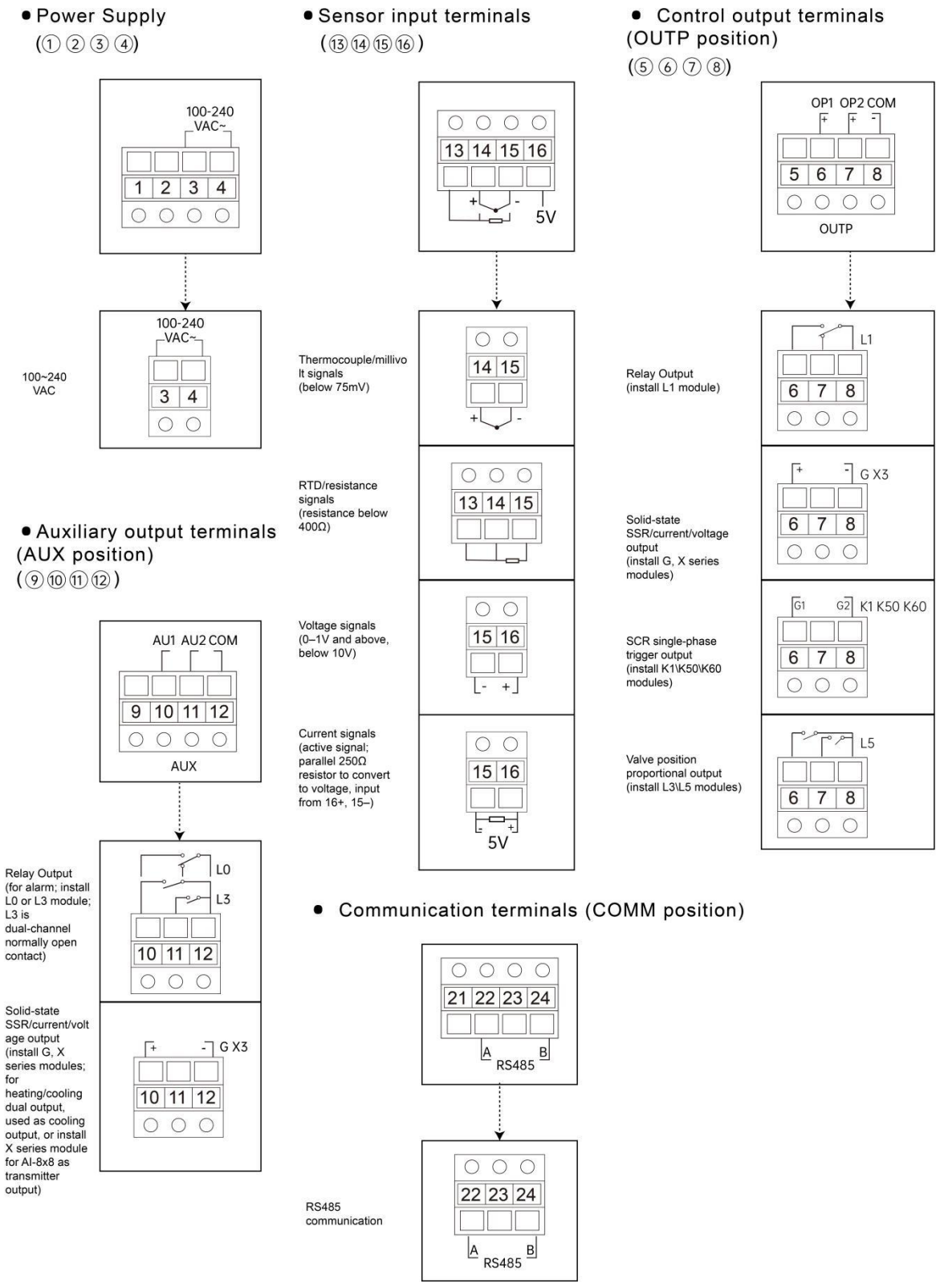
● Alarm output terminals (ALM position)
(① ② ③ ④)



● Other usage wiring terminals (MIO position)
(㉑ ㉒ ㉓ ㉔)



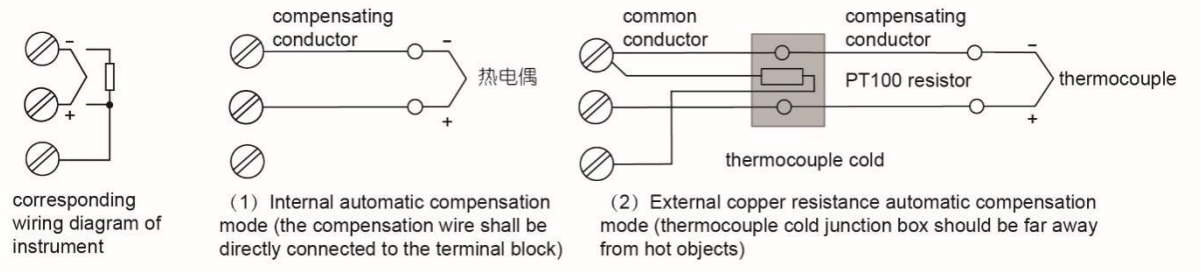
2.2. 32 The wiring diagram for the E7 panel instrument (22.5X100mm) is as follows:



2.2.4Thermocouple Cold Junction Compensation Method Description

Using the wiring method to select the thermocouple cold junction automatic compensation mode: When a thermocouple is used as the input signal, according to the principle of thermocouple temperature measurement, it is necessary to perform temperature compensation on the cold end of the thermocouple. The AI instrument can measure the temperature near the rear terminal of the meter and automatically compensate the cold end of the thermocouple. However, due to the error of the measuring element, the heating of the instrument itself and other heat sources near the instrument, etc., the automatic compensation method often results in a large deviation, which may exceed 2℃ in the worst case. Therefore, when the temperature measurement accuracy is required to be high, an external junction box can be installed, and the PT100 resistor (to be purchased separately) and the cold end of the thermocouple are placed together and kept away from various heating objects, so that the measurement inconsistency due to compensation can thus be less than 0.3℃. because of the error of the Cu50 copper resistor itself, there may be a little error at room temperature, which can be corrected by the Sc parameter. By changing the external copper resistance into a precision fixed resistance, the compensation function of the constant temperature bath can also be realized. For example, an external 60 ohm fixed resistor can be used to check the Cu50 indexing table to obtain a compensation temperature of 46.6℃. At this time, the cold end of the thermocouple can also be accurately compensated by placing it in a constant temperature bath with a control temperature of 46.6℃, and its compensation accuracy is better than that of copper resistors. If the external resistor is changed into a short-circuit line, the freezing point compensation can be achieved. At this time, it is required to place the cold end of the thermocouple (the connection between the thermocouple or the compensation wire and the ordinary wire) in the ice-water mixture (0℃), and the compensation accuracy can be as high as 0.1℃ or more.

The wiring diagrams of the two compensation modes are as follows:

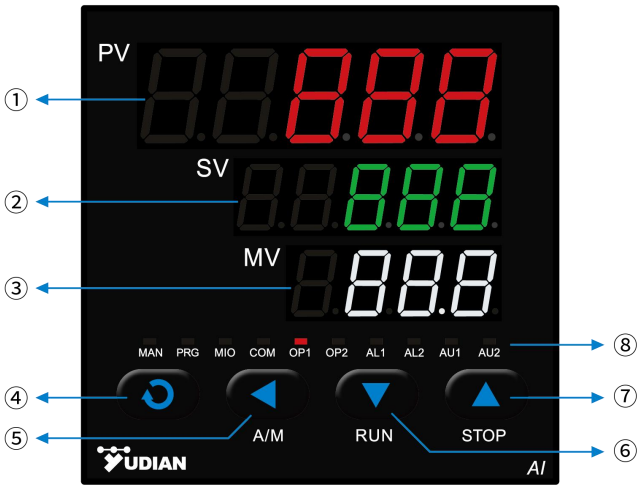


corresponding wiring diagram of instrument

（1）Internal automatic compensation mode (the compensation wire shall be directly connected to the terminal block)

（2）External copper resistance automatic compensation mode (thermocouple cold junction box should be far away from hot objects)

3 Display and Operation



①The upper display window displays the measured value PV, parameter name, etc.

② The middle display window displays the given value SV, alarm code, parameter value, etc.

③The lower display window displays the output percentage MV

④Setting key, used to enter parameter setting state, confirm parameter modification, etc.

⑤ Data shift (also fixed-point control operation)

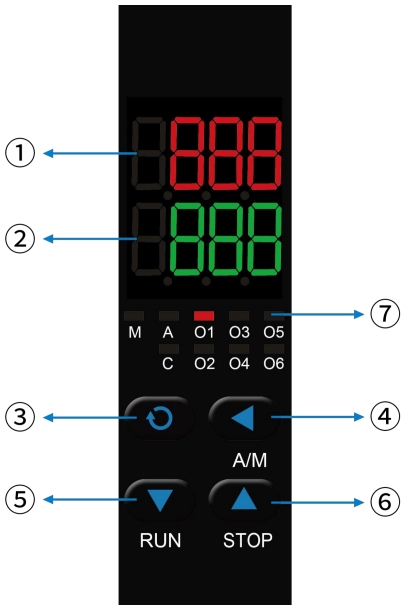
⑥ Data reduction key (also run/pause operation)

⑦ Data increase key (also stop operation)

⑧10 LED indicator lights, MAN light on means in manual output state; PRG light on means in program running state, flashing in wait function state; The MIO, OP1, OP2, AL1, AL2, AU1, AU2 lights correspond to the input and output actions of the corresponding position module respectively; the COM light

Display rail surface panel description.

Panel Description



① The upper display window displays the measured value,PV, parameter title, etc .

② The middle display window displays the set value SV, alarm code, parameter value, etc .

③ Setting key is used to enter parameter setting state and confirm parameter modification.

④ Data shift (also fixed-point control operation)

⑤ Data reduction key (also run/pause operation)

⑥ Data increase key (also stop operation)

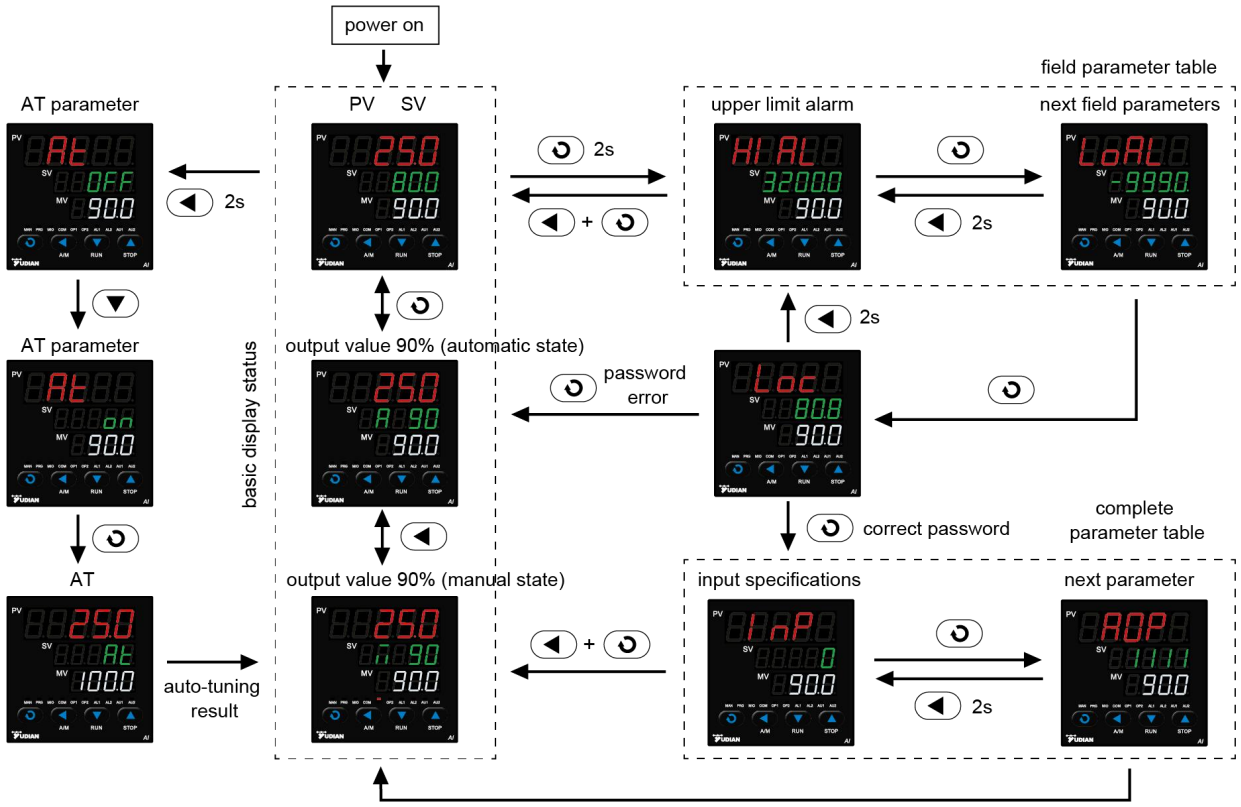
⑦ Data increase key （also switch to display the next channel）

⑧9 LED indicators, among which M and A correspond to Models with manual automatic and MIO input functions.

O1, O2, O3, O4, O5, and O6 correspond to OP1, OP2, AU1, AU2, AL1, and AL2 respectively;

The C light flashes to indicate that it is in communication.

3.2 Parameter Setting Process



3.3Operating Instructions

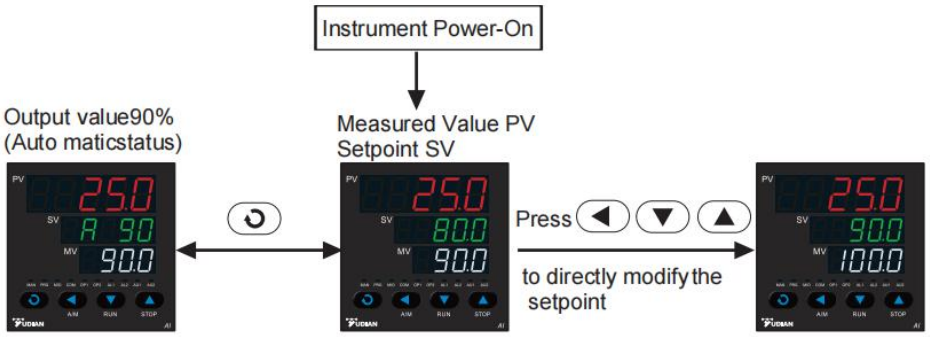
3.3.1 Setting Parameters

Press and hold the key for about 2 seconds in the basic display state to enter the customized on-site parameter setting state. Directly press , , and other keys to modify the parameter value. Press the key to decrease the data, press the key to increase the data, the decimal point of the modified numerical digit 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 the key to directly move the position (cursor) of the modified data, which makes the operation more efficient. Press the key to save the modified parameter value and display the next parameter, keep pressing the key to quickly go down; press and hold the key for more than 2 seconds to return to the display of the previous parameter; press and hold the key first and then press the key again to exit the parameter setting state directly; if there is no key operation, it will automatically return to the basic display state after about 25 seconds.

3.3.2 Quick Operating Instructions

All functions of the AI-8 series can be completed by modifying parameters, but for some commonly used functions, such as modifying the given value and running/stopping the program, we have designed shortcut operations to simplify the use. The convenience mode can also be set to prohibit use to prevent misoperation.

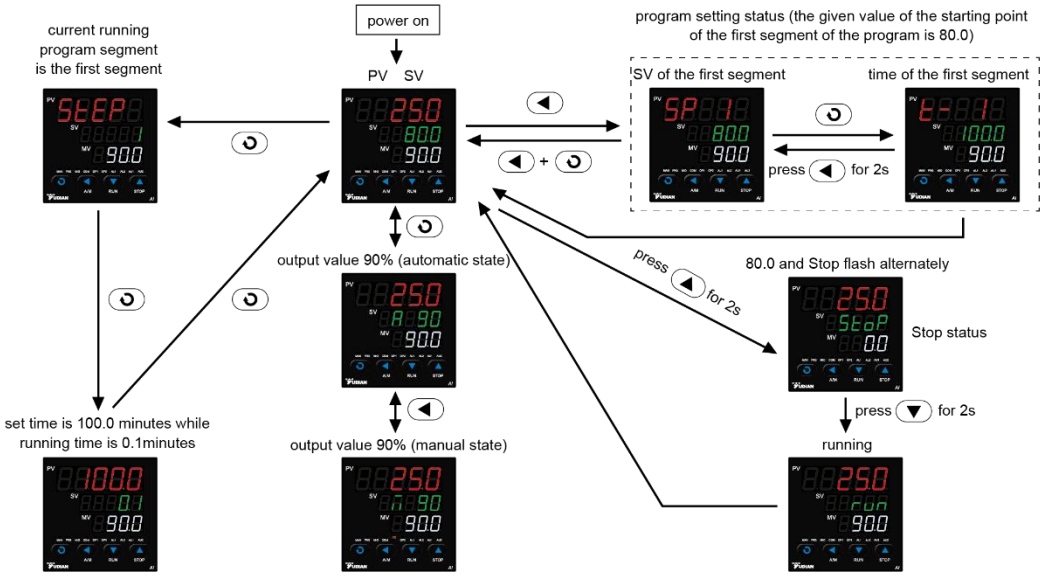
Given value setting: If the instrument uses the fixed-point control mode (parameter Pno=0), in the basic display state where the lower display window displays the given value (If the lower display window displays the output value, press the key to switch to the given value display state, the same below), press the key to enter the state of modifying the current given value, and then press the , , and other keys to directly modify the given value.



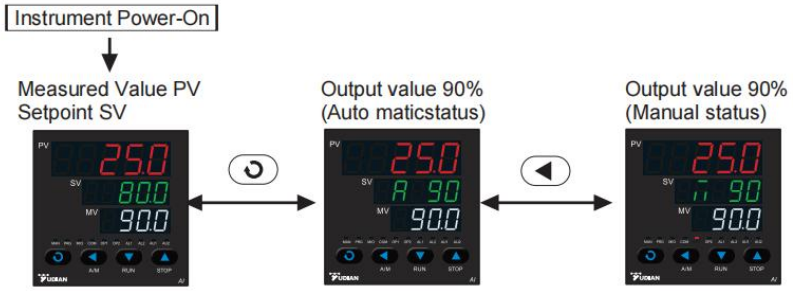
Program setting: The instrument uses program control mode (parameter Pno≥1), in the state that the lower display window displays the given value, press the key to enter the program setting state, the given value of the current running segment is displayed first, and the next data can be displayed by pressing the key , each program is arranged in the order of "given value-time-given value". Programs can be modified even while the program is running.

Running control: When it is necessary to start the running control, press the key and hold it for about 2 seconds so that the lower display of the instrument displays the "*run*" symbol. AI-8 series will start the program operation in the stopped state. For AI-8 series and the parameter PAF.F=1, if the program of the instrument is already in the running state, the operation will enter the hold running (HoLd) state, and the time will be paused in this state, and the *run* operation will be executed again. Normal operation can be resumed.

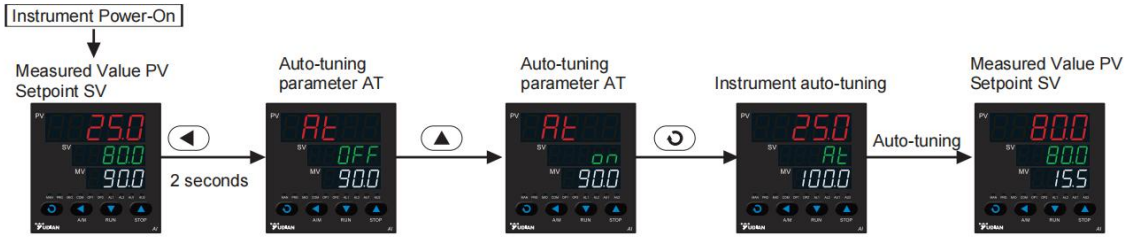
Stop control: In the state that the lower display window displays the given value, press the key for about 2 seconds so that the lower display will display the "StoP" symbol, and the instrument stops controlling the output. AI-8 series stops the program running, and the parameter StEP of the block number is modified to 1.



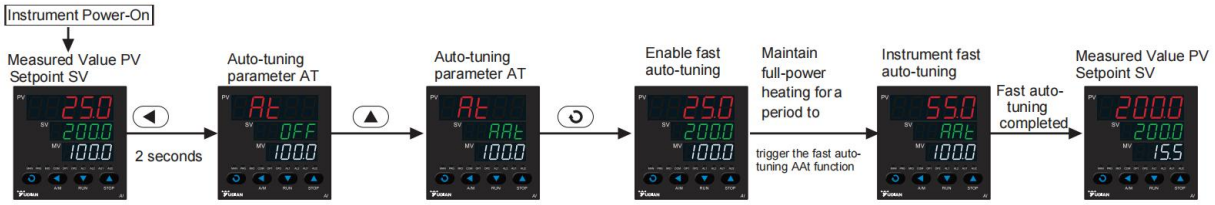
Automatic/manual control switching (A/M): In the state where the lower display window displays the output value (if the lower display window displays the given value, press the key to switch to the output value display state), press the A/M key ( ) to make the instrument switch between automatic and manual without disturbance. In the manual state and the output value is displayed 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 also be fixed in the automatic state and not allowed to be switched to the manual state by the operation of the panel keys, so as to prevent entering the manual state by mistake.



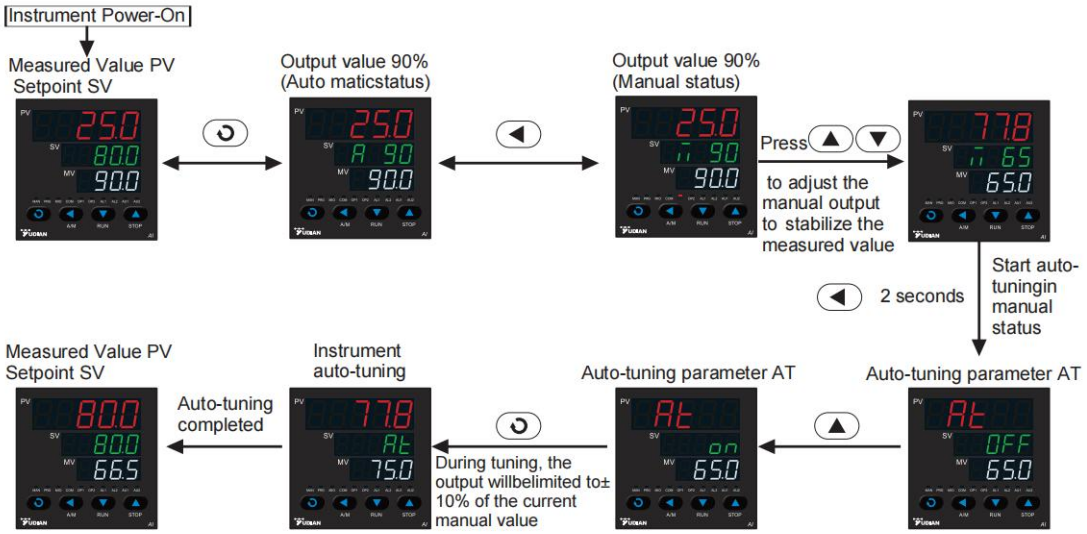
Auto-tuning AT: Press and hold for 2 seconds, the *At* parameter will appear, press to change the *OFF* of the lower display window to *on*, and then press to confirm to start the self-tuning function. The lower display of the instrument will flash and display the word "*At*", and the instrument can automatically calculate the PID parameters after 2 oscillation cycles of ON-OFF control. If the auto-tuning is determined to be given up in advance, press again and hold it for about 2 seconds to call up the *At* parameter, and set *on* to *OFF*, and then press to confirm. If the instrument is running, auto-tune will cause the program timing to be paused to ensure that the given value does not change. In the system with heating/cooling bidirectional output, it is necessary to separate two groups of tuning PID parameters. When the instrument control is in the AUX cold output, start *At,* and then automatically tune the cold output parameters such as P2, I2, and d2.



Quick self-tuning function AAT: Press and hold it for 2 seconds, the At parameter will appear, press to change the *OFF* of the lower display window to *AAt*, and then press to confirm, on this condition, When the instrument is in full power heating output state after power-on, *AAT*'s advanced fast parameter self-tuning function is automatically activated, and PID parameters can be set in advance without the need for traditional periodic oscillation self-tuning. In most cases, accurate control can be achieved by heating for the first time. If the *AAt* does not automatically complete the instrument and exits the full power output state, the *AAT* fails, and the rapid auto-tuning is terminated, and the PID parameters will not be modified; next time the instrument is in full power heating output state, the *AAT* function will be activated again. When *AAT* is fast self-tuning, the lower display of the instrument will flash and display the word "*AAt*". After the end, the *At* parameter will automatically return to *OFF*.



Manual auto-tuning: Since auto-tuning is performed with positional adjustment, its output will be positioned at the position defined by parameters OPL and OPH. In some occasions where the output is not allowed to change greatly, such as where some actuators use control valves, conventional self-tuning is not suitable. In this regard, AI-8 series instruments have manual self-tuning mode. The method is to adjust manually first, and after the manual adjustment is basically stable, start auto-tuning in manual state, so that the output value of the instrument will be limited to the range of +10% and -10% of the current manual value instead that of OPL and OPH, which avoids the phenomenon of large valve changes that are not allowed on the production site. In addition, when the controlled physical value responds quickly, the manual self-tuning method can obtain more accurate self-tuning results. Note: Before the manual auto-tuning is started, the manual output value should be within the range of 10%~90%, and the measured value and the given value should be basically consistent and stable, otherwise the correct parameters will not be set.



Note 1: AI-8 series adopts advanced PID adjustment algorithm integrated with AI artificial intelligence technology, which solves the problem of easy overshoot of standard PID algorithm and has high control accuracy. We call this improved PID algorithm the APID algorithm. When the instrument chooses APID or PID adjustment mode and is used for the first time, the self-tuning function can be activated to assist in determining PID and other control parameters.

Note 2: The parameter values obtained by the system tuning under different given values are not exactly the same. Before executing the auto-tuning function, the given value *SV* should be set to the most commonly used value or the middle value, if the system is an electric furnace with good heat preservation performance, the given value SV should be set at the maximum value used by the system, and it is forbidden to modify the SV value during the self-tuning process. Depending on the system, the time required for auto-tuning can vary from seconds to hours.

Note 3: The control hysteresis parameter *CHYS* also affects the auto-tuning results. Generally, the smaller the setting value of *CHYS*, the higher the accuracy of the auto-tuning parameters. However, if the *CHYS* value is too small, it may cause the misoperation of the bit adjustment due to the input fluctuation, which may set completely wrong parameters. CHYS=2.0 is recommended.

Note 4: The control effect may not be the best at the end of self-tuning. Due to the self-learning function, the best effect can be obtained after a period of use.

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

3.3.3 Instructions for E5 Rail Mounted Instruments

AI-8 E5 rail-mounted instrument itself has no display and keyboard. It can install an RS485 communication interface, and use the connection with the upper computer or touch screen to complete the function and operation of its display interface, or use an external E85 keyboard and monitor for display and parameter setting. E85 supports hot swapping, that is, it can be hand-held or installed on DIN rails. E5 has double-row 4-digit digital display, but there is no LED indicator, its operation and display are fully compatible with panel mounted instrument. Each time the LED indicator of the E5 instrument flashes when it communicates with the upper computer in the instrument, it means that it communicates with the upper computer once. If the meter does not receive a signal from the host computer within 6 seconds, then it will flash on/off with equal time, and its meaning are as follows:

When the indicator light flashes slowly with a cycle of 1.6 seconds, it means that although there is no communication, the instrument is working normally without an alarm.

When the indicator light flashes quickly with a cycle of 0.6 seconds, it means that the instrument has no communication, and there is a general error such as an alarm.

When the indicator light flashes rapidly with a cycle of 0.3 seconds, it means that there is no communication and there are serious errors such as input overrange (such as thermocouple, thermal resistance open circuit).

If the indicator light is always off, it means that the instrument is out of power or damaged; if the indicator light is always on (more than 8 seconds), it means that the instrument is powered on but it is damaged.

4 Parameter Description

4.1Typical Setting Process and Common Parameters

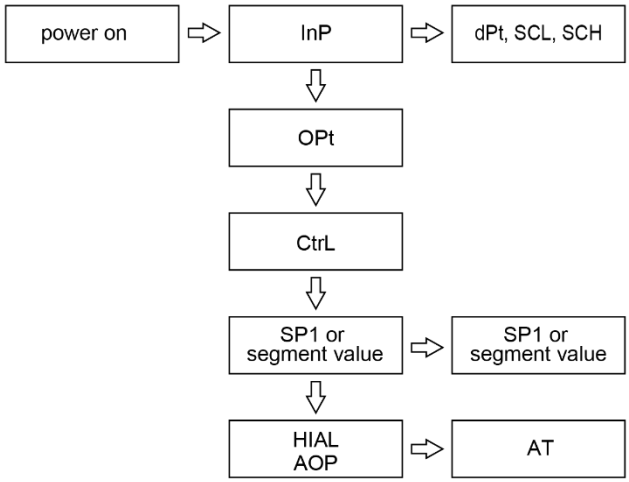
①Please refer to the complete parameter table for the description of the parameters in the figure. For other functions, please refer to the description of common functions.

②The input range does not need to be set when the thermocouple or thermal resistance is selected for the input specification, and the range is set only when the analog signal input or the transmission function is required.

③Auto-tuning is only required when APID or nPID is selected as the control mode. Auto-tuning must be performed when the equipment can work normally.

④After the setting, if the instrument is in the stop or pause state, it needs to run manually or the upper

⑤computer executes the running command。



4.2Parameter Lock and Custom Parameter Table

4.2.1Parameter Lock(Loc)

Loc can provide a variety of different parameter operation authority and password input operation to enter the complete parameter table, and its functions are as follows:

Loc=0, allowed to modify the field parameters, and allowed to directly modify the given value in the basic display state;

Loc=1, it is forbidden to modify the field parameters, and it is allowed to directly modify the given value in the basic display state;

Loc=2~3, it is allowed to modify the field parameters, but it is forbidden to directly modify the given value in the basic display state;

Loc=4~255, any parameters other than Loc are not allowed to be modified, and all shortcut operations are also prohibited;

Set Loc=password (the password can be a number between 256~9999, the initial password is 808), and press to confirm, it is able to have access to display and modify the complete parameter list. Once the complete parameter list is entered, all parameters except read-only parameters are authorized to be modified. The Loc parameter can also set the communication write limit, please refer to the description of the communication protocol for details; the manual/automatic function and the AT function are independently set and controlled.

4.2.2Custom Parameter Table

The parameter table of AI-8 can be programmed to define the function, which means the parameter table of the instrument can be customized for you. In order to protect important parameters from being arbitrarily modified, we call the parameters that need to be displayed or modified in the field as field parameters. The field parameter table is a subset of the complete parameter table and can be defined by the user, and can be directly called out for the user to modify, while the complete constant table must be called out under the condition of entering a 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: the parameter table we need has three parameters such as HIAL, HdAL and At, and the EP parameters can be set as follows: EP1=HIAL, EP2=HdAL, EP3=At, EP4=nonE

4.3 Complete Parameter Table

The complete parameter table is divided into 8 blocks, including alarm, adjustment control, input, output, communication, system function, given value/program and field parameter definition, etc. The parameters are as follows:

Parm.	Meaning	Description	Range
Add Addr	Postal address	The Addr parameter defines the instrument communication address and has a valid range of 0-80. Instruments on the same communication line should have a different Addr value to distinguish them from each other.	0~99
bAud bAud	Baud rate	The bAud parameter defines the communication baud rate, with a definable range of 0~28800bit/s. When the baud rate exceeds 9600bit/s and a fourdigit display is used, for example, setting 19.20 represents 19200bit/s. When the COM port is not used for communication functions, the bAud parameter can be set to use the COM port for other functions: bAud=0, COMM slot transmitted as a set value of 0-20ma for output; bAud=1, as an external switching value input, has the same function as the MIO position. When the MIO position is occupied, the I2 module can be installed in the COMM position. bAud=3, the COMM port is used for transmission and output function of the 0~20mA measurement value; bAud=4, the COMM port is used for transmission and output function of the 4~20mA measurement value ; bAud=8, the COMM port is used for transmission and output function of the 0~20mA set value; bAud=12, the COMM port is used for transmission and output function of the 4~20mA set value.	0~28800

<table>
<tr>
<td>AFC
AFC</td>
<td>communication mode</td>
<td>Select communication mode, its calculation method is as follow:
AFC=A*1+D*8+G*64
A=0, standard MODBUS; A=1, AIBUS; A=2, MODBUS compatible mode; A=4, compatible with S6 module.
D=0, no parity check; D=1, even parity check.
F=0, the external setpoint and valve position feedback upper limit is 5V; F=1, the external setpoint and valve position feedback upper limit is 10V.
G=0, AUX used normally; G=1, AUX used as event input.
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>0~255</td>
</tr>
<tr>
<td>InP
InP</td>
<td>Enter specification code</td>
<td>InP is used to select the input specification, and the input specification corresponding to its value is as follows:
<table>
<tr><td>0 K</td><td>21 Pt100</td></tr>
<tr><td>1 S</td><td>22 Pt100 (-80.00~+300.00℃)</td></tr>
<tr><td>2 R</td><td>25 0~75mV voltage input
0~20mA current input (D61 only, please specify)</td></tr>
<tr><td>3 T</td><td>27 0~400Ω resistance input</td></tr>
<tr><td>4 E</td><td>28 0~20mV voltage input</td></tr>
<tr><td>5 J</td><td>30 0~60mV voltage input</td></tr>
<tr><td>6 B</td><td>31 0~1V voltage input</td></tr>
<tr><td>7 N</td><td>32 0.2~1V voltage input</td></tr>
<tr><td>8 WRe3-WRe25</td><td>33 1~5V voltage input</td></tr>
<tr><td>9 WRe5-WRe26</td><td>34 0~5V voltage input</td></tr>
<tr><td>10 User-specified extended input specification</td><td>35 -20~+20mV voltage input</td></tr>
<tr><td>12 F2 Radiation Pyrometer</td><td>37 -5V~+5V voltage input</td></tr>
<tr><td>13 T (0~300.00℃)</td><td>38 10~50mV voltage input</td></tr>
<tr><td>15 MIO input 1(4~20mA, installing I45)</td><td>39 15~75mV voltage input
4~20mA current input (D61 only, please specify J4 input)</td></tr>
<tr><td>16 MIO input 2(4~20mA, installing I45)</td><td>42 0~10V voltage input</td></tr>
<tr><td>17 K (0~300.00℃)</td><td>43 2~10V voltage input</td></tr>
<tr><td>18 J (0~300.00℃)</td><td>44 -10V~+10V voltage input</td></tr>
<tr><td>19 Ni120</td><td></td></tr>
<tr><td>20 Cu50</td><td></td></tr>
</table>
Note: When InP=10 is set, the non-linear table can be entered by yourself, or the manufacturer can enter it for a fee.</td>
<td>0~106</td>
</tr>
</table>

AOP AOP	Alarm output definition	The 4-digit ones, tens, hundreds and thousands of AOP are used to define the output positions of 4 alarms such as HIAL, LoAL, HdAL and LdAL, as follows: AOP = 3 3 0 1 ; LdAL HdAL LoAL HIAL The value range is 0-9, 0 means that the alarm is not output from any port, 1, 2, 3, 4 means that the alarm is output by AL1, AL2, AU1, and AU2, respectively;Value 5, 6, 7 and 8 refers that alarms are assigned to AL1, AL2, AU1 or AU2 and the main output are set to zero mandatorily or a value defined by Ero (configured via AF2). Value 9 refers the main output are set to zero mandatorily or a value defined by Ero (configured via AF2) without any alarm. For example, if AOP=3301 is set, it means that the upper limit alarm HIAL is output by AL1, the lower limit alarm LoAL is not output, and HdAL and LdAL are output by AU1. Note 1: When AUX is used as auxiliary output in the two-way adjustment system, the output of alarm designated AU1 and AU2 is invalid. Note 2: If AL2 or AU2 is used, the L3 two-way relay module can be installed at the ALM or AUX position.	0~9999

OPt OPt	output type	**SSr**, to output SSR driving voltage or SCR zero crossing trigger time proportional signal, modules G, K1 or K3 shall be installed respectively, and the output power shall be adjusted by adjusting the on-off time ratio, with a period of 0.5-4.0 seconds. **rELy**, when the output is a relay contact switch or there is a mechanical contact switch in the actuating system (such as a contactor or compressor), this setting should be used. To protect the mechanical contact life, the system limits the output cycle to 3-120 seconds. 0-20, 0~20mA linear current output, X3 or X51 linear current output module shall be installed. 4-20, 4~20mA linear current output, X3 or X51 linear current output module shall be installed. **PHA1**, single-phase phase-shift output, K50/K60 phase-shift trigger output module shall be installed to realize phase-shift trigger output. In this setting state, AUX cannot be used as the cold output end of the regulating output. **nFEd**, position proportional output without feedback signal, directly controls forward/reverse rotation of valve motor, and valve travel time is defined by Strt parameter. **FEd**, position proportional output with feedback signal, the valve travel time should be more than 10 seconds, and the feedback signal is input from the 0~5V/1~5V input end of the instrument. Note: In this output mode, externally given functions can no longer be used. **FEAt**, automatically adjust the valve position. The instrument will first close the valve and record the feedback signal in the SPSL parameters, then fully open the valve to memorize the valve feedback signal in the SPSH parameters, and then automatically return to the FEd control mode. **Note: AI-8* 6 series doesn't possess position proportional control output**	
At AT	Auto tuning	**OFF**, the auto tuning At function is off. **on**, start PID and Ctl parameter auto-tuning function, and automatically return to FOFF after auto-tuning. **FOFF**, the auto-tuning function is closed, and it is prohibited to start the auto-tuning from the panel operation. **AAt**, fast auto-tuning function, automatically returns to OFF after auto-tuning. Note: AAt option is selected for At parameter. When the instrument is in the full power heating output state after power on, the advanced AAt fast parameter auto-tuning function can be automatically started. PID parameters can be set in advance without traditional periodic oscillation auto-tuning. In most cases, accurate control can be achieved for the first heating. If AAt exits the full power output state before automatically completing the instrument, AAt fails, the auto-tuning is terminated, and the PID parameters will not be modified.	

A-M A-M	Automatic/manual control selection	**MAn:** manually controls the state, and the operator manually adjusts the output of OUTP. **Auto:** automatically control status, OUTP output is determined by CtrL after calculation. **FSv:** is compatible with the manual automatic function instrument mode, and it is prohibited to enter the manual automatic switching interface. **FAut:** is in fixed automatic control state, which prohibits direct key operation from front panel to manual state.	
Srun Srun	Running state	**Run**, running control status, PRG light is on. **Stop**, stop state, the lower display flashes show "Stop", and the PRG light is off. **HoLd**, keep the operation under control state. If the instrument is thermostatically controlled for unlimited time (when Pno=0), this state is equivalent to the normal operation state, but it is prohibited to run or stop from the panel. If the instrument is under program control (Pno>0), the instrument will maintain the control output under this state, but the timing will be suspended. At the same time, the lower display will flash to display "HoLd" and the PRG light will flash. The panel keys can be used to execute the operation control or stop to release the operation status.	
Pno Pno	Numbers of program segments	It is used to define the number of effective program segments, which can reduce the number of unnecessary program segments as needed, so that the operation and program settings are convenient for the end user. When Pno=0 is set, the instrument is in constant temperature mode; At the same time, SPr parameters can also be set to limit the heating rate; 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 state; When Pno=2~50 is set, normal program control instrument operation mode is adopted for operation. **Note: 8* 6 series only supports one program segment.**	0~50
PonP PonP	Power-on automatic operation mode	**Cont**, if it is stopped before power failure, continue to stop; otherwise, continue to execute at the original termination after the instrument is powered on. **Stop**, no matter what happens after power on, the instrument will enter the stop state. **Run1**. If it is stopped before power failure, it will continue to stop; otherwise, the program will automatically start running from the first section after power failure. **dASt**, after power on, if there is no deviation alarm, the program will continue to execute; if there is deviation alarm, the program will stop running. **HoLd** (only when Pno ≥ 1), the instrument is powered off during operation. No matter what happens after the power is on, the instrument will enter the suspend state. However, if the instrument is stopped before power failure, it will remain stopped after power on.	

Et Et	Event Input Type	The Et parameter has been extended to 2 inputs (modules such as I5 need to be installed if dual inputs are used), Et=Et1 * 10+Et2, where Et1 and Et2 represent event input 1 and input 2, respectively. The numerical meanings of Et1 or Et2 are as follows: **0(nonE):** Disable event input function. **1(ruSt):** Run / Stop switching function. Connected in short time, start to run program, keep connect more than 2 sec, program switch to stop. **2(SP1.2):** Switching set value under set point regulation(Pno=0); when MIO in open status, SV=SP1; when MIO in close status, SV=SP 2. **3(PId2):** When used as single direction control, MIO in open status, P, I, d and Ctl are active; when MIO in close status, P2, I2, d2 and Ctl2 are active **4(EAct):** External switch to switch the heating/cooling. When MIO turns off, parameters P, I, d and Ctl are used for heating regulation. When MIO turns on, parameters P2, I2, d2 and Ctl2 are used for cooling regulation. **5 (Eman):** External switch to switch between manual/automatic. Instrument in automatic mode when switch is off and in manual mode when switch is on. **6(Erun):** External switch to RUN/STOP. Instrument stops when switch is off and runs when switch is on. **7(Eout):** Forces the main output to be 0 or Ero when the external switch turns on. (Based on the AF2. E parameter function). **Note:** If Et1=Et2 is set, the system will execute Et1 first and then Et2, and the result will be based on Et2.	0-77
CtrL CtrL	Control mode	**OnoF**, which adopts position adjustment (ON-OFF), is only suitable for control in low requirements. **APID**, an advanced AI artificial intelligence PID adjustment algorithm, is recommended. **NPID**, standard PID regulation algorithm, has anti-saturation integration function. **PoP**, which directly takes PV value as output value, can make the instrument become a temperature transmitter. **SoP**, the SV value is taken as the output value directly. When Pno ≥ 1, the instrument becomes a program generator.	

OPL OPL	Output lower limit	When it is set to 0~100%, it is used as the minimum limit value of regulating output OUTP in normal one-way regulation. When the setting is - 1~- 110%, the instrument becomes a two-way output system with heating/cooling dual output function. When the Act is set to rE or rEbA, the main output OUTP is used for heating and the auxiliary output AUX is used for cooling. On the contrary, when the Act is set to dr or drbA, OUTP is used for cooling and AUX is used for heating. When the instrument is a two-way output, OPL is used to reflect the maximum cold output limit. When OPL=- 100%, there is no limit on cold output. - 110% can make the current output, such as (4~20mA), exceed the maximum range by more than 10%. It is suitable for special occasions. When SSR or relay outputs, the maximum cold output limit should not be more than 100%.	-110~ +110%
OPH OPH	Output upper limit	When the measured value PV is less than OEF, limit the maximum output value of the main output OUTP, and when PV is greater than OEF, the system corrects the upper limit of the output to 100%; In the proportional output without feedback position (when OPt=nFEd), if OPH is less than 100, the instrument will automatically set the valve position when powered on; if OPH=100, the instrument will automatically set the valve position when the output is 0% and 100%, which can shorten the power on and startup time. The OPH setting must be greater than OPL.	0~110%
Aut 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 SCR zero crossing trigger time proportional signal, install G or K1 modules respectively, and adjust the output power by adjusting the on-off time ratio, with a period of 0.5-4.0 seconds. **rELy**, when the output is a relay contact switch or there is a mechanical contact switch in the actuating system (such as a contactor or compressor), this setting should be used. To protect the service life of mechanical contacts, the system limits the output cycle to at least 3-120 seconds, generally 1/5-1/10 of the system delay time. 0-20, 0~20mA linear current output, X3 or X51 linear current output module shall be installed on AUX. 4-20, 4-20mA linear current output, X3 or X51 linear current output module shall be installed on AUX. **Note**: If the OPt or Aut output is set to rELy, the output cycle is limited to 3-120 seconds in principle. If the heating or refrigeration output signal is 4-20mA, when the heating is output, the refrigeration output signal will return to zero, and the output is 0mA instead of 4mA; When there is an output of refrigeration, the signal at the heating output terminal is zero, and the output is 0mA instead of 4mA.	

CHYS CHYS	Control return difference (dead zone, hysteresis)	It is used to avoid frequent action of ON-OFF position regulating output relay. It is used to avoid frequent action of ON-OFF position regulating output relay. When it is used for reaction (heating) control, the relay is turned off when PV is greater than SV, and the output is switched on again when PV is less than SV-CHYS; When it is used for positive action (refrigeration) control, the output is turned off when PV is less than SV, and turned on again when PV is greater than SV+CHYS.	0~9999unit
Act Act	Positive/negative reaction	**rE** is a reaction regulation mode. When the input increases, the output tends to decrease, such as heating control. **dr** is a positive regulation mode. When the input increases, the output tends to increase, such as refrigeration control. **rEbA**, a reaction regulation, and has the functions of power-on exemption from lower limit alarm and deviation lower limit alarm. **drbA**, a positive adjustment mode, and has the functions of power-on exemption from upper limit alarm and deviation upper limit alarm.	
P P	Proportional band	Define the proportional band adjusted by APID and PID, and the unit is the same as the PV value, rather than the percentage of the range. Note: The At function is usually used to determine P, I, D and Ctl parameter values, but for familiar systems, such as batch-produced heating equipment, the known correct P, I, D, Ctl parameter values can be directly entered.	1~32000 unit
I I	Integral Time	Defines the integral time adjusted by PID, in seconds, when I=0, the integral action is canceled.	0~9999s
d d	Differential time	Defines the differential time adjusted by PID, in 0.1 seconds. When d=0, the differential action is canceled.	0~3200s
Ctl Ctl	Control cycle	When SSR, thyristor or current output is used, it is generally set to 0.5-3.0 seconds. When relay switch is used for output or heating/cooling dual output control system is used for output, short control cycle will shorten the service life of mechanical switch or lead to frequent switching and starting of cold/hot output. If the cycle is too long, the control accuracy will be reduced. Therefore, it is generally between 15-40 seconds. It is recommended that Ctl be set to about 1/5-1/10 of differential time (basically equal to the lag time of the system). When the output is a relay switch (OPt or Aut is set to rELY), the actual Ctl will be limited to more than 3 seconds, and the auto setting At will automatically set the Ctl to a suitable value to give consideration to the control accuracy and mechanical switch life. If the output is a control valve, Ctl is recommended to be 3~15s, giving consideration to response speed and avoiding frequent valve action. When the regulation mode parameter CtrL is defined as the ON-OFF mode, Ctl defines the delay time of ON action after the output is disconnected or powered on to avoid being connected immediately after disconnection. This function is intended to protect the operation of the compressor.	0.2~300.0s

P2 P2	Cold output proportional band	Define the cold output proportional band adjusted by APID and PID, and the unit is the same as the PV value, rather than the percentage of the range.	1~32000 unit
I2 I 2	Cold output integration time	Define the integral time of cold output adjusted by PID, in seconds, and the integral action is canceled when I=0.	0~9999s
d2 d2	Cold output differential time	Define the differential time of cold output adjusted by PID, in 0.1 seconds. When d=0, the differential action is canceled.	0~3200s
Ctl2 Ctl 2	Cold output cycle	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 (OPt or Aut is set to rELY), the actual Ctl will be limited to more than 3 seconds, generally 20~40 seconds.	0.2~ 300.0s
dPt dPt	Position of decimal point	Four display formats can be selected: 0, 0.0, 0.00 and 0.000. Note 1: For general thermocouple or thermal resistance input, 0 or 0.0 can be selected. Even if the 0 format is selected, the internal resolution of 0.1 ℃ is still maintained for control calculation. When using S, R and B thermocouples, it is recommended to select the 0 format; When INP=17, 18, 22, the internal resolution of the instrument is 0.01 ℃, and two display formats, 0.0 or 0.00, can be selected. Note 2: When using linear input, if the measured value or other relevant parameter values may be greater than 9999, it is recommended not to use the 0 format but the 0.000 format, because the display format will change to 00.00 after the value is greater than 9999.	
Scb Scb	Input translation correction	The Scb parameter is used for translation correction of input to compensate the error of sensor, input signal, or thermocouple cold end automatic compensation. Note: Generally, it should be set to 0. Incorrect setting will lead to measurement error.	-9990~ +4000 unit
SCL SCL	Enter lower scale limit	It is used to define the lower limit scale value of linear input signal and also to define the lower limit scale of the signal when the instrument is displayed as the transmitting output or light column display.	-9990 ~ +32000 unit
SCH SCH	Enter upper scale limit	It is used to define the upper limit scale value of the linear input signal, and also to define the upper limit scale of the signal when the instrument is used as the transmission output or light column display.	
FILt FILt	Input digital filtering	FILT determines the digital filtering strength. The larger the setting, the stronger the filtering, but the slower the response speed of the measured data. When the measurement is greatly disturbed, increase FILT gradually to make the instantaneous runout of the measured value less than 2~5 words. When the instrument is calibrated, set FILT to 0 or 1 to improve the response speed. The unit of FILT is 0.5 second.	0~40

Fru Fru	Power frequency and temperatu-re Unit-selection	50C means that the power frequency is 50Hz, and the input has the maximum anti-interference capability to this frequency; The unit of temperature is ℃. 50F means that the power frequency is 50Hz, and the input has the maximum anti-interference capability to this frequency; The temperature is in ° F. 60C means that the power frequency is 60Hz, and the input has the maximum anti-interference capability to this frequency; The unit of temperature is ℃. 60F means that the power frequency is 60Hz, and the input has the maximum anti-interference capability to this frequency; The temperature is in ° F.	
SPSL SPSL	Lower limit of external given scale	It is used to define the lower limit of scale of external given input signal when external given function is used; The lower limit of the valve position feedback signal is defined when the position proportional output is used, and the parameter can be automatically set by the valve auto-tuning function.	-9990 ~ + 32000 unit
SPSH SPSH	Upper limit of external given scale	It is used to define the upper limit of external given input signal scale when external given function is used; The upper limit of the valve position feedback signal is defined when the position proportional output is used, and the parameter can be determined by the valve auto-tuning function. Warning: The value of valve position after auto-setting is only for display and reference. Unless professionals, please do not manually modify SPSH and SPSL parameters.	
AF AF	Advanced function code	AF parameter is used to select advanced functions, and its calculation method is as follows: AF=A×1+B×2 +C×4 +D×8+E×16+F×32+G×64+H×128 A=0, HdAL and LdAL are deviation alarms; A=1, HdAL and LdAL are absolute value alarms, so the instrument can have two absolute value upper limit alarms and absolute value lower limit alarms respectively. B=0, the return difference of alarm and position adjustment is unilateral return difference; B=1, refers to bilateral backlash. C=0, the third row of instrument has a decimal point; C=1, there is no decimal point in the third row of the instrument (only the third row display is available). D=0, the password of entering the parameter table is public 808; D=1, the password is the parameter PASd value. Switch to on-site parameters and long press the left key to find LOC. E=0, HIAL and LOAL are absolute value upper limit alarm and absolute value lower limit alarm respectively; E=1, HIAL and LOAL are changed to upper limit and lower limit deviation alarms respectively, so there are four deviation alarms. F=0, fine control mode, internal control resolution is 10 times of the display, but the maximum display value is 3200 units in linear input; F=1 is the high resolution	0~255

AF RF	Advanced function code	display mode, which is selected when the display value is required to be greater than 3200. If G=0, the upper limit alarm is allowed when the measured value increases due to sensor disconnection (the upper limit alarm setting value should be less than the upper limit of signal range); G=1, the increase of measured value caused by sensor disconnection does not allow upper limit alarm. Please note that in this mode, even the normal upper alarm limit (HIAL) will delay about 15 seconds before it acts. H=0, HIAL and LOAL are independent alarm logic; If H=1, HIAL and LOAL become interval alarm, and only when LOAL>PV>HIAL is met, the alarm will be given. The alarm code is HIAL, and HIAL is also used for output. Note: For non-professional users, this parameter can be set to 0.	0~255
AF2 RF2	Advanced function code 2	AF2 is used to select the second group of advanced function codes, and its calculation method is as follows: AF2=A×1+B×2 +C×4 +D×8+E×16+F×32+G×64+H×128 A=0, the given value is internally given; A=1, the given value is external given, and the external given signal is input from the 5V input terminal. B = 0, the external given signal is 1~5V; B = 1, the external given signal is 0~5V. C=0, normal input mode; C=1, the linear input signal is squared. D=0, the transmitting output uses SCH SCL to define the scale; D=1, the transmission output uses SPSL SPSH to define the scale (Note: Do not use the valve feedback signal input). E=0, output 0 when sensor is disconnected, E=1, the Ero parameter is output when the sensor is disconnected. F=0, the system automatically sets Ero, F=1, set Ero manually. Automatic definition of Ero is one of the contents of AI auto-learning control, that is, the instrument will automatically memorize the average output value when the measured value is consistent with the given value, which can be used for PID adjustment operation as a reference to improve the control effect. For safety, the maximum learning value of Ero is 70% of the output power. If a higher value of Ero is required, it should be set as the safest common output when Ero parameters can be manually set. G=0, standby. H=0, CT function is disabled; The CT measurement function must be disabled during position proportional output (valve motor servo) to avoid conflicts between the two; H=1, the CT function is activated and needs to work with I9 module to detect current, which can be used for judging load disconnection or actuator short circuit. Note: The AI-8 * 6 series does not support external functions.	0~255

PAF PAF	Program operation mode (Pno≥1)	PAF parameter is used to select program control function, and its calculation method is as follows: PAF=A×1+B×2 +C×4 +D×8+E×16+F×32+G × 64+H×128 A=0, the preparation function (rdy) is invalid; A=1, the preparation function is effective. B=0, slope mode, when there is temperature difference during program operation, different temperature rise modes can be defined according to broken line transition, and it can also be used for cooling operation; B=1, platform mode (constant temperature mode), each segment of the program defines the given value and holding time, reaching the conditions of the next segment can be limited by the rdy function, and the rising/cooling rate can be limited by the SPr/SPrL parameter; in addition, even if B=0 is set, if the last segment of the program is not the end command, the constant temperature mode will also be executed, and the time will automatically end. C=0, the program time is in minutes; C=1, time is in hours. D=0, without measurement value activation function; D=1, with measurement value activation function. E=0, displays the measured value as a window when the program gives the generator; E=1, displays the program segment number as a window when the program gives the generator. F=0, standard operation mode; F=1, when the program is running, the RUN operation will enter the HoLd state. G=0, the program time is in minutes; G=1, the time is in seconds. H=0, standard operation mode; H=1, each segment has preparation function (rdy) in slope mode.	0~255
SPr SPr	Temperature -rising rate limit	When SPr is set as valid, the program runs or the set value is changed, and the measured value is lower than the set value, the instrument will rise to the set value at the temperature rise rate limit defined by SPr. The PRG light will flash under the temperature rise rate limit state. SPR is valid for fixed point control (Pno=0) and program platform mode, but not for slope mode. When item C of PAF=1, the units of SPR and SPRL become ℃/hour.	0~3200 ℃/ min
SPrL SPrL	Cooling rate limit	When SPrL is set as valid, the program runs or the set value is changed, and the measured value is higher than the given value, the instrument will cool down to the given value with the limit value of the cooling rate defined by SPrL. In the cooling rate limit state, the PRG light will flash. SPrL is valid for fixed-point control (Pno=0) and program platform mode, but not for slope mode. If the system has no refrigeration output, when the natural cooling rate is lower than SPrL, the instrument cannot guarantee the cooling slope, so it will be cooled at the natural cooling rate. When item C of PAF=1, the units of SPR and SPRL become ℃/hour.	0~3200 ℃/ min

Ero Ero	Output value at excessive range	When the instrument control mode is PID or APID, Ero defines the output value to be adjusted when the input is over range (usually caused by sensor failure or disconnection). AF2 parameter can define whether the Ero is valid and the setting mode. When the Ero is defined as the automatic setting mode and the deviation is less than 4 measurement units, the instrument automatically stores the integral output value, so the Ero value will automatically change with the system. When the mode is set manually, the Ero value is set manually.	-110 ~110%
OPrt OPrt	Output soft start time	If PV is less than OEF when the instrument is powered on or stopped, the maximum allowable output of main output OUTP will rise to 100% after OPrt. If PV is less than OEF when the instrument is powered on or stopped, the maximum allowable output of main output OUTP will rise to 100% after OPrt.	0~3600s
OEF OEF	Effective range of OPH	When the measured value PV is less than OEF, the upper limit of output OUTP is OPH, yet when PV is greater than OEF, the regulator output is not limited to 100%. Note: This function is used in some occasions where full power heating is not possible at low temperature. For example, because of the need to dry the moisture in the furnace or to avoid too fast temperature rise, a heater only allows 30% of the maximum heating power when the temperature is lower than 150 ℃, then it can be set: OEF=150.0 (℃), OPH=30 (%).	-999.0 ~ +3200.0 ℃ or linear unit
HIAL HIAL	Upper limit alarm	When the measured value PV is greater than the HIAL value, the instrument will generate an upper limit alarm; When the measured value PV is less than the HIAL-AHYS value, the instrument will remove the upper limit alarm. Note: Each alarm can be freely defined as controlling the action of output ports such as AL1, AL2, AU1 and AU2, or not doing any action. Please refer to the description of alarm output definition parameter AOP.	-9990~ +32000 unit
LoAL LoAL	Lower limit alarm	When PV is less than LoAL, the lower limit alarm will be generated, and when PV is greater than LoAL+AHYS, the lower limit alarm will be released. Note: HIAL and LoAL can also be set as deviation alarm if necessary (see AF parameter description).	
HdAL HdAL	Deviation upper limit alarm	When the deviation (measured value PV - given value SV) is greater than HdAL, the deviation upper limit alarm will be generated; When the deviation is less than HdAL-AHYS, the alarm will be released. When HdAL is set to the maximum value, the alarm function is canceled.	
LdAL LdAL	Deviation lower limit alarm	When the deviation (measured value PV - given value SV) is less than LdAL, the deviation lower limit alarm will be generated. When the deviation is greater than LdAL+AHYS, the alarm will be released. When LdAL is set to the minimum value, the alarm function is canceled. Note: If necessary, HdAL and LdAL can also be set as absolute value alarm (please refer to AF parameter description).	

AHYS AHYS	Alarm return difference	Also known as alarm dead zone, hysteresis, etc., it is used to prevent the alarm critical position from frequently acting due to the alarm relay. Please refer to the above.	0~2000 unit
AdIS AdIS	Alarm indication	OFF, the alarm symbol is not displayed at the lower display during alarm. On, in case of alarm, the alarm symbol is alternately displayed on the lower display as a reminder, which is recommended. FOFF, energy saving/confidential display mode, in which the instrument will turn off the display of measured value and set value, which can save the instrument power consumption or confidential process temperature. The lower display window displays the current station number, and the alarm symbol will be displayed in case of alarm.	
SPL SPL	lower limit of SV	The minimum value allowed by the SP.	-9990~ +32000 unit
SPH SPH	upper limit of SV	The maximum value allowed by the SP.	
SP1 SP 1	Given point 1	When the parameter Pno=0 or 1, the given value SV=SP1.	SPL~ SPH SPL~ SPH
SP2 SP2	Given point 2	When parameter Pno=0 or 1, I2 module is installed at MIO position, and parameter Et=SP1.2 is set, SP1/SP2 can be switched through an external switch. When the switch is off, SV=SP1, and when the switch is on, SV=SP2.	
PASd PASd	Password	When PASd is equal to 0-255 or AF.D=0, set Loc=808 to enter the complete parameter table. When PASd is equal to 256-9999 and AF.D=1, Loc=PASd must be set to enter the parameter list. Note: Only professional users can set PASd. It is recommended to use a unified password to avoid forgetting.	0~9999
Strt Strt	Valve rotation stroke time	Strt is used to define the stroke time of valve rotation when the instrument is a position proportional control output; If there is a valve feedback signal, the instrument will automatically select the return difference of the valve control signal according to the Strt setting. The shorter the stroke time, the greater the return difference, and the lower the valve positioning accuracy. When the mode of no valve feedback signal is used or the valve feedback signal generates an over range fault, the instrument will determine the action time of the valve motor according to the stroke time comparison defined by Strt.	10~240s

Nonc nonc	N.O. /N.C. selection	A single channel alarm relay can simultaneously output normally open and normally closed, while a dual channel alarm module L3 only has normally open output. However, the normally open output can be defined as normally closed output through the non c parameter. nonc=0, L3 relays installed in AL1, AL2, AU1, and AU2 are all normally open outputs; nonc=15, all instrument alarms are normally closed outputs. When it is necessary to keep some channels open and some channels closed, the nonc value can be calculated according to the following formula. Non c=A*1+B*2+C*4+D*8 A, B, C, and D represent the normally open and normally closed outputs of AL1, AL2, AU1, and AU2, respectively. When the value is 1, it is the normally closed output, while 0, it is the normally open output.	0~15
EFP1 EFP1	Lower limit of current alarm value	The percentage is used by EFP1~3. The CT function (AF2. H=1) needs to be enabled, paired with the I9 module, and the external transformer needs to be converted to AC 0~50mA. Try to match two or more transformers, so that the normal current percentage is around 20%~40%. For example, the normal current is about 15A, and 50mA is optional. This way, EFP3 will display around 30 during normal use, indicating a current of 30%; At this point, set EFP1=20 for load disconnection judgment, and EFP2=50 for actuator short circuit judgment; When a current alarm is generated, the instrument will flash CtAL while AU1 outputs. Setting AF. C=1, the three row display instrument can display the EFP3 current percentage on the third row. Note: SSR output or relay output should be selected, and the output cycle should be greater over 0.2 seconds.	0~100
EFP2 EFP2	Upper limit of current alarm value		0~100
EFP3 EFP3	Current percentage		
EAF EAF	Parameter selection for expanding advanced functions	The EAF parameter is used to extend advanced functions, and its calculation method is as follows: EAF=A*1+C*4+D*8+E*16+F*32 A=0, automatically selects the refresh speed of the main input based on the setting of CTI control cycle parameters (120mS~960mS; 100~800mS when Fru=60Hz). A=1, standby, the refresh speed of the main input is customized by special VIP users; A=2, the refresh speed of the main input is about 60mS (approximately 50mS when Fru=60Hz); A=3, the refresh speed of the main input is about 120mS (approximately 100mS when Fru=60Hz); C=0, disable automatic switching of two sets of PID parameters based on SV size; C=1, enable automatic switching of two sets of PID parameters based on SV size. D=0, PID parameter switching set value is defined by parameter OEF; If SV>OEF, use the second set of PID parameters, otherwise, use the first set of PID parameters; If D=1, the parameter switching set value is defined by the parameter SPSH;	

EAF EAF	Parameter selection for expanding advanced functions	Note: To avoid output disturbance during switching, the output cycles of the two sets of PIDs should usually be set to be consistent, and the differential time should be consistent too. E=0, AUX slot is in normal use; E=1, AUX slot for transmission output, needs to be paired with AUX. F=0, AUX for transmission output and transmits PV; F=1, AUX for transmitting output and transmits SV. Note: AI-8 * 6 series does not have EAF function	
Prn Prn	Functional parameters for selecting multiple program segments	Prn represents the number of the currently selected program group (0-9); When the Prn value is modified and the instrument is in the STOP status, the instrument will automatically save the previous 50 program segments to FLASH memory and load a new numbered program segment. Even if the number of program segments in the instrument is set to 0, modifying Prn will switch between 10 different sets of given values for SP1 and SP2. Note: FLASH large capacity memory is used to store data. According to the chip manufacturer's manual, the switching write life is 100,000 times, which is different from the instrument's description (including the currently loaded program) that the number of write times exceeds 2 billion. When switching program segments, the system will pause for about 10ms to write to FLASH memory, which will affect some real-time communication and control functions. Therefore, when the instrument is in the STOP status, the command to switch the program is executed. Note: AI-8 * 6 series does not have Prn function	
EP1-EP8 EP 1-EP8	Definition of parameters used on site	One to eight field parameters can be defined, which are commonly used after Loc locking and need to be modified by field operators. If there are no or less than eight field parameters, their values can be set to nonE.	

5 Common Function Description

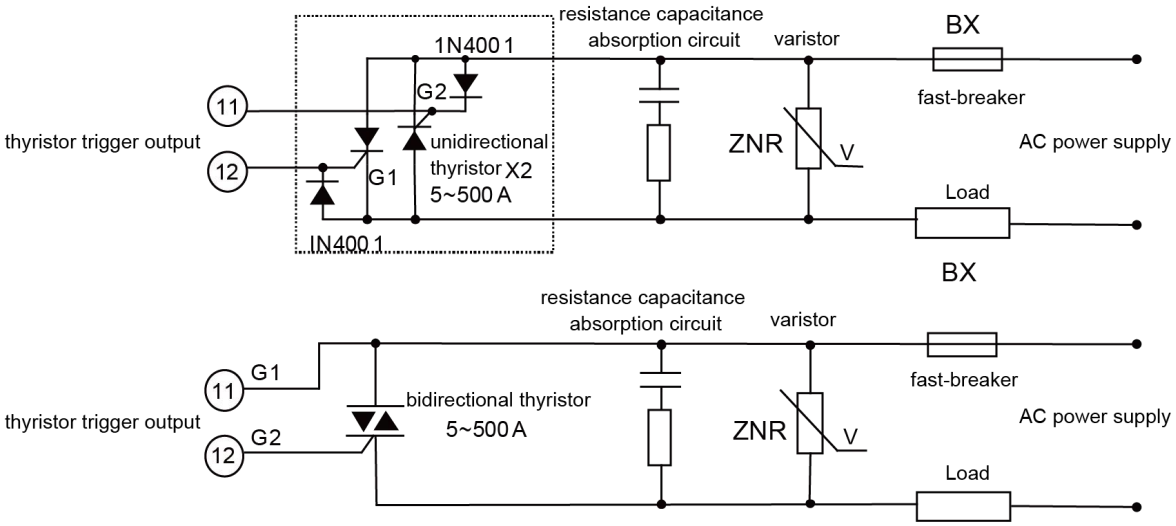
Note: For a complete description of the parameters involved in the following function introduction, please refer to the complete parameter table

5.1 SCR Trigger Output Function

5.1.1Single-phase Phase-shift Trigger Output

Parm.	Setting	Description
OPt	PHR 1	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 realize continuous heating power adjustment 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 instrument power and heater power 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: Resistor-capacitor absorption and varistor must be added when phase-shift trigger is used to improve possible harmonic interference.

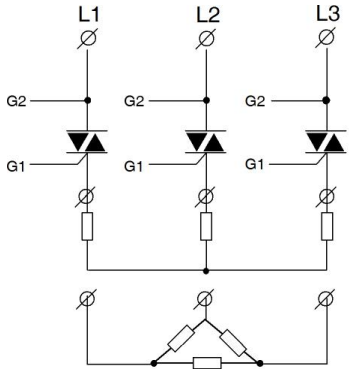
Note 2: It is recommended to use a SCR power module. One power module contains two unidirectional SCRs, as shown by the dotted line in the figure.

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

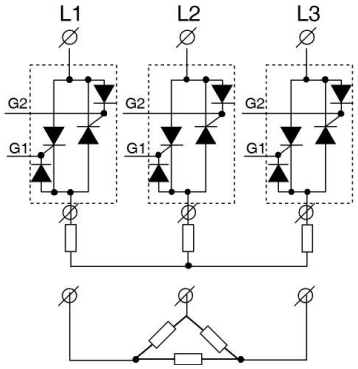
5.1.2Single-phase/Three-phase Zero-crossing Trigger Output

Parm.	Setting	Description
OPt OPt	SSr 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-parallel)

5.2 Position Proportional Output Function

5.2.1 Proportional output with feedback position

After setting this output, if OPH is less than 100, the instrument will automatically set the valve position when powered on, that is, it will automatically close the valve when powered on, and the time is the valve stroke time.The OPH parameter can limit the maximum valve opening when the measured value PV is less than the parameter OEF. If the OPH=100 is set, the instrument will automatically set the valve position when the output is 0% and 100%, and will not automatically set the valve position to shorten the startup time when power on.

Parm.	Setting	Description
OPt	nFEd	Position proportional output without valve position feedback signal
StrT rt	60	Valve stroke time, the factory default value is 60S, which needs to be modified according to the actual valve stroke time

5.2.2 Proportional output with feedback position

When there is proportional output with feedback position, it is necessary to do valve position auto-tuning. The instrument will automatically close the valve first, and then fully open the valve, then measure the feedback signal to set

the valve position and save it. After the valve position self-tuning is completed, the instrument will automatically set the parameter OPt to FEd, and the valve position signal will be saved in SPSL and SPSH parameters. During normal control, if the feedback signal exceeds 2% of the measuring range, it will be considered that the feedback signal is abnormal, and the control will be automatically carried out in the mode of no valve feedback signal. At the same time, "FErr" will be displayed on the lower display window to indicate an error.The feedback signal can be 1K resistance (V5 module is required) or 0~5V/1~5V signal (current 0~20mA/4~20mA can be converted by parallel resistance). It is recommended to use A2, E2 and other instrument panels with light column indication, which can indicate the valve opening rather than the output value calculated by the instrument.

Note: When setting the position proportional output with feedback, please do not set the measurement input signal to 0-1V and above voltage signal or set the external given function.

Parm.	Setting	Description
OPt OPt	FEd/FEAt FEd / FEAt	After other parameters are set and wiring is completed, set the instrument to FEAt to open the valve position auto-tuning
SPSL SPSL	0 0	It is the lower limit of the valve position, which is automatically written after the valve position is set
SPSH SPSH	1000 1000	It is the upper limit of the valve position, which is automatically written after the valve position is set

5.3 External Event Input Function

If I2 module is installed on MIO socket (or set bAud=1, and I2/I5 module is installed on COMM socket), a switch can be connected externally, and control functions can be executed through on-off of the switch to realize operation stop switching, dual set value switching, manual/automatic switching, etc.

Parm.	Setting	Description
Et Et	RuSt、SP1.2 etc ruSt SP1. etc.	Set different options to realize the function switching of the instrument controlled by external switches

5.4Quick Tuning of AAT Function

Traditional periodic oscillation auto-tuning requires 2 cycles to set PID parameters, which requires a long debugging time. The fast tuning function is that when the instrument is powered on and in the full power heating output state, the PID parameters can be calculated by analyzing the temperature rise curve, and the PID parameters can be set in advance without periodic oscillation. In most cases, accurate control can be achieved by the first heating, greatly shortening the commissioning time. If the AAT has not been completed automatically, the instrument will exit the full power output state, then the AAT will fail, the self-tuning will be terminated, and the PID parameters will not be modified.

Parm.	Setting	Description
At AE	AAt AAE	The quick setting function can be started after the instrument is powered on for operation

5.5External Given Function

External setting refers to changing the setting value of the instrument through external analog signals, which can realize the functions of proportional adjustment, cascade adjustment, manual operator, etc. The external given signal is fixed as 0-5/1-5V voltage signal. When the external given function is valid, the internal given value does not work. When the external given signal is disconnected, the internal given value will be switched automatically.

Note: When the external given function is set as valid, please do not set the measurement input signal as 0-1V or above voltage signal or set the feedback position proportional output.

Parm.	Setting	Description
AF2 AF2	1 or 3 1或3	It is used to set whether the external given function is effective, and set the external given signal as 0-5/1-5V
SPSL SPSL	0 0	Lower limit of external given signal range
SPSH SPSH	1000 1000	Upper limit of external given signal range

5.6 Soft-starting Function

This function can be enabled when the equipment needs to gradually increase output according to time when it is powered on or started up for operation. If the measured value PV is less than OEF when the instrument is powered on or stopped, the maximum allowable output of the main output OUTP after operation will rise to the output percentage set by OPH after the set time. If the measured value is greater than OEF when powered on or stopped, the rising time of the output is limited to 5 seconds.

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

5.7Heating and Cooling Dual output function

When the OPL parameter is set to - 1~- 110% and the control mode Ctrl is set to APId/nPid, the instrument will become a two-way output system, with two opposite PID control outputs, the main output OUTP and the auxiliary output AUX. The main output uses P, I, d, ctl control parameters, and the auxiliary output uses P2, I2, d2, ctl2 control parameters. When the instrument is a two-way output, OPL is used to reflect the maximum cold output limit. When

OPL=- 100%, there is no limit on cold output, -110% can make the maximum range of current output (4~20mA) exceed 10% or more, which is suitable for special occasions; When SSR or relay outputs, the maximum cold output limit shall not be greater than 100%.

Heating/Cooling Dual Output Self-tuning Explanation:

At room temperature, set SV to the commonly used heating temperature and turn on heating self-tuning At=on. During this period, heating MV=100%, cooling MV=-10%. Tuning ends after the temperature rises and falls for one and a half cycles, and the At parameter changes to FOFF.

Then set SV to the commonly used cooling temperature. When the cooling output is active, turn on cooling self-tuning At=on. During this period, heating MV=20%, cooling MV=-100%. Tuning ends after the temperature falls and rises for one and a half cycles. After both heating and cooling are tuned, normal operation can proceed.

Parm.	Setting	Description
OPt OPt	SSr etc SSr etc.	Set signal type of the main output
Aut Aut	SSr etc SSr etc.	Set signal type of auxiliary output
OPL OPL	-1~-110% -1_-110	Set as the maximum output percentage of auxiliary output terminal
OPH OPH	0~110% 0_110	Set as the maximum output percentage of the main output terminal

5.8Overrange Output Definition Function

During the operation of the instrument, when the input sensor signal exceeds the range or "orAL" alarm occurs abnormally, the instrument will automatically close the output. In some special occasions, dangerous situations may occur, for example, the control instrument of the cooling water valve in the machine room closes its output due to abnormal measurement signals, which may cause overheating or burning of the equipment. When the input signal of the instrument "orAL" alarms, after the over range output function is set, the instrument can work according to the preset output percentage signal or automatically set the appropriate output to avoid the above situations

Parm.	Setting	Description
AF2 AF2	16or48 16或48	Set whether to enable the over range output function, and set the Ero output in manual or automatic mode
Ero Ero	0 0	Set the output of the overrange, manually set in the manual mode, and automatically set in the automatic mode

5.9Limiting function of Temperature Rise/Fall Rate

When the equipment does not allow rapid heating or cooling due to material and other factors, the function of setting the temperature rise/drop rate limit is effective. After the instrument changes the set value or the program starts (platform mode), if the measured value is not equal to the set value, it will rise/fall to the set value or program segment value according to the set rise/fall rate limit value.The PRG light will flash when the rise/fall rate is limited. If the system has no refrigeration output, when the natural cooling rate is lower than SPrL, the instrument cannot guarantee the cooling slope,

thus it will be cooled at the natural cooling rate

Parm.	Setting	Description
SPr SPr	0~3200 0~3200	Set the temperature rise rate limit value, in ℃/min
SPrL SPrL	0~3200 0~3200	Set the limit value of cooling rate, in ℃/min

5.10Power-on Operation Mode Selection Function

After the equipment is powered on or powered on again due to accidental power failure, the instrument can select the power on operation mode to change the working state of the instrument as required.

Parm.	Setting	Description
PonP PonP	Cont/StoP etc. Cont/StoP etc.	Select the operating state of the instrument after power-on again

5.11Instrument Power Frequency and Temperature Unit Selection Function

After the equipment is powered on or powered on again due to accidental power failure, the instrument can select the power on operation mode to change the working state of the instrument as required.

Parm.	Setting	Description
Fru Fru	50C\50F\60C\60F 50C\50F\60C\60F	Select operating power frequency and temperature unit

5.12 Exempt from Alarm Function at Power-on

The instrument often leads to some unnecessary alarms after it is just powered on, for example, when the electric furnace temperature is controlled (heating control), and it is just powered on, its actual temperature is far lower than the given temperature. At this time, if the user sets the lower limit alarm or the lower limit deviation alarm, the instrument will meet the alarm conditions as soon as it is powered on, but in fact, the control system may not have problems. On the contrary, under the refrigeration control (positive action control), the instrument may have an upper limit alarm or deviation upper limit alarm just after being powered on. Therefore, AI instruments provide power on alarm exemption settings. Even if the instrument meets the corresponding alarm conditions after power on, it will not alarm immediately. After the alarm conditions are canceled, if the conditions that meet the alarm requirements occur again, the corresponding alarm will be generated.

Parm.	Setting	Description
Act Act	rEbA or drbA rEbA或drbA	Set rEbA as the power-on exemption lower limit alarm; set drbA as power-on exemption upper limit alarm

5.13 Communication Function

AI series instruments can be installed with S or S4 and other communication modules at the COMM position, and can be connected with computers to realize various operations and functions of the instrument. For the computer without RS485 interface, one RS232C/RS485 converter or USB/RS485 converter can be added. Each communication port can directly connect 1-60 instruments. With RS485 repeater, up to 80 instruments can be connected. One computer can support multiple communication ports. Please note that each instrument shall be set with a different address. When there are more than one instrument, two or more computers can be used, and a local network can be formed between the computers. The manufacturer can provide AIDCS application software, which can run under the Chinese WINDOWS operating system, realize centralized monitoring and management of 1~200 AI series instruments of various models, and automatically record and print measurement data. If users want to develop their own configuration software, they can ask the instrument seller for free when obtaining the communication protocol. A variety of configuration software can support AI instrument communication.

Parm.	Setting	Description
AFC AFC	0~12 0~ 12	Set communication mode, select MODBUS-RTU or AIBUS, etc
Addr Addr	0~99 0~99	Set communication address
bAud bAud	0~28.80/28800K 0~28.00/28000	When communication baud rate does not exceed 28800, set the corresponding value. Starting from version 9.36, higher baud rates are added. Setting 384, 576, 1152 corresponds to baud rates 38400, 57600, 115200 respectively. However, if communication success rate is low, please reduce the baud rate.

5.14 Temperature Transmitter/Programmed Generator

In addition to the conventional APID/nPID or ON-OFF position adjustment, the instrument can also directly output the measured value (PV) or the given value (SV) from the OUTP or COMM terminal. When the output is defined as current output, AI-8 can be used as a temperature transmitter, and when the program function is enabled, it can be used as a program given generator. The current output accuracy is 0.3% FS of the corresponding display value.

5.14.1 The OUPT terminal transmitting output

Parm.	Setting	Description
CtrL CtrL	POP or SOP POP或SOP	Set the transmitted PV value or transmitted SV value
SCL SCL	0 0	Set the lower limit value of input signal and that of transmission
SCH SCH	1000 1000	Set the upper limit value of input signal and that of transmission

OPt OPt	0-20/4-20 0-20 / 4-20	Set transmission signal type

For example, the instrument is required to have the K index thermocouple transmitting function, the temperature range is 0~400 ℃, and the output is 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 the temperature is less than or equal to 0 ℃, the output of X3 or X5 linear current module installed at the OUTP position is 4mA; when the temperature is greater than or equal to 400 ℃, the output is 20mA; when the temperature is between 0 ℃ and 400 ℃, the output changes continuously between 4 and 20mA.

5.14.2 Transmit output at the COMM terminal (Note: only one of the functions of COMM position transmission, communication and event input can be selected)

Parm.	Setting	Description
bAud bAud	0 or 4 or 8 or 12 0或4或8或 12	Set PV value or SV value and 0-20 or 4-20mA
SCL SCL	0 0	Set the lower limit value of input signal and that of transmission
SCH SCH	1000 1000	Set the upper limit value of input signal and that of transmission

5.15 Fine Control

Fine control refers to that the PID operation resolution is 10 times higher than the display resolution. For example, the instrument temperature signal is displayed as 1 ℃, but the internal PID is still calculated and controlled according to the resolution of 0.1 ℃, which can achieve a much higher control accuracy than the display resolution. In previous versions of AI series instruments, only the temperature signal adopts the fine control mode; When the new version is used for linear input, as long as the displayed value range is less than 3000 words (most industrial applications are no more than 3000 words), fine mode is used by default for control to obtain higher control accuracy and more stable output. When the displayed value range is greater than 3000 words, high resolution mode can be set.

Parm.	Setting	Description
AF AF	AF.F＝0 or1 0或 1	If F is selected as 0 in AF parameter, it is fine control mode; Select 1 as the high resolution display mode

5.16 Custom Input Specifications

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 01: Defines input type, its numerical definitions are as follows:

A 01=A×1 +H×128

A=0 corresponds to 0~20mV (K coefficient range 0~32000); A=1 corresponds to 0~40mV (K coefficient range 0~32000);

A=2 corresponds to 0~75mV (K coefficient range 0~30000); A=3 corresponds to 0~150mV (K coefficient range 0~30000);

A=4 corresponds to 0~5V (K coefficient range 0~25000); A=10 corresponds to MIO, e.g., when equipped with I45, 0~20mA (K coefficient range 0~30000);

A=64 corresponds to 0~100Ω (K coefficient range 0~25000); A=65 corresponds to 0~200Ω (K coefficient range 0~25000); A=66 corresponds to 0~400Ω (K coefficient range 0~25000);

When H=0, the table output value is the displayed value. When H=1, the output value from the table for a linear input signal still needs to be calibrated using the SCL/SCH parameters. (The table range is calculated based on 0~20000, independent of A02 and A03)

For example,For a 1-5V voltage input signal, the SCL and SCH ranges must also be calculated 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.

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.

5.17 Multi-segment Linear Correction Function of Input Signal

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.

5.18Nonlinear Power Control Function of 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 modify the data according to their own needs):

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 * 8 program type instrument is used in situations where it is necessary to automatically change the set value for control according to a certain time rule. It not only has the function of 50 segments programming, which can set the rise and fall slope of any given value, but also has programmable/operable commands such as jump, run, pause and stop, which can modify the program during program control operation; in addition, it has power failure processing mode, measured value startup function and preparation function as well, which makes program execution more efficient and perfect.

6.1 Function and Concept

Program segment: the segment number can range from 1 to 50. The current segment (StEP) represents the segment currently being executed.

Setting time: refers to the total running time set in the program segment, in minutes or hours, with effective values ranging from 0.1 to 3200.

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

Jump: the program segment can be programmed to automatically jump to any segment to achieve loop control. Jumping can also be achieved by modifying the value of StEP.

Run (run/HoLd): When the program is in the running state, the time is timed, and the given value changes according to the prearranged program curve. When the running state is maintained (paused), the time stops timing and the given value remains unchanged. The pause operation (HoLd) can be programmed in the program segment.

Stop: The execution of stop operation will stop the program running. At this time, the running time is cleared and the timing is stopped, and the control output is stopped. If the operation is executed in the stopped state, the instrument will start the operation program from the segment number set by StEP. The function of automatic stop can be programmed into the program segment, and the StEP value of the running segment number can be set at the same time. Besides, Manually stop is enabled at any time (StEP is set to 1 after execution, but users can modify it again). If the program segment number has finished running the last segment defined in the Pno parameter, it will stop automatically.

Power failure/startup event: it refers to the power on of the instrument or the accidental power failure during operation. A variety of different treatment schemes can be selected by setting PonP parameters.

Preparation (rdy) function: If the measured value is different from the given value (if the measured value startup function is allowed, the system first uses the measured value startup function for processing; if the measured value startup function can work effectively, the standby function does not need to work, and only those that do not meet the processing conditions of the measured value startup function can be processed with the preparation function) when the running program is started and the program needs to be continued after the unexpected power outage/startup, And when the difference is greater than the deviation alarm value (HdAL and LdAL), the instrument will not immediately give a

positive (or negative) deviation alarm, but first adjust the measured value to a value whose error is less than the deviation alarm value. At this time, the program also pauses timing, and does not output the deviation alarm signal. The program will not start until the positive and negative deviations meet the requirements. The preparation function is also useful for setting the segment where the rise/fall time cannot be predicted. To allow or cancel the preparation function, the instrument is allowed to set it in the PAF parameters. The preparation function can ensure the integrity of the whole program curve, but the preparation time may increase. Both the preparation function and the measured value startup function are used to solve the uncertainty of the program operation caused by the inconsistency between the measured value and the given value during startup and operation, so as to obtain the program operation results that are efficient, complete and meet the user's requirements.

Start function of measured value: When starting the running program and continuing the running program after an unexpected power outage/startup, the actual measured value of the instrument is often different from the set value calculated by the program, and this difference is sometimes unexpected and unpredictable. For example, for a temperature rise section program, the instrument is set to rise from 25 ℃ to 625 ℃ after 600 minutes, with a temperature rise of 1 ℃ per minute. Assuming that when the program is started from the starting position of this section, if the measured value is just 25 ℃, the program can be successfully executed as originally planned. The measured value startup function can be made consistent by the instrument by automatically adjusting the running time. For example, in the above example, if the measured temperature is 100 ℃ when starting the operation, the instrument will automatically set the running time to 75 minutes, so that the program will start running directly from the position of 100 ℃.

Curve fitting: it is a control technology adopted by AI-8 instrument. Because the control object usually has the characteristics of time lag, the instrument automatically smooths the linear rise, drop and constant temperature curves at the break point. The degree of smoothness is related to the system's lag time t (t=differential time d+control cycle Ctl). The greater t is, the greater the degree of smoothness is, and vice versa. The smaller the lag time (such as thermal inertia) of the control object, the better the program control effect. Processing program curves by curve fitting can avoid overshoot.

Note: The characteristic of curve fitting causes the program control to produce a fixed negative deviation when the linear program heats up and a fixed positive deviation when the linear program heats down. The value of the deviation is proportional to the lag time (t) and the rate of temperature rise (fall). This is a normal phenomenon.

6.2 Programming

6.2.1 Slope mode

When parameter PAF.B=0 is set, The program is arranged in the format of temperature~time~temperature, which is defined as: set the temperature from the current segment, and reach the next temperature after the time set in this segment. The unit of temperature setting value is the same as the measured value PV, while the unit of time value can be selected as minute or hour. In slope mode, if the last segment of program defined by Pno is not a stop command or jump command (the time setting in the following text can be edited), it means that it will end automatically after holding this segment of time at this temperature. The following example is a five segment program example including linear temperature rise, constant temperature, linear temperature drop, jump cycle, preparation and pause.

1st segment SP 1=100.0 t 1=30.0; Starting from 100 ℃, the temperature rises linearly to SP 2, with a temperature rise time of 30 minutes and a temperature rise slope of 10 ℃/minute

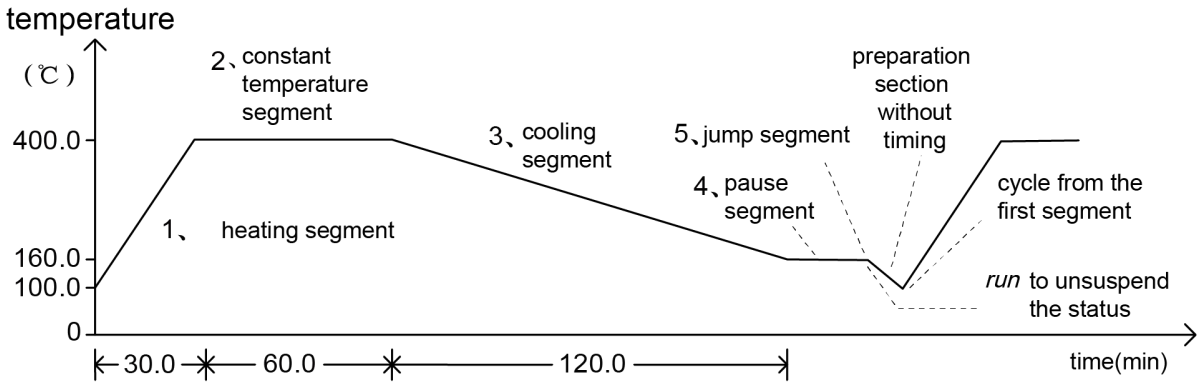
2nd segment SP 2=400.0 t 2=60.0; Run at 400 ℃ for 60 minutes

3rd segment SP 3=400.0 t 3=120.0; Cool down to SP 4, the cooling time is 120 minutes, and the cooling slope is 2 ℃/minute

4th segment SP 4=160.0 t 4=0.0; When the temperature drops to 160 ℃, it will enter the pause state, and the next section can continue after *run* is executed

5th segment SP 5=160.0 t 5=- 1.0; Skip to the first paragraph for execution and start running from the beginning of the cycle.

In this example, after the fifth segment jumps to the first segment, because its temperature is 160 ℃, while C 01 is 100 ℃, which is not equal, and the fifth segment is also a jump segment, assuming that the upper limit of deviation alarm value is set to 5 ℃, the program will first enter the preparation state after the fifth segment jumps to the first segment, that is, that is, control the temperature to less than the upper limit of deviation alarm value first, i.e. 105 ℃, and then conduct the temperature rise program in the first section. The temperature control procedure is shown in the figure below:



The advantage of using temperature-time programming method is that the slope setting range of temperature rise and drop is very wide. The heating and constant temperature sections have a unified setting format, which is convenient for learning. Besides, it is more flexible to set curve, and possible to set a continuous heating section (for example, use a heating section with different slopes to approximate functional heating), or a continuous constant temperature section as well.

6.2.2 Platform Mode

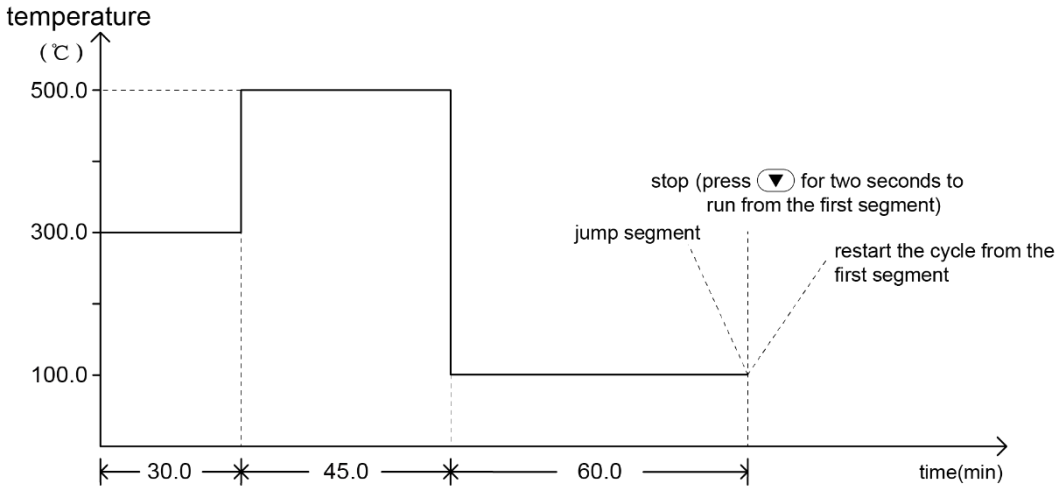
When parameter PAF.B=1 is set, the platform mode can be selected, which is suitable for applications that do not need to set the temperature rise slope independently and do not need to set the temperature drop slope. It can simplify programming and make more effective use of the number of segments. Each segment of the program means the temperature~the constant temperature time of the temperature. A temperature rise rate limit can also be defined with the SPR parameter between segments. If SPR is set to 0, it means full speed temperature rise. Since the temperature rise time cannot be determined and will occupy the holding time, rdy can be set to be effective to ensure the correct constant temperature time.

1st segment SP 1=300.0 t 1=30.0; temperature at 300 ℃ for 30 minutes

2nd segment SP 2=500.0 t 2=45.0; temperature at 500 ℃ for 45 minutes

3rd segment SP 3=100.0 t 3=60.0; temperature at 100 ℃ for 60 minutes

4th SP 4=100.0 t 4=-121.0; the program enters the stop state.



The platform mode only needs to set the temperature and constant temperature time. It does not need to set the temperature rise process. As shown in the figure above, the platform mode can be set to skip, stop, cycle, etc. The above settings are actually listed as stop.

6.2.3 Set Program Given Value and Time

Each program section includes a given value and time. The range of values that can be set for a given value is limited by SPL and SPH. It is - 999~+3200 ℃, representing the temperature value (℃) to be controlled or the linear definition unit. Time, in addition to the running time, has special control functions, with the following meanings:

t-XX ＝ 0.1~3200 (min) indicates the time value set in the XX segment (Note: the time unit can also be changed to hour with PAF parameter).

t-XX ＝ 0.0 The instrument enters HoLd in the XX segment, where the program stops running and stops timing.

t-XX ＝ - 121.0, the program executes the Stop operation and enters the stop state.

t-XX ＝ - 0.1~- 122.0 A negative time value indicates a jump+event output command. The integer part - 1~- 120 represents the jump segment, but it is invalid when the number of segments exceeds the number defined by Pno. The integer is 0 (the decimal is not 0), which means that the next segment is run. The decimal position is the event output programming, which can be programmed to make AL1 and AL2 act during the program running. -XXX. 0 means that it does not affect the program event state, but only jumps. Note that if the alarm output definition AOP also defines that the alarm is output by AL1 or AL2, the program event or alarm can cause AL1 or AL2 to act. The meaning of - XXX.1~- XXX4 is as follows:

-XXX.1, AL1 acts and AL2 is released;

-XXX.2, AL1 is released and AL2 acts;

-XXX.3, Both AL1 and AL2 act;

-XXX.4, Both AL1 and AL2 are released;

For example, if t - 5=- 1.1 is set, it means that when the fifth segment of program is run, AL1 acts, and AL2 releases and jumps to the first segment.

For another example, if t - 6=- 0.3 is set, it means that when the sixth segment of program is run, AL1 and AL2 act and continue running the next segment of program (the seventh segment).

Note:In addition to the jump segment encountered during the operation or power on, the jump operation can be continued. If the jump segment jumps to the jump segment during the program operation, the program will automatically suspend execution (that is, the instrument will automatically insert the pause operation in two consecutive jumps), and external operation is required to remove the pause status. Please note that if the jump segment jumps to itself (for example, t - 6=- 6), it will not be able to release the suspended state, because such a segment can be said to be meaningless.

6.2.4 The Programming Method of Running Multiple Curves

The programming method of AI-8x8 is advanced and flexible, and the newly added Prn is used to select numbers (0-9) for the current program group; When the Prn value is modified and the instrument is in the STOP status, the instrument will automatically save the previous 50 program segments to FLASH memory and load a new numbered program segment. Even if the number of program segments in the instrument is set to 0, modifying Prn will switch between 10 different sets of given values for SP1 and SP2.

7. Communication Description and Register Addresses

The AI-8 series instruments use an asynchronous serial communication interface, with interface levels conforming to the RS232C or RS485 standards. The data format is: 1
start bit, 8 data bits, no parity or even parity, 1 or 2 stop bits. The communication baud rate can be adjusted from 4800 to 28800 bps.
Typically, 9600 bps is used. For faster refresh rates, 19200 or 28800 bps can be attempted. When the communication distance is long or communication is
unreliable and frequently interrupted, 4800 bps can be selected.

Yudian V9.x version intelligent instruments use the AFC parameter to select the protocol type, where AFC = AFC.A + AFC.D 8. The functions are as follows:

AFC Parameter Value	Functional Description	AFC Parameter Value	Functional Description
0	Standard MODBUS-RTU protocol, no parity	8	Standard MODBUS-RTU protocol, even parity
1	AIBUS protocol, no parity	9	AIBUS protocol, even parity
2	Compatible MODBUS-RTU protocol, no parity	10	Compatible MODBUS-RTU protocol, even parity
4	Standard MODBUS-RTU protocol S6/S7 address compatibility mode, no parity. Note: The modules used are still S, S1, S4	12	Standard MODBUS-RTU protocol S6/S7 address compatibility mode, even parity. Note: The modules used are still S, S1, S4

7.1 AIBUS Protocol Communication Instruction Description

This document uses hexadecimal data format to represent various instruction codes and data. The AIBUS

communication protocol has only two instructions: one read instruction and one write instruction. The length of both transmitted and received instruction bytes is fixed (8 bytes for sending, 10 bytes for receiving), making it easy to develop host computer software while still allowing complete operation of the instrument. Instructions must be sent continuously; if the byte length is incorrect, the instrument will not respond.

Instrument Address: The AIBUS protocol address range is 0~80. A maximum of 81 AI instruments can be connected on one communication line. The communication address of an instrument is determined by the parameter Addr. Address Code Representation: Internally, the instrument uses two repeated values between 128~208 (hexadecimal 80H~D0H) to represent the address code. Since two consecutive numbers within 128~208 typically do not appear in AI instrument data, conflicts between data and addresses are avoided. Address Instruction: The AI instrument communication protocol specifies that the address instruction consists of two identical bytes, with a value of (Instrument Address + 80H). Example: If the instrument parameter Addr = 10 (hexadecimal 0AH, 0A + 80H = 8AH), then the address instruction for this instrument is:

8AH 8AH

Parameter Address: Instrument parameters are represented by an 8-bit binary number (one byte) parameter address code. It indicates the parameter to be read/written in the instruction. The meanings of various parameters are shown in the table later.

Check code: The check code uses a 16-bit summation method. For read instructions, the check code calculation is:

Parameter Code to Read × 256 + 82(52H) + Addr

For write instructions, the check code is the remainder (overflow is ignored) obtained from the 16-bit binary addition of:

Parameter Code to Write × 256 + 67(43H) + Parameter Value to Write + Addr

Returned Data: Whether reading or writing, the instrument returns 10 bytes of data. PV, SV, and the read parameter value each occupy 2 bytes, representing a 16-bit signed two's complement integer. The low-order byte comes first, followed by the high-order byte. Integers cannot represent decimal points, requiring the host computer to handle them. MV occupies one byte, formatted as an 8-bit signed binary number with a range of -110 to +110. The status byte occupies one byte. The check code occupies 2 bytes, totaling 10 bytes. The check code is the remainder obtained from the 16-bit integer addition of: `PV + SV + (Alarm Status × 256 + MV) + Parameter Value + Addr`, ignoring overflow.

Specific Command Interactions:

Read Parameter Instruction:

Address Code Low Byte	Address Code High Byte	Read Function Command	Parameter Code to Read	Low Byte	High Byte	Checksum Low Byte	Checksum High Byte
80H+ Instrument address	80H+ Instrument address	52H	Refer to the parameter code table	00H (Fixed value)	00H (Fixed value)	See Note 1	

Note 1: Checksum = Parameter Code to Read × 256(100H) + 82(52H) + Instrument Address

Example: Command to read the upper limit alarm value (parameter code 01H) from instrument address 1 (Addr=1, address code=81H):

Address Code Low Byte	Address Code High Byte	Read Function Command	Parameter Code to Read	Low Byte	High Byte	Checksum Low Byte	Checksum High Byte
81H	81H	52H	01H	00H	00H	53H	01H

Checksum = 1(01H) × 256(100H) + 1(01H) + 82(52H) = 339(153H). Since low byte first, high byte last, it's 53H 01H.

Write Parameter Command

Address Code Low Byte	Address Code High Byte	Write Function Command	Parameter Code to Write	Value to Write Low Byte	Value to Write High Byte	Checksum Low Byte	Checksum High Byte
80H+ Instrument address	80H+ Instrument address	43H	Refer to the parameter code table	See Note 1		See Note 2	

Note 1: Data to be written to the instrument: low byte first, high byte last.

Note 2: Checksum = remainder of (Parameter Code to Write × 256(100H) + 67(43H) + Instrument Address + Value to Write) & FFFFH.

For example, the command to write a setpoint value of 100.0 for instrument address 1 is as follows:

Address Code Low Byte	Address Code High Byte	Write Function Command	Parameter Code to Write	Value to Write Low Byte	Value to Write High Byte	Checksum Low Byte	Checksum High Byte
81H	81H	43H	00H	E8H	03H	2CH	04H

Checksum = 0(00H) × 256(100H)+1(01H)+1000(03E8H)+67(43H) = 1068(42CH). Since low byte first, high byte last, it's 2CH, 04H.

Return Data: Whether it is a read or write command, the instrument returns 10 bytes of data

Low byte of measured value	High byte of measured value	Low byte of setpoint value	High byte of setpoint value	Output value MV	Status byte	Low byte of read or written parameter value	High byte of read or written parameter value	Checksum Low Byte	Checksum High Byte
Note 1								Note 2	

Note 1: Measured value = (High byte of measured value × 256) + Low byte of measured value

The same parsing method applies to setpoint values and read or written parameter values

Note 2: Checksum = (Measured value + Setpoint value + Status byte × 256 + Output value MV + Read or written parameter value + Instrument address) & FFFFH (remainder). If communication data is interfered with, the checksum in the returned data can be compared with the calculated checksum during acquisition. If they match, the data is normal; otherwise, interference may have caused an abnormality.

Assume the instrument with address 1 currently displays a measured value of 100.0, a setpoint value of 0.0, no alarms, and no output. The returned command for reading or writing a setpoint value of 0.0 is as follows:

Low byte of measured value	High byte of measured value	Low byte of setpoint value	High byte of setpoint value	Output value MV	Status byte	Low byte of read or written parameter value	High byte of read or written parameter value	Checksum Low Byte	Checksum High Byte
E8H	03H	00H	00H	00H	60H	00H	00H	E9H	63H

The status byte indicates instrument alarms and alarm relay states, with the following meanings (Bit 7 is fixed as 0):

Status byte	Meaning		
Bit 0	Upper limit alarm (HIAL)	0: No alarm	1: Alarm triggered
Bit 1	Lower limit alarm (LoAL)	0: No alarm	1: Alarm triggered
Bit 2	Positive deviation alarm (dHAL)	0: No alarm	1: Alarm triggered
Bit 3	Negative deviation alarm (dLAL)	0: No alarm	1: Alarm triggered
Bit 4	Input over-range alarm (orAL)	0: No alarm	1: Alarm triggered
Bit 5	AL1 state: 0 = Active		
Bit 6	AL2 state: 0 = Active		

7.2 MODBUS-RTU Communication Protocol Command Description

The AI series instruments support the MODBUS protocol, with support for two commands: 03H (read parameters and data), and 06H (write a single parameter). They can communicate with other MODBUS devices. To ensure speed, the AI instruments use RTU (binary) mode, baud rate can be set from 4800~19200bps, 1 or 2 stop bits, no parity bit, and instrument address range 0~80.

For the 03H command, 1~ 20 piece(s) of data can be read at a time, with each data being 2 bytes. For example, to read 2 data, the command would be as follows:

Instrument address	Read command (function code)	Read parameter code address	Read data length	Check code
XXH	03H	00H XXH	00H 02H	CRC

06H Write Command Format: For example, to write SV value as 100.0 (parameter dPt=1), the command is:

Instrument address	Write command (function code)	Write parameter code address	Write data value	Check code
XXH	06H	00H 00H	03H E8H	CRC

Instrument return data format follows the standard MODBUS protocol, and most user configuration software can handle it automatically. Note: Write commands do not support returning measurement values, only the parameter value written. Due to MODBUS protocol limitations, write commands cannot return measurement values, so measurement values cannot be refreshed during writing. When writing parameters continuously, alternate write and read commands to avoid failure to refresh measurement values. If there is a bug in the program causing write commands to be mistakenly called, it may result in incorrect parameter writing. Therefore, minimize the use of write commands in your program to avoid abnormal instrument operation.

For more efficient reading of large amounts of data, you can use the company's Modbus-AIBUS communication relay control and protocol converter or the S6 enhanced communication module with its own CPU. For more details, refer to the relevant product manuals.

7.3 Parameter Codes (Register) Addresses and Meanings (Same for AIBUS and MODBUS-RTU Protocols)

This table lists the readable/writable parameter codes for the AI series single-channel temperature controllers and single-display devices. If using AFC = 4 (S6 compatibility mode), refer to the S6 module manual.

Note: Decimal codes, hexadecimal codes, and MODBUS register numbers are different representations of the same parameter. Different host computer software may use different notations. If one notation is not recognized, try the other two.

Decimal Code	Hexadecimal Code	MODBUS Register	Parameter Name	Description
0	0	40001	Setpoint	Same unit as measured value
1	1	40002	HIAL Upper Limit Alarm	Same unit as measured value
2	2	40003	LoAL Lower Limit Alarm	Same unit as measured value
3	3	40004	HdAL Deviation High Limit Alarm	Same unit as measured value
4	4	40005	LdAL: Deviation Low Limit Alarm	Same unit as measured value
5	5	40006	AHYS Alarm hysteresis	Same unit as measured value
6	6	40007	CtrL Control mode	0: ON/OFF; 1: APID; 2: nPID; 3: PoP; 4: SoP
7	7	40008	P Proportional band	Same unit as measured value
8	8	40009	I Integral time	second
9	9	40010	d Derivative time	0.1 seconds
10	A	40011	Ctl Control Cycle	0.1 seconds
11	B	40012	InP Input specifications	Refer to the user manual)
12	C	40013	dPt Decimal Point Position	0: 0; 1: 0.0; 2: 0.00; 3: 0.000. When processing dPt as the decimal point, 0–3 are normal. When the read value exceeds 127, subtract 127 to get the actual decimal point position. For example, if INP = 0, communication must process it as 1 decimal place, but if the device does not want to display the decimal point, dPt is set to 0, and the read value is 128, it must be processed as 1 decimal place. The write range for dPt is 0–3, without adding 128.
13	D	40014	ScL Scale Lower Limit	Same unit as measured value
14	E	40015	ScH Scale Upper Limit Value	Same unit as measured value
15	F	40016	AOP Alarm Output Selection	Refer to the manual for meanings
16	10	40017	Scb Measurement Offset Correction	Same unit as measured value
17	11	40018	oPt Main Output Type	0, SSR; 1, rELy; 2, 0-20; 3, 4-20; 4, PHA1; 5, nFEd; 6, FEd; 7, FEAT
18	12	40019	OPL Output Lower Limit	%
19	13	40020	OPH Output Upper Limit	%
20	14	40021	AF Function Selection	Refer to the manual for meanings
21	15	40022	Instrument Model Characteristic Code	Refer to the instrument model and feature code table for meanings
22	16	40023	Addr Communication Address	

23	17	40024	FILt Digital Filtering	
24	18	40025	AMAn Manual/Auto selection	0, MAN; 1, Auto; 2, FSV; 3, FAut
25	19	40026	Spare	
26	1A	40027	MV Manual output value	
27	1B	40028	Srun 0-Run/1-Stop/2-Hold	0, run; 1, StoP; 2, HoLd
28	1C	40029	CHYS Control hysteresis	Same unit as measured value
29	1D	40030	At Auto-tuning selection	0, OFF; 1, on; 2, FoFF; 3, AAt
30	1E	40031	SPL Setpoint lower limit	Same unit as measured value
31	1F	40032	SPH Setpoint upper limit	Same unit as measured value
32	20	40033	Fru Unit and power frequency	0, 50C; 1, 50F; 2, 60C; 3, 60F
33	21	40034	OEF OPH effective range	Same unit as measured value
34	22	40035	Act Direct/Reverse action	0, rE; 1, dr; 2, rEbA; 3, drbA
35	23	40036	AdIS Alarm selection	0, OFF; 1, on; 2, FoFF
36	24	40037	Aut Cold output specification	0, SSR; 1, rELy; 2, 0-20; 3, 4-20
37	25	40038	P2 Cold output proportional band	Same unit as measured value
38	26	40039	I2 Cold output integral time	second
39	27	40040	d2 Cold output derivative time	0.1 seconds
40	28	40041	CtI2 Cold output cycle	0.1 seconds
41	29	40042	Et Event input type	Et = Et1 + Et2 * 10; Et1 and Et2 each have 7 options. 0, nonE; 1, ruSt; 2, SP1.2; 3, PId2; 4, EAct; 5, Eman; 6, Erun; 7, Eout
42	2A	40043	SPr Heating rate limit	Measurement value unit/(minute or hour) (requires unit processing consistent with the measurement value)
43	2B	40044	Pno Number of program segments	Integer
44	2C	40045	PonP Power-on selection	0, Cont; 1, StoP; 2, run1; 3, dASt; 4, HoLd
45	2D	40046	PAF Program parameter	Function as per the manual
46	2E	40047	STEP Program segment number	Integer
47	2F	40048	Elapsed time	0.1 seconds, 0.1 minutes, or 0.1 hours, determined by the PAF parameter.
48	30	40049	Event output status	0 No event output; 1 Event 1 (AL1) active; 2 Event 2 (AL2) active; 3 AL1 and AL2 active.
49	31	40050	OPrt: Soft-start time	
50	32	40051	Strt: Valve rotation time	Defines the time required for valve rotation
51	33	40052	SPSL External setpoint lower limit	can be used to define external setpoint range; used in forward/reverse valve control with feedback
52	34	40053	SPSH External setpoint upper limit	

53	35	40054	Ero Fault output value	
54	36	40055	AF2 Advanced function 2	Function parameter 2
55	37	40056	Spare	
56	38	40057	SPrL Cooling rate limit	
57	39	40058	EFP1 Current lower limit alarm	
58	3A	40059	EFP2 Current upper limit alarm.	
59	3B	40060	EFP3 Current percentage	
60	3C	40061		
61	3D	40062	nonc 8-series normally open/normally closed selection	Starting from bit 0, corresponding to AL1, AL2, AU1, AU2 respectively
62	3E	40063	EAF Extended advanced function parameter	Function as per the manual
63	3F	40064	Prn Multi-group program segment selection	Used to select the recipe group; must be in STOP state.
64	40	40065	EP1 On-site Parameter	Users can define 8 parameters for read/write as needed
65	41	40066	EP2 On-site Parameter	
66	42	40067	EP3 On-site Parameter	
67	43	40068	EP4 On-site Parameter	
68	44	40069	EP5 On-site Parameter	
69	45	40070	EP6 On-site Parameter	
70	46	40071	EP7 On-site Parameter	
71	47	40072	EP8 On-site Parameter	
72	48	40073	L5 Output valve position (read-only)	
73	49	40074		
74	4A	40075	PV (read-only)	Single-channel meter measurement value (read-only, short type)
75	4B	40076	SV (read-only)	Single-channel meter real-time setpoint value (read-only, short type)
76	4C	40077	Output value (MV) + alarm status	Low byte MV output percentage; high byte alarm status (alarm status corresponds to AIBUS). Bit0~4 HIAL, LOAL, HDAL, LDAL, ORAL status bits (0 no alarm, 1 alarm). Bit5~6 AL1 and AL2 output status (0 output active, 1 output inactive)
77	4D	40078	Output port status + operating status	Bit0~1 Run/Stop/Pause status; Bit2 1 indicates auto-tuning started; Bit3 1 indicates manual mode; Bit4~7 Reserved; Bit8~13 Output port status OP1/OP2/AU1/AU2/MIO2/MIO1 (0 active, 1 inactive) For example, in Model A, I2's MIO1 corresponds to 14 16. In I5, MIO1 corresponds to 14 15, and MIO2 corresponds to 14 16.
78	4E	40079	Room temperature compensation	For some models, reads the internal thermocouple cold junction compensation temperature (read-only)
79	4F	40080	Output value (-25600~25600)	

80	50	40081	SP1	Program segment initial temperature.
81	51	40082	t1	Program segment initial time.
82	52	40083	SP2	
83	53	40084	t2	
84	54	40085	SP3	
85	55	40086	t3	
86	56	40087	SP4	
87	57	40088	t4	
88	58	40089	SP5	
89	59	40090	t5	
90	5A	40091	SP6	
91	5B	40092	t6	
92	5C	40093	SP7	
93	5D	40094	t7	
94	5E	40095	SP8	
95	5F	40096	t8	
96	60	40097	SP9	
97	61	40098	t9	
98	62	40099	SP10	
99	63	40100	t10	
100	64	40101	SP11	
101	65	40102	t11	
102	66	40103	SP12	
103	67	40104	t12	
104	68	40105	SP13	
105	69	40106	t13	
106	6A	40107	SP14	
107	6B	40108	t14	
108	6C	40109	SP15	
109	6D	40110	t15	
110	6E	40111	SP16	
111	6F	40112	t16	
112	70	40113	SP17	
113	71	40114	t17	
114	72	40115	SP18	
115	73	40116	t18	
116	74	40117	SP19	
117	75	40118	t19	
118	76	40119	SP20	
119	77	40120	t20	

120	78	40121	SP21	
121	79	40122	t21	
122	7A	40123	SP22	
123	7B	40124	t22	
124	7C	40125	SP23	
125	7D	40126	t23	
126	7E	40127	SP24	
127	7F	40128	t24	
128	80	40129	SP25	
129	81	40130	t25	
130	82	40131	SP26	
131	83	40132	t26	
132	84	40133	SP27	
133	85	40134	t27	
134	86	40135	SP28	
135	87	40136	t28	
136	88	40137	SP29	
137	89	40138	t29	
138	8A	40139	SP30	
139	8B	40140	t30	
140	8C	40141	SP31	
141	8D	40142	t31	
142	8E	40143	SP32	
143	8F	40144	t32	
144	90	40145	SP33	
145	91	40146	t33	
146	92	40147	SP34	
147	93	40148	t34	
148	94	40149	SP35	
149	95	40150	t35	
150	96	40151	SP36	
151	97	40152	t36	
152	98	40153	SP37	
153	99	40154	t37	
154	9A	40155	SP38	
155	9B	40156	t38	
156	9C	40157	SP39	
157	9D	40158	t39	
158	9E	40159	SP40	
159	9F	40160	t40	
160	A0	40161	SP41	
161	A1	40162	t41	
162	A2	40163	SP42	
163	A3	40164	t42	
164	A4	40165	SP43	

165	A5	40166	t43	
166	A6	40167	SP44	
167	A7	40168	t44	
168	A8	40169	SP45	
169	A9	40170	t45	
170	AA	40171	SP46	
171	AB	40172	t46	
172	AC	40173	SP47	
173	AD	40174	t47	
174	AE	40175	SP48	
175	AF	40176	t48	
176	B0	40177	SP49	
177	B1	40178	t49	
178	B2	40179	SP50	
179	B3	40180	t50	
180	B4	40181		
181	B5	40182		
182	B6	40183		
183	B7	40184		
184	B8	40185	A00	Used to define multi-point correction, segmented power limit, and custom input specifications. (some models/versions do not support this function)
185	B9	40186	A01	
186	BA	40187	A02	Start value
187	BB	40188	A03	Full scale
188	BC	40189	A04	Segmented range
189	BD	40190	D00	Display value or output value corresponding to the zero point.
190	BE	40191	D01	
191	BF	40192	D02	
192	C0	40193	D03	
193	C1	40194	D04	
194	C2	40195	D05	
195	C3	40196	D06	
196	C4	40197	D07	
197	C5	40198	D08	
198	C6	40199	D09	
199	C7	40200	D10	
200	C8	40201	D11	
201	C9	40202	D12	
202	CA	40203	D13	
203	CB	40204	D14	
204	CC	40205	D15	
205	CD	40206	D16	
206	CE	40207	D17	
207	CF	40208	D18	
208	D0	40209	D19	

209	D1	40210	D20	
210	D2	40211	D21	
211	D3	40212	D22	
212	D4	40213	D23	
213	D5	40214	D24	
214	D6	40215	D25	
215	D7	40216	D26	
216	D8	40217	D27	
217	D9	40218	D28	
218	DA	40219	D29	
219	DB	40220	D30	
220	DC	40221	D31	
221	DD	40222	D32	
222	DE	40223	D33	
223	DF	40224	D34	
224	E0	40225	D35	
225	E1	40226	D36	
226	E2	40227	D37	
227	E3	40228	D38	
228	E4	40229	D39	
229	E5	40230	D40	
230	E6	40231	D41	
231	E7	40232	D42	
232	E8	40233	D43	
233	E9	40234	D44	
234	EA	40235	D45	
235	EB	40236	D46	
236	EC	40237	D47	
237	ED	40238	D48	
238	EE	40239	D49	
239	EF	40240	D50	
240	F0	40241	D51	
241	F1	40242	D52	
242	F2	40243	D53	
243	F3	40244	D54	
244	F4	40245	D55	
245	F5	40246	D56	
246	F6	40247	D57	
247	F7	40248	D58	
248	F8	40249	D59	

Description:

1. This system adopts a master-slave multi-device communication structure. Each command sent to the instrument will receive a response from the instrument. When developing the host computer software, ensure that the instrument responds to each valid command within 0~10mS (Note: this excludes data transmission time required by the MODBUS

protocol, which should be calculated based on different baud rates and data lengths). The host computer must wait for the instrument to return data before sending a new command; otherwise, errors may occur. If the instrument does not respond within the maximum response time, the potential reasons could include invalid commands, incorrect instrument or parameter addresses, communication line faults, the instrument being powered off, or mismatched communication addresses. In such cases, the host computer should resend the command or skip that instrument's address.

2. To improve efficiency, all numerical values transmitted by the instrument are 16-bit binary two's complement integers. For example, if the instrument's setpoint is 100.0°C, the transmitted data is the integer 1000. The host computer must convert the integer into the actual data with a decimal point according to specific rules. After the host computer program starts, it should first read the parameter dPt (0CH) to obtain the decimal point position of the measurement signal. Note If the value of dPt is greater than or equal to 128, it indicates that the transmitted measurement value and parameters with the same unit as the measurement value should be divided by 10 before display. When writing such parameter values to the lower computer, the displayed number should be converted to an integer by removing the decimal point, multiplied by 10, and transmitted as a 16-bit binary two's complement.

3. If reading a parameter code outside the table (invalid or reserved parameter code), the instrument returns a parameter value of 32767. Since the maximum setting range for AI series instrument parameters is 32000, 32767 can be used as a flag for reading an incorrect parameter code and handled in the host computer program.

4. If writing a parameter code outside the table, or if the instrument model does not support the parameter, the instrument will not report an error but will ignore the write operation and return a parameter value of 32767. If the written value exceeds the instrument's internal range (e.g., setting an output value beyond the system's allowed upper limit), the instrument will write the upper limit value and return it.

5. For instruments with manual adjustment functionality in manual mode, the manual output value can be adjusted by writing to parameter 1AH.

6. As the application of communication-enabled instruments and the MODBUS protocol becomes increasingly widespread, to prevent host computer programs from mistakenly writing important instrument parameters and to optimize MODBUS protocol performance, starting from version V9.1, the instrument has added communication write parameter restriction functionality. The instrument also allows customers to customize commonly used field parameters for reading and writing. The field parameter definition function allows commonly used parameters to be arranged consecutively, facilitating the MODBUS protocol to read multiple customer-interested field parameters with a single command, greatly improving MODBUS communication efficiency while preventing accidental writes to parameters other than field parameters. The write permission is controlled by the instrument's Loc parameter, with the following rules:

Loc=0~63, allows writing all parameters, compatible with the communication rules of previous instrument versions from our company, with added field parameter read/write functionality;

Loc=128~191 (recommended setting), instrument-side operations correspond to Loc=0~63, while the communication end only allows writing SV, program segments, four alarm parameters (HIAL~dHAL), the Srun run/stop control parameter, and field parameters defined by EP1~EP8. Field parameters are set via the instrument panel and can be selected from the instrument parameter table (0~8 parameters that need to be read/written by the communication end), with all other parameters prohibited from writing;

Loc=192~255, prohibits writing all parameters, communication only allows reading instrument data, and instrument-side operations correspond to Loc=0~63.

7. 15H is the model feature byte of the instrument. Different instrument models have different values, which can be used by the host computer to distinguish instrument models and process transmitted data in different modes accordingly. The instrument model and feature byte table is as follows:

Instrument Model	Model Characteristic Code
AI-8X8 Series AI Controller/Temperature Controller	8080
AI-8X9 Series Cascade AI Controller/Temperature Controller	8090
AI-8X6 Series AI Controller/Temperature Controller	6080
AI-500 Single-Loop Universal Measuring Instrument	5010
AI-501 Single-Loop Universal Measuring Instrument	5010
AI-516 Intelligent Temperature Controller	5160
AI-516P Programmable Intelligent Temperature Controller	5167
AI-526 Intelligent Temperature Controller	5260
AI-526P Programmable Intelligent Temperature Controller	5267
AI-518 Intelligent Temperature Controller	5180
AI-518P Programmable Intelligent Temperature Controller	5187
AI-700 Single-Loop Universal Measuring Instrument	7010
AI-701 Single-Loop Universal Measuring Instrument	7010
AI-716 High-Precision Intelligent Temperature Controller	7160
AI-716P High-Precision Programmable Intelligent Temperature Controller	7167
AI-719 High-Precision Intelligent Temperature Controller/Controller	7190
AI-719P High-Precision Programmable Intelligent Temperature Controller/Controller	7197
AI-998 High-Performance Multifunction Artificial Intelligence Industrial Controller	9980

8、Output Port Status and Operating Status Register 4DH Description:

Bit Arrangement	Status Description
Bit 0	00: Instrument is in running state 01: Instrument is in stopped state 02: Instrument is in paused state
Bit 1	
Bit 2	0: No action 1: Instrument self-tuning AT is enabled, automatically resets to 0 after tuning is completed
Bit 3	0: Automatic operation state 1: Manual operation state (only meaningful for instruments supporting manual/automatic switching; otherwise, it is always 0 for automatic state)
Bit 4	Reserved, default is 0
Bit 5	
Bit 6	
Bit 7	
Bit 8	0: OP1 Port ON 1: OP1 Port OFF
Bit 9	0: OP2 Port ON 1: OP2 Port OFF
Bit 10	0: AU1 Port ON 1: AU1 Port OFF
Bit 11	0: AU2 Port ON 1: AU2 Port OFF

Bit 12	0: MIO2 Port ON 1: MIO2 Port OFF
Bit 13	0: MIO1 Port ON 1: MIO1 Port OFF
Bit 14	
Bit 15	

8 Display/Alarm Symbols and FAQs

8.1Display/Alarm Symbols

After the instrument is powered on, it enters the basic display state. At this time, the upper and lower display windows of the instrument display the measured value (PV) and the set value (SV) respectively. The SV display window can also alternately display symbols or display symbols to indicate the status, as shown in the following table:

Parm.	Description	Solution
At AtE	Indicates that the meter is in auto-tuning state	Wait for the end of the tuning, or manually change the At parameter to OFF
AAt AAtE	Indicates that the instrument is in the fast self-tuning state	Wait for the end of the tuning, or manually change the At parameter to OFF
StoP StoP	Indicates that the instrument is stopped	Press ▽ for two seconds to run the instrument, if it fails to run, please check whether there are functions such as communication and event input that restrict the running operation.
Run run	Indicates that the instrument is running	This symbol is displayed once when the run operation is successful and does not need to be handled
HoLd HoLd	Indicates that the instrument program function is suspended	Press ▽ for two seconds to run the instrument. If it fails to run, please check whether there are functions such as communication and program segment settings that restrict the running operation.
Rdy rdy	Indicates that the instrument program function is in a ready state	After waiting for the measurement signal to meet the setting requirements, it will automatically continue to run the program, or modify the PAF parameters to cancel this function
A 50 A50	Indicates that the instrument is in automatic output state, and the number represents the output percentage	Click ↻ to switch to the SV value display state or click ◁ to switch to the manual output state

M 50 M 50	Indicates that the instrument is in the manual output state, and the number represents the output percentage	At this time, the MAN light on the panel is on, click ◁ to switch to the automatic output state, and click △ and ▽ to modify the output percentage
orAL orAL	Indicates that the input measurement signal is out of range	Check whether the input specifications and parameters are set correctly, check whether the input wiring is correct, and check whether the input signal is normal
HIAL HI AL	Indicates that an upper limit alarm has occurred	When the measured value PV is less than the HIAL-AHYS value, the alarm will be automatically canceled, or modify the HIAL to 32000 to cancel the alarm
LoAL LoAL	Indicates that a lower limit alarm has occurred	When the measured value PV is greater than LoAL+AHYS, the alarm will be canceled automatically, or modify LoAL to -9990 to cancel the alarm
HdAL HdAL	Indicates that a deviation upper limit alarm has occurred	When the deviation of PV and SV of the measured value is less than HdAL-AHYS, the alarm will be canceled, or modify HdAL to 32000 to cancel the alarm
LdAL LdAL	Indicates that a deviation lower limit alarm has occurred	When the deviation of PV and SV of the measured value is greater than LdAL+AHYS, the alarm will be canceled, or modify LdAL to -9990 to cancel the alarm
FErr FErr	Indicates that the valve feedback or external given signal is over-range	Check whether the valve feedback signal and wiring are normal
FErr EErr	Indicates that an error is detected within the system, such as parameter loss, etc.	Need to return to the factory for repair
CtAL CtAL	current alarm warning	When a current upper or lower limit alarm is generated after pairing with the I9 module, please check the load circuit. Set EFP1 and EFP2 to 0 to cancel this function

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

8.2 FAQs

8.2.1How to self-tune?

When the measured value PV is room temperature, set the set value SV to about 60% of the common temperature (for signals such as pressure or flow, it can be directly set to the common set value), then press ◁ and hold it for two seconds to call up the *At* parameter, change the parameter value from OFF to ON and click ↻ to start auto-tuning. It can work normally after the auto-tuning At symbol does not flash automatically.

8.2.2 How to enter the internal parameter table?

Press and hold it for two seconds to enter the parameter table, then short press to find the next parameter. If the complete parameters are locked, find the password lock parameter Loc, and set it (the default is 808, if it need to be modified, please set the correct password), and then short press to see all the parameters.

8.2.3 How to judge whether the instrument has output?

First, check whether the OP1 indicator light on the instrument panel is on. If it is not on, please confirm whether the instrument is running, and then check whether the parameters of the instrument are set correctly; if it is on, it means that the output state of the instrument is normal. At this time, the multi-meter can be used to detect whether the output terminal signal of the instrument is normal. If the output signal 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 instrument output module is abnormal.

8.2.4Instrument panel flashing orAL?

This means that the instrument is not detecting an input signal.First, check whether the sensor model corresponds to the input specification parameter Inp, and then check whether the wiring of the instrument input terminal is correct. If there is no problem, regardless of whether the incoming signal from the measuring sensor is correct, the sensor may be damaged.

8.2.5How to enter the program segment settings?

After the instrument is powered on, click on the initial display interface to enter the program segment menu, and then click to display the next data. Each program is arranged in the order of "given value-time-given value". The program segment setting is described in detail in the program control chapter of the manual.

8.2.6How to set alarm parameters?

First, set the alarm parameter to the required value (for example: if the upper limit alarm is set to be 200 degrees, change the HIAL parameter to 200), then enter the internal parameters to find the AOP parameter to define the alarm signal output terminal (for example: if the upper limit alarm needs to be output from AL1, set the AOP single digit to 1. For the specific definition, please refer to the introduction of AOP parameters in the manual).

8.2.7How to set bidirectional output for heating and cooling?

Enter the internal parameter table 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, and the auxiliary output AUX is used for refrigeration control.

8.2.8How to set the external given function?

Enter the instrument's internal parameter list to find the AF2 parameter and set it to 1 (enable the external given function), then set the external given scale lower limit parameter SPSL and the external given scale upper limit parameter SPSH parameter, making these two parameters correspond to the given value range. The external given signal input terminals are 17+, 18- (0-5V/1-5V DC signal). After connecting the wires, the external given function can be used normally.

8.2.9How to switch manual/auto output?

Click  once on the initial interface of the instrument, the SV window of the instrument will switch from the set value to the output value state, then click  to make the instrument switch between automatic and manual without disturbance, A is automatic state, M is manual state. If it cannot be switched, please make sure that the A-M parameter is MAn or Auto

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