AI-226

Artificial Intelligence Temperature Controller

Operation Instruction

(V9.18)

Scan the code to for video tutorial

CONTENTS

1 Summary

1.1 Main Features

● Accurate digital calibration technology for input measurement. Wide range of thermocouples and RTD are supported. Maximum resolution is 0.01℃.

● Advanced artificial intelligent control algorithm to avoid overshoot. Auto tuning (AT) is provided.

● Innovative modular structure enables abundant output options to adapt different applications. Quick production lead time and convenience in maintenance are benefited.

● User-friendly operation user interface.

● Customization on operation authorization and interface, as if it is tailor-made.

● Universal power supply 100-240VAC or 24VDC is possible. Different installation dimensions are available.

● Anti-interference ability complies with requirement of electromagnetic compatibility under adverse industrial environment.

POINTS FOR ATTENTION

● This manual is for Artificial Intelligence Temperature Controller AI-226 9.18. Some functions described in this manual may not applicable in other versions. The display will show instrument model and firmware version upon power on. User should pay attention to the difference between different versions. Please read this manual carefully in order to use the instrument correctly and make it to its full use.

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

1.2 Ordering Code Definition

Advanced modularized hardware design is utilized for AI series instruments. There are maximum 5 module slots: main output (OUTP), alarm (ALM), communication (COMM) and other functions. The input type can be freely set to thermocouple, RTD and linear current/voltage. The ordering code of AI-226 series instrument is made up of 9 parts. For example:

AI－226	A1	N	X3	L3	N	S4	－	24VDC	－(F2)
①	②	③	④	⑤	⑥	⑦		⑧	⑨

It shows that the model of this instrument is ①AI-226, ②front panel dimension is A size(96×96mm), ③no module is installed in MIO slot, ④linear current output module is installed in OUTP (main output), ⑤ALM (alarm) is L3 dual relay contact output module, ⑥no module is installed in AUX, ⑦S4 (RS485 communication interface module) is installed at COMM , ⑧and the power supply of the instrument is 24VDC, ⑨an extended input type (F2 radiation type pyrometer) is available. The following is the meanings of the 9 parts:

① Instrument Model

AI-226 Economical temperature controller with measurement accuracy 0.25%F.S, with artificial intelligent controlling technology, various types of alarm, retransmission and communication.

② **Panel Dimension**

	Panel Code	Dimension Width x Height (mm)	Depth behind mount (mm)	Opening Dimension Width x Height (mm)	Light Bar
Short Depth	A1	96×96	70	$92^{+0.5}$×$92^{+0.5}$	---
	E1	48×96	70	$45^{+0.5}$×$92^{+0.5}$	---
	F1	96×48	70	$92^{+0.5}$×$45^{+0.5}$	---
	D61	48×48	80	$46^{+0.5}$×$46^{+0.5}$	---
Dail Mount	E51	48×96	70	DIN rail mount. Optional external E8 keypad is required to be plugged for parameter setting and operation.	

③ **Module available in multiple functions I/O (MIO)**: I2, K3, V, etc. N denotes that there is no module installed. Same as below.

④ **Module available in main output (OUTP)**: L1, L2, L4, W1, W2, G, K1, K3, X3, X5, etc.

⑤ **Module available in alarm (ALM):** L0, L2, L3, L4, W1, W2, G, etc.

⑥ **Module available for auxiliary output (AUX)**: L0, L2, L3, L4, G, etc.

⑦ **Module available for communication (COMM)**: S, S4, V, etc.

⑧ **Power supply of the instrument**: If it is left blank, the power of the instrument is100~240VAC. 24VDC means the power supply of 20~32V DC or AC power.

⑨ **Extended graduation specification:** (If there is none, leave it blank). AI-226 series instruments input is already universally supporting common thermocouples and resistance inputs (Please refer to the latter part of technical specification). If it is required, an additional specification can be extended.

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

1.3 Modules

1.3.1 Slots of modules

There are 5 module slots in AI-226 series instruments (3 slots, OUTP, AUX and COMM for D61 dimension). Different modules installed will provide different functions and output types.

Multiple function Input(MIO): Installing K3 module will provide three-phase thyristor zero-crossing triggering output.

Main output (OUTP): As control output such as on-off control, standard PID control, and AI PID control. It can also be used as retransmission output of process value (PV) or set point (SV). Installing L1 or L4 modular will provide relay contact output. Installing X3 or X5 module will provide 0-20mA/4-20mA/0-10mA linear current output. Installing G module will provide SSR voltage output. Installing W1 or W2 module will provide TRIAC no contact switch output.

Alarm (ALM): Installing L0 or L2 will provide 1 normally open + normally close relay output (AL1). Installing L3 module will provide 2 normally open relay outputs (AL1+AL2).

Auxiliary output (AUX): Installing L0, L1, L2 or L3 relay module can work as alarm. Installing R module (RS232C interface) will provide communication feature with computer.

Communication Interface (COMM): Installing module S or S4 (RS485 communication interface) provides communication feature with computer. Installing voltage output module will provide power supply for external sensor or transmitter.

1.3.2 Commonly used modules

Name	Function Description
N	(Or left blank) No module installed
L0	Large capacity and large size relay. Normally open(NO) + normally close(NC) relay output module.(Capacity: 30VDC /2A, 250VAC/2A, suitable for alarm)
L1	Large capacity and large size relay. NO relay output module. (Capacity: 30VDC/2A, 250VAC/2A)
L2	Small capacity and small size relay. NO+NC relay output module. (Capacity: 30VDC/1A, 250VAC/1A, suitable for alarm)
L3	Dual channel, large capacity and large size relay. NO relay output module. (Capacity: 30VDC/2A, 250VAC/2A)
L4	Large capacity but small size relay. NO+NC relay output module. (Capacity: 30VDC/2A, 250VAC/2A)
W1、W2	TRIAC no contact NO (W2 is NC) output module (Capacity: 100~240VAC/0.2A, burn-proof)
G	Solid-state relay (SSR) voltage output module (12VDC/30mA)
G5	Dual SSR voltage output module

K1/K3	Single channel/3-channel burn-proof thyristor zero-crossing trigger output module (Each channel triggers one loop of a TRIAC or a pair of inverse parallel SCR with current of 5~500A)
K50/K60	Single channel 220VAC/380VAC burn-proof thyristor phase-shift trigger output module
X3	Photoelectric programmable linear current output module
X5	Photoelectric programmable linear current output module with own photoelectric isolated power supply.
S	Photoelectric RS485 communication interface module.
S1	Photoelectric RS485 communication interface module. (Uses internal 24V isolated power)
S4	Photoelectric RS485 communication interface module with own photoelectric isolated power supply.
V24 / V12 / V10	Isolated 24V/12V/10V DC voltage output with maximum current of 50mA for power supply of external transmitter or circuit.
I2	Switch / frequency signal input interface for external switch or frequency signal, with 12VDC power supply for external sensor.

1.3.3 Electric isolation of the modules

There are a group of 24V and a group 12V power supply built in the instrument and isolated to the main circuit. The 24V power commonly supplies voltage output module, such as V24/V12/V10 (24V/12V/10V voltage output), I2 (frequency/on-off input, with 12V isolated voltage output). The 12V power commonly supplies power for output or communication module. Generally, the relay contact output and TRIAC contact output are self-isolated from the other circuit or does not require isolated power. Therefore, only the electric isolation between the communication interface and the current output should be considered. If the input and output terminals of S(RS485 communication interface), R (RS232 communication interface) and X3 (linear current output) are electrically isolated from the input circuit of the instrument, that is, the main circuit, yet they all draws from the internal 12V power supply. If more than one of the above modules are installed, they will be not electrically isolated because they share the same power supply.

To avoid interference, S4 (RS485 communication interface) or X5 (linear current output) is designed. They have their own isolated power supply, without drawing from instrument internal power. For example, if an X3 module is installed in main output (OUTP) slot, S module installed in the communication interface (COMM), the X3 and S modules cannot be isolated, thus S4 or X5 should be installed in communication (COMM) slot. For relay contact point and thyristor no contact point output, they are isolated from other circuits already. Isolation for SSR voltage output (G) generally is not required because solid –state relay itself is isolated.

1.3.4 Further descriptions about module applications

Voltage output module: The voltage output modules like V24, V12, \/10 are often used for supplying power for external transducer or feedback resistance of transmitter. These modules can be installed in any slot. To standardize the wiring, it is recommended to be installed in the first idle slot in the order of MIO, AUX, and COMM.

No contact switch module: W1/W2 are newly developed non-contact switch module with advanced burn-proof technology and zero-crossing conduction. It can replace the relay contact switch to control AC contactor actuator or electric servo motor. Compared to the relay contact output module, W1/W2 have longer life span and are able to lower the interference spark. This improves the stability and reliability of the system. Since the driving component is thyristor, it is suitable to control 100~240VAC but no DC. Since output terminals are connected in series with protection components, the allowed continuous current for control is up to 0.2A with allowed maximum instantaneous current up to 2A. This driving power can directly control AC contactor of 220VAC with current below 80A. For the load larger than 80A, an intermediate relay is needed.

Relay switch module: The relay modules are widely used in industrial control. However, they are the only modules with life time limit and size limit and also bringing large amount of electromagnetic interference. It is important to choose a suitable relay module. To control equipment with 100~220VAC supply, such as AC contactor and electromagnetic valve, W1 module is recommended. To control DC or AC above 50VAC, relay module L1, L4, etc can only be chosen. L3 module provides dual relay outputs. It can be used to support two loops of alarm, for example, AL1+AL2. If mechanical switch is not preferred, G5 (dual SSR voltage driver) with external solid-state relay (SSR) can be used to drive the load instead.

1.4 Technical Specification

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

Thermocouple: K, S, R, E, J, T, B, N, WRe3-WRe25, WRe5-WRe26, etc

Resistance temperature detector: Cu50, Pt100

Linear voltage: 0~100mV, 20~100mV, 0~20 mV, 0~60mV etc.

Extended specification: Apart from the above-mentioned input specification, an additional type can be provided upon request. (Graduation index may be required to provide by customer)

● **Instrument Input range**

K(-50~+1300℃), S(-50~+1700℃), R(-50~+1700℃), T(-200~+350℃),
E(0~800℃), J(0~1000℃), B(200~1800℃), N(0~1300℃),
Cu50(-50~+150℃), Pt100(-200~+800℃), Ni120(-50~+270℃)

Linear Input: -9990~+32000 defined by user

● **Measurement accuracy :** 0.3%FS

● **Sampling period:** 8 times per second. By setting digital filter parameter FILt=0, the response time ≤0.5 second.

● **Control period :** 0.24~300.0 seconds selectable.

● **Regulation mode:**

On-off control mode (dead band adjustable)

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

● **Output specification (Modularized)**

Relay output (NO+NC): 250VAC/1A or 30VDC/1A

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

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

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

Linear current output: 0~20mA or 4~20mA customized. (X3 module installed, output voltage≥10.5V; X5 module installed, output voltage≥7V)

● **Alarm function:** 4 types of alarm, high limit, low limit, deviation high limit and deviation low limit with alarm blocking at the beginning of power on.

● **Electromagnetic compatibility (EMC):** ±4KV/5KHz according to IEC61000-4-4 (Electrical Fast Transient); 4KV according to IEC61000-4-5 (Electrical Surge).

● **Isolation withstanding voltage:** Among power, relay contact or signal terminals ≥2300VDC. Among isolated electroweak terminals ≥600V

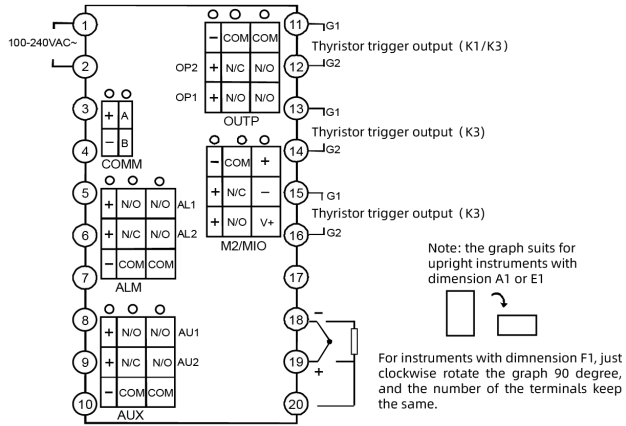
● **Power supply:** 100~240VAC, -15%, +10% / 50~60Hz; 120~240VDC; or 24VDC/AC, -15%, +10%.

● **Power consumption:** ≤5W

● **Operating ambient:** Temperature -10~60℃; Humidity ≤90%RH

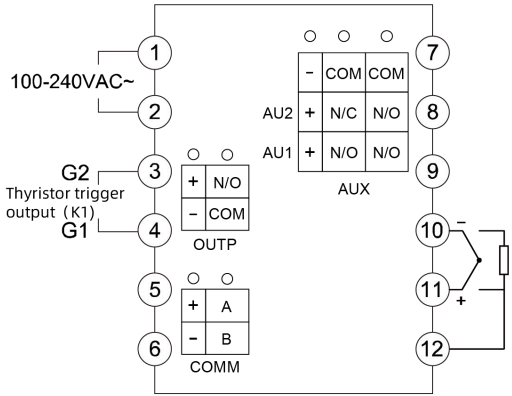
1.5 Wiring Diagram

Wiring diagram of rear terminals of standard depth

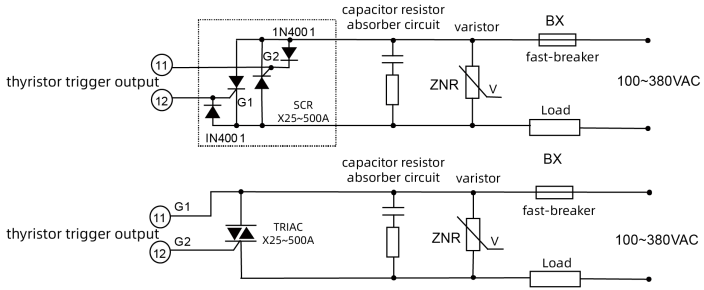


Note: ① For linear voltage input, if the range is below 500mV, connect to terminals 19 and 18.
② 4~20mA linear current signal can change to 20~100mV voltage signal by connecting a 5 ohm resistor, and then be inputted from terminals 19 and 18.
③ The compensation wires for different kinds of thermocouple are different. When the internal auto compensation mode is used, connecting the common wire between the compensation wire and the terminals
will cause measurement error.
④When main output is selected linear current or SSR voltage, the output will be given from terminal 13+, 11-.
⑤OP1/AL1/AU1 are normal open and OP2/AL2/AU2 are normal close when single channel relay module such as L1 or L2 is installed.

Wiring diagram of dimension D61(48*48mm)：



Note: 4~20mA linear current signal can change to 20~100mV voltage signal by connecting a 5 ohm resistor, and then be inputted from terminals 11 and 10.



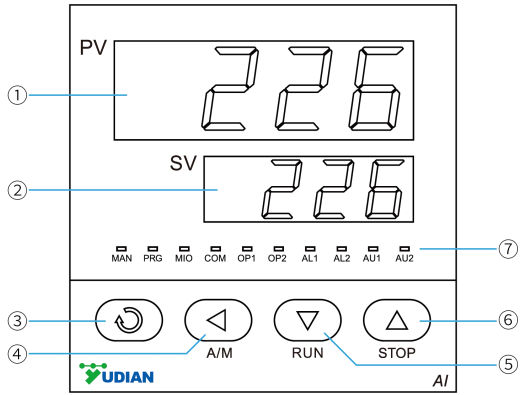
Note 1: According to the voltage and current of load, choose a suitable varistor to protect the thyristor. A resistor-capacitor circuit (RC circuit) is needed for inductance load or phase-shift trigger output.

Note 2: SCR power module is recommended. A power module includes two SCRs, is similar to the above dashed square.

Note 3: When K60 module is used, the power should be 380VAC. When K50 phase-shifting triggering module is used, the AC power range is narrowed to 200~240VAC. The power frequency must be 50Hz.

2 Displays and operations

2.1 Front Panel Description



①Upper display window: Displays PV, parameter code, etc.

②Lower display window: Displays SV, parameter value, or alarm message

③ Setup key: For accessing parameter list and conforming parameter modification.

④Data shift key (cursor pointer)

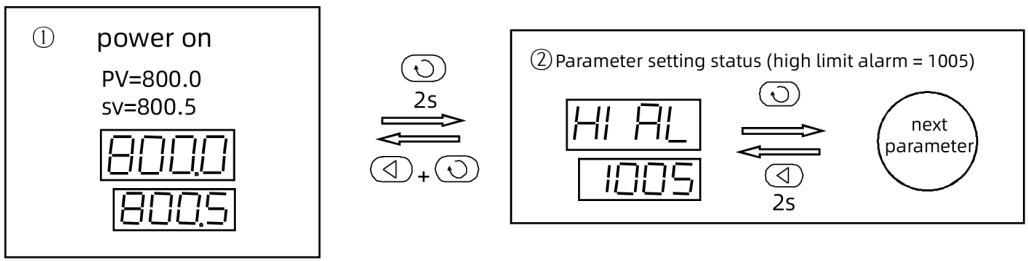
⑤Data decrease key (RUN/HOLD button)

⑥Data increase key (STOP button)

⑦10 LED indicators. MAN is not applicable in this series. PRG turns on when program is running. MIO, OP1, OP2, AL1, AL2, AU1 and AU2 turns on when the corresponding module are giving output. COMM turns on when the instrument is communicating with upper device.

The instrument starts the basic display status upon power on, the upper and lower display windows of the instrument display the process value (PV) and the set value (SV) respectively, and the lower display window can also display the following characters alternately: ① "OrAL", indicating that the input signal is out of range; ② "HIAL", "LoAL", "HdAL" or "LdAL" indicates that the high limit alarm, low limit alarm, deviation upper limit alarm and deviation lower limit alarm have occurred respectively; ③ "Stop" means it is in the stop status.

2.2 Display Status



2.3 Operation Description

2.3.1 Parameter Setting

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

2.3.2 Short-cut operation

All function in AI-226 can be accessed through changing parameters. For common operation such as set point editing, changing the status of program RUN/STOP/HOLD, short-cut key is provided. These short-cut can be prohibited to avoid any incorrect operation.

Set Value Setting: press (↺) to switch to the set value display status, then press (◁), (▽) and (△) to directly edit the set value.

Run the program: Press and hold (▽) for about 2 seconds until the lower display window shows the "run" message.

STOP the program: Press and hold (△) for about 2 seconds until the lower display window shows the "StOP" message. The instrument output will be stopped.

Auto Tuning: Press (◁) for 2 seconds, At parameter will appear. Press (△) to change the value of At from OFF to on, then press (↺) to activate the auto-tuning process(If SPr parameter is set to be effective and in the temperature regulating status, auto-tuning will be paused temporary and restart automatically after the temperature finishes rising). During auto tuning, the lower display blinks with At. After two fluctuating cycles by ON-OFF control, the instrument will obtain the optimal PID control parameter value. If you want to quit from auto tuning, press and hold the (◁) for about 2 seconds until the At parameter appear again. Change At from on to OFF, press (↺) to confirm. If the instrument is running the program, the program timer will be paused to avoid changing SV.

Note 1: The advanced artificial intelligence algorithm APID in AI-226 instrument is able to avoid overshooting problem over standard PID algorithm and achieve precise control. Both APID and PID can be calculated based on auto-tuning.

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

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

Note 4: The control effect at the first run after auto tuning is probably not perfect, but excellent control result will be obtained after a period of time because of self-adaptation.

3 Parameters and setting

3.1 User-defined Parameter list

AI-226 parameter list can program defined functions, which can be defined by users and protect important parameters from changed accidentally. We call those parameters required to be displayed or modified on site as "**field parameters**". Field parameter list is a subset of the full parameter list and can be defined and modified by users, while the full list must be entered by passwords. Parameter lock (Loc) offers several authorization levels to several parameters:

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

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

Loc=2~3, allowed to edit field parameters, but forbidden to use shortcuts such as changing set value and program steps, Able to perform shortcuts of program RUN/HOLD/STOP and set point control;

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

Set Loc=808 and press ⟲ to confirm and to access and edit the full parameter list. Once the full parameter list is entered, all parameters except read-only parameters are authorized to be edited.

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

Note: Since V9.1, communication input can be limited by Loc parameter. Please refer to the communication protocol for details.

3.2 Full parameter list

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

Code	Name	Description	Setting Range
HIAL	High limit alarm	Alarm turns on when PV>HIAL Alarm turns off when PV<HIAL-AHYS, Note: Alarm output location can be defined by parameter AOP. All alarms can be assigned to AL1, AL2, AU1, AU2 or none. More alarm allocation is explained in AOP section below.	-9990~ +32000 units
LoAL	Low limit alarm	Alarm turns on when PV<LoAL Alarm turns off when PV>LoAL+AHYS Set to the minimum value to disable the alarm. Note: HIAL and LoAL can be assigned as deviation alarms. Details please refer to the description of parameter AF.	
HdAL	Deviation high alarm	Alarm turns on when PV-SV>HdAL; Alarm turns off when PV-SV<HdAL-AHYS Set to the maximum value to disable the alarm.	
LdAL	Deviation low alarm	Alarm turns on when PV-SV<LdAL Alarm turns off when PV-SV>LdAL+AHYS Set to the minimum value to disable the alarm. Note: HdAL and LdAL can be assigned as absolute high limit and low limit alarms. Details please refer to the description of parameter AF.	

AHYS	Alarm hysteresis	Also known as dead band or lag. To avoid frequent alarm on-off action caused by the fluctuation of PV. Usage of AHYS is shown above.	0~2000 units
AdIS	Alarm display	OFF: Will not display alarm message in the lower display window when alarming. On: Alternately display alarm message in the lower display window when alarming, recommended. FOFF, energy saving/confidential display mode; In this mode, the instrument will not only turn off the display of process value and set value, which can save power consumption of the instrument or keep the process temperature confidential, but also display the current program number in the lower display window, and display the alarm symbol when giving an alarm.	

<table>
<tr>
<td>AOP</td>
<td>Alarm output allocation</td>
<td>
<table>
<tr><th>Alarm / Output to</th><th>LdAL (x1000)</th><th>HdAL (x100)</th><th>LoAL (x10)</th><th>HIAL (x1)</th></tr>
<tr><td>None</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>AL1</td><td>1</td><td>1</td><td>1</td><td>1</td></tr>
<tr><td>AL2</td><td>2</td><td>2</td><td>2</td><td>2</td></tr>
<tr><td>AU1</td><td>3</td><td>3</td><td>3</td><td>3</td></tr>
<tr><td>AU2</td><td>4</td><td>4</td><td>4</td><td>4</td></tr>
</table>
Example:
$$AOP = \underset{\text{LdAL}}{3}\ \underset{\text{HdAL}}{3}\ \underset{\text{LoAL}}{0}\ \underset{\text{HIAL}}{1}$$
It shows that HdAL and LdAL are sent to AU1, LoAL has no output, HIAL is sent to AL1.
Note: Installing L3 dual relay output module in ALM or AUX, AL2 or AU2 can be used
</td>
<td>0~4444</td>
</tr>
</table>

nonc	NO/NC selection	Single channel alarm relay can have normally open + normally closed output at the same time, but dual channel alarm module L3 only has normally open output. Normally open output can be defined as normally closed output through the nonc parameter. When nonc=0 is set, L3 relays installed at AL1, AL2, AU1 and AU2 are normally open. When nonc=15 is set, instrument alarms are normally closed. When some channels are normally open and some channels are normally closed, the nonc value can be calculated according to the following formula. **nonc=A*1+B*2+C*4+D*8** In the formula, A, B, C and D respectively represent the normally open and normally closed selection of AL1, AL2, AU1 and AU2. When the value is 1, the corresponding alarm is normally closed output, and when the value is 0, the corresponding alarm is normally open output.	0~15
CtrL	Control mode	onoF: on-off control, for situation not requiring high precision APId: advanced artificial intelligence PID control. (Recommended) nPId: standard PID algorithm with anti integral-saturation function. POP: Direct PV retransmission, working as a temperature re-transmitter. SOP: Direct SV retransmission.	

Srun	Running Status	run, running status, indicator PRG turns on. StoP, stop status, the lower display flashes StoP, and the indicator PRG turns off. HoLd, keep running status. When the instrument is in an unlimited thermostatic control status, it indicates that the it is in a normal operation state. At this time, it is prohibited to run or stop from the panel.	
Act	Acting method	rE: Reverse acting. Increase in measured variable causes a decrease in the output, such as heating control. dr: Direct acting. Increase in measured variable causes an increase in the output, such as refrigerating control. rEbA: Reverse acting with low limit alarm and deviation low alarm blocking at the beginning of power on. drbA: Direct acting with high limit alarm and deviation high alarm blocking at the beginning of power on.	

At	Auto tuning	oFF: Auto tuning is off. on: Active auto turning of PID and CtI parameter, automatically return to FoFF after auto tuning FoFF : Auto tuning is off, cannot activate again by pressing key from panel AAt, fast auto-tuning, automatically returns to OFF after self-tuning. Note: If AAt is selected as the AT parameter, the AAt auto-tuning function can be automatically started when the instrument is in the output status of full power heating after power on. PID parameters can be set in advance without traditional periodic oscillation. In most cases, accurate control can be achieved by first heating. If the AAT has not completed the auto-tuning, but the instrument has already exited the full power output status, then the AAT fails and the auto-tuning will be terminated, but the PID parameters will not be modified.	
P	Proportional band	Proportional band in PID and APID control. Instead of percentage of the measurement range, the unit is the same as PV. Note: Generally, optimal P, I, D and CtI can obtained by AT auto tuning. They can also be manually input if users already know the correct values of P, I, D and CtI when batch production of heating equipment is required.	1~32000 units
I	Time of Integral	No integral effect when I=0	1~9999s

d	Time of Derivative	No derivative effect when d=0	0~3200s
CtI	Control period	For SSR, thyristor or linear current output, it is generally 0.5~3 sec. For Relay output or in a heating/refrigerating dual output control system, generally 15~40 sec, because small value will cause the frequent on-off action of mechanical switch or frequent heating/refrigerating switch, and shorten its service life. CtI is recommended to be 1/5 – 1/10 of derivative time. (It should be integer times of 0.5 second.) When the parameter OPt or Aut = rELy, CtI will be limited to more than 3 seconds. Auto tuning will automatically set CtI to suitable value considering both control precision and mechanical switch longevity. When the parameter CtrL = ONOF, CtI will used as timer to make delay time to avoid the power restart in short period. It suits for compressor protection.	0.2~300.0s
CHYS	Control Hysteresis	CHYS is used for on-off control to avoid frequent on-off action of relay. For a reverse acting (heating) system, when PV > SV, output turns off; when PV<SV-CHYS, output turns on. For a direct acting (cooling) system, when PV<SV, output turns off; when PV>SV+CHYS, output turns on.	0~2000 units

InP	Input specification Code	**InP**	**Input spec.**	**InP**	**Input spec.**	0~106
		0	K	**20**	Cu50	
		1	S	**21**	Pt100	
		2	R	**22**	Pt100 (-80~+300.00℃)	
		3	T	**25**	0~75mV voltage input	
		4	E	**26**	0~80ohm resistor input	
		5	J	**27**	0~400ohm resistor input	
		6	B	**28**	0~20mV voltage input	
		7	N	**29**	0~100mV voltage input	
		8	WRe3-WRe25	**30**	0~60mV voltage input	
		9	WRe5-Wre26	**31~34**	spare	
		10	Extended input specification	**35**	-20~+20mV voltage input	
		12	F2 radiation type pyromter	**36**	-100~+100mV voltage input	
		17	K (0~300.00℃) *	**37~38**	spare	
		18	J (0~300.00℃) *	**39**	20~100mV voltage input	
		19	Ni120			
		Note: While InP=10, the non-linear table can be self-defined or input by factory under a paid service.				

dPt	Display Resolution	Four formats (0, 0.0, 0.00, 0.000) are selectable Note: For thermocouples or RTD input, only 0 or 0.0 is selectable, and the internal resolution is 0.1℃. When S type thermocouple is used, dPt is recommended to be 0. If INP= 17,18 or 22, resolution 0.01℃ will support display 0.0 or 0.00	
SCL	Signal scale low limit	Define scale low limit of input. It is also the low limit of retransmission output and light bar display.	-9990~ +32000 units
SCH	Signal scale high limit	Define scale high limit of input. It is also the high limit of retransmission output and light bar display.	
Scb	Input Shift Adjustment	Scb is used to shift input to compensate the error caused by transducer, input signal, or auto cold junction compensation of thermocouple. It is generally set to 0. The incorrect setting will cause inaccurate measurement.	-9990~ +4000 units
FILt	PV input filter	The value of FILt will determine the ability of filtering noise. The larger the value is set, the more stable the measurement input is, but the slower the response speed is. If great interference exists, then it is allowable to increase parameter “FILt” gradually to make momentary fluctuation of process value less than 2 to 5. When the instrument is being metrological verified, “FILt” s can be set to 0 or 1 to shorten the response time. The unit of FILt is 0.5 second.	0~40

Fru	Selection of power frequency and temperature scale	50C: Power at 50Hz and maximum anti-interference is achieved ; Display in ℃ 50F: Power at 50Hz and maximum anti-interference is achieved; Display in ℉ 60C: Power at 60Hz and maximum anti-interference is achieved; Display in ℃ 60F: Power at 60Hz and maximum anti-interference is achieved, Display in ℉.	
OPt	Main output type	SSr: Output SSr drive voltage or thyristor zero crossing trigger signal. G, K1 or K3 module should be installed. The output power can be adjusted by the on-off time proportion. The period (CtI) is generally 0.5~4 seconds. rELy: for relay contact output or for execution system with mechanical contact switch(such as contactor or compressor). To protect the mechanical switch, the output period (CtI) is limited to 3~120 seconds, and generally is 1/5 to 1/10 of derivative time. 0-20: 0~20mA linear current output. X3 or X5 module should be installed. 4-20: 4~20mA linear current output. X3 or X5 module should be installed. PHA: Single-phase phase-shift output. K50/K60 module should be installed.	

OPL	Output low limit	0~100%: OPL is the minimum output of OUTP in single directional control system.	0~110%
OPH	Output upper limit	OPL limits the maximum of OUTP when PV<OEF. OPH should be greater than OPL.	0~110%
OEF	Work range of OPH	When PV<OEF, the upper limit of OUTP is OPH; when PV>OEF, the upper limit of OUTP is 100%. Note: This function is used in some occasions where full power heating is not available at low temperature. For example, to avoid that the temperature raises too quickly, under 150℃, a heater can work only under 30% of power, then we can set OEF=150.0 (℃), OPH=30 (%)	-999.0~ +3200.0 ℃ or linear unit
Addr	Communication address	Define the instrument communication address with a valid range of 0~100. In the same communication line, different instrument should be set to different address.	0~100

bAud	Baud rate	Define the communication baud rate. The range of baud rate is 0~28800bit/s(28.8K). When COMM slot is not used communication, bAud value defines its function. bAud=0, COMM slot used to retransmit and output process value of 0-20mA; bAud=1, as an external switching input; bAud=2, COMM slot used to output AU1+AL1; bAud=3, COMM slot used to output AU1+AU2; bAud=4, COMM slot used to retransmit and output the process value of 4~20mA; bAud=8, COMM slot used to retransmit and output the set value of 0~20mA; bAud=12, COMM slot used to retransmit and output the set value of 4~20mA;	0~28.8K

AF	Advanced function	AF is used to select advanced function. The value of AF is calculated as below: AF=A*1 + B*2 + C*4 + D*8 + E*16 + F*32 + G*64 + H*128 A=0: HdAL and LdAL work as deviation high and low limit alarms; A=1: HdAL and LdAL work as high and low limit alarms, and the instrument can have two groups of high and low limit alarms. B=0: Alarm and control hysteresis work as unilateral hysteresis; B=1: As bilateral hysteresis. C=0, displayed in the third row with a decimal point; C=1, displayed in the third row without a decimal point. D=0, Loc=808 can access the parameter list; D=1, Loc=PASd can access the parameter list. E=0, HIAL and LOAL work as high and low limit alarms respectively; E=1, HIAL and LOAL work as deviation high and low limit alarms respectively, then there are four deviation alarms. F=0, Fine control, internal control resolution was demonstration's 10 times. When on linear input mode, biggest display value is 3200 units; F=1, Wide range display mode, when the value is required to be larger than 3200, it is recommended to choose this mode. G=0, When the thermocouple or RTD input is burnt out, PV value will increase and trigger the high limit alarm(set value of the upper limit alarm should be less than the upper limit of signal range). G=1, When the thermocouple or RTD input is burnt out, PV value will increase and NOT trigger the high limit alarm. After it was set, high limit alarm(HIAL) will have 15s delay to trigger in normal usage. H=0, HIAL and LOAL can alarm independently; H=1, HIAL and LOAL become interval alarm, and will alarm only when LOAL>PV>HIAL is met. The alarm code is HIAL, and HIAL is also used for output. Note: AF=0 is recommended for ordinary usage.	0~255

AFC	Communication mode	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 calibration; D=1, even calibration. 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.	0~12
PASd	Password	When PASd=0~255 or AF.D=0, set Loc=808 can enter the full parameter list. When PASd=256~9999 and AF.D=1, only Loc=PASd can access the full parameter table. Note: Please setting PASd cautiously, if the password is lost, you cannot access the parameter list again.	0~9999
SPL	Low limit of SV	Minimum value that SV is allowed to be.	-9990~ +30000 units
SPH	Upper limit of SV	Maximum value that SV is allowed to be.	

EP1~ EP8	Field parameter definition	Define 1~8 field parameters for those commonly used parameters when the Loc lock is applied. If there is none or less than 8 field parameters, please set as nonE.	

3.3 Additional Explanation On Special Functions

3.3.1 Single-phase phase-shift trigger output

When OPt is set to PHA1, installing a K50/K60 module in OUTP slot can single-phase phase-shift trigger a TRIAC or 2 inverse parallel SCRs. It can continuously adjust heating power by control the conduction angle of thyristor. With non-linear power adjustment according to the characters of sine wave, it can get ideal control.The trigger adopts self-synchronizing technology, so it can also work even when the power supplies of the instrument and the heater are different. Phase-shift trigger has high interference to the electric power, so user should pay attention to the anti-interference ability of other machines in the system. Now the K50 or K60 module can be only used in 50Hz power grid.

3.3.2 Alarm blocking at the beginning of power on

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

corresponding low or high alarms are blocked until the alarm condition first clears. If the alarm condition is satisfied again, the alarm will work.

3.3.3 Communication function

RS485 communication interface modules of S or S4 module can be installed at COMM slot to communicate with a computer. The instrument can be controlled by computer. AI instruments without RS485 interface can be connected to the computer through RS232C/RS485 convertor or USB/RS485 convertor. Every communication port of a computer can connect up to 60 AI instruments. With RS485 repeater, up to 80 AI instruments can be connected. One computer can support multiple communication slots. Each instrument shall be set with a different address. If large quantity of instrument is required, 2 or above computers can be used with a local network formed.

AIFCS application software, a distributed control system software developed by Yudian, can control and manage 1~120 AI instruments, record the data, generate and print reports. If users want to develop their own distributed control system by themselves, the communication protocol of AI instruments can be freely offered. There are many famous distributed control system software supporting AI instruments.

3.3.4 Temperature re-transmitter

Apart from APID/PID control and ON-OFF control, the instrument can retransmit PV (processed value) or SV (set value) from OUTP terminals. When the output is defined as current output, AI-226 becomes a temperature re-transmitter. The precision of 4~20mA current output is 0.3%FS. The corresponding parameters are set as below:

CtrL=PoP, PV is retransmitted. When CtrL=SOP, SV is retransmitted.

OPt defines the specification of output, generally it is 4~20mA or 0~20mA.

InP, SCH, SCL and Scb define the input specification of thermocouple or thermal resistance and retransmit

low limit or high limit of PV and doing adjustment.

For example, in order to retransmit temperature reading from a K-type thermocouple, ranging 0~400℃, output as current 4~20mA, the parameters are set as below: InP=0, ScL=0.0, ScH=400.0, OPt=4~20. X3 or X5 linear current module is installed in OUTP slot. When the temperature is lower than or equal to 0℃, the output is 4mA. When the temperature equals to 400℃, the output is 20mA. When the temperature reading is in between 0~400℃, the output will sit between 4~20mA.

3.3.5 Fine Control

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

3.3.6 User-defined 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=3698 to enter the table setting status. The parameter A 00 definition table is used for: 0 for input nonlinear measurement or multi segment linear correction of input signal, 1 for nonlinear power control of high temperature furnace; Parameters include A01~A04 and d00~d59 (the values of A02~A04 and d00~d59 have decimal places. If dPt is set to 0.0, the values of A02~d59 should be divided by 10), respectively set as follows:

A 00: 0

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

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

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

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

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

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

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

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

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

A 04: Define the table spacing of input signals, A04=A03/number of curve segments. If there is only one segment, A04=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. for example, set d 00=0

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.

3.3.7 Multi-step Linear Correction to 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=3698 to enter the table setting status (if Loc=808, set Loc to 0 first, exit the parameter setting status, and then enter the parameter status again to set Loc=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.

3.3.8 Nonlinear Power Control to High Temperature Furnace

For high-temperature furnaces with non-linear load, the resistance will change dramatically with the temperature change. Take the silicon-molybdenum bar furnace as an example, its room temperature is about 6% when the resistance is only 1600 degrees. If the output power of the instrument is not limited and transformed, it will lead to two problems. First, when the instrument starts at low temperature, the current of the electric furnace is too large and exceeds the maximum allowable load of the power grid, thyristor and transformer, which causes damage to thyristor, electric furnace and transformer or even causes power grid tripping. In addition, when the instrument has the same output, the power of the electric furnace in the low temperature zone and the high temperature zone will differ by more than 10 times at most, which means that the proportional band P in the PID parameter needs to change by more than 10 times at different temperatures to enable accurate temperature control in the low temperature and high temperature zones. However, the method of limiting parameter OPH can only limit the output power and cannot achieve proportional band transformation. If accurate temperature control is required in high and low temperature areas, multiple sets of PIDs need to be set, which is not only complex to use, but also ineffective. The user-defined output limit transformation function simultaneously solves the function of limiting output and transforming the proportional band P. This function limits and transforms the

instrument output according to the measured temperature. It not only limits the power in the low temperature zone, but also automatically corrects the parameters of the proportional band at different temperatures. The power limit and the change of the proportional band are both continuous broken line mode, which is better than the grouping mode. The power limit only reduces the actual output of the instrument proportionally, while the display range of the instrument output is still 0~100%. For example, when it is used for silicon molybdenum bar furnace, it can be set as follows (customers can also edit the data according to their own needs):

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

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.

4 FAQs

4.1 How to set self-tuning?

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

4.2 How to enter the internal parameter list?

Press ↻ and hold for two seconds to enter the parameter list, and then press ↻ briefly to refer to the next parameter. If the parameters are locked, please find the password lock LOC and set it=808, then press ↻ briefly to refer to all the parameters.

4.3 How to judge whether the instrument has output?

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

4.4 Panel flashes orAL?

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

4.5 How to set alarm parameters?

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