AI-519 ARTIFICIAL INTELLIGENCE INDUSTRIAL CONTROLLER

Operation Instruction
Ver. 7.5

(Applicable for accurate controls of temperature, pressure, flow, level, humidity etc.)

CONTENTS

1. SUMMARY

1.1 Main Features

● Universal thermocouples, RTDs and linear current/voltage signals are selectable, integrating non-linear graduation tables, digital calibration and auto zero technology, and achieving accurate and stable measurement.

● Application of advanced AI artificial intelligence control algorithm with auto tuning function, no overshoot.

● Provided with auto/manual bumpless switch and soft-start function.

● New generation of X3 and X5 current output modules with accuracy 0.2%F.S., improving the precision of control and retransmission.

● Application of advanced modular structure, conveniently providing plentiful output options, can satisfy various application requirements, and make quick delivery and easy maintenance.

● Friendly and customized operating interface leads to easy learning and simple manipulation.   Any parameter can be promoted to immediate operator access in Field Parameter Table or password protected in Full Parameter Table.

● With worldwide power supply of 100-240VAC or 24VDC and various dimensions for user to choose.   50Hz or 60Hz power frequency, and unit of ℃ or ℉ are selectable by parameter.

● High quality and performance hardware design, using high performance tantalum capacitor or ceramic capacitor. Compared to competing models, it consumes less electricity, experiences less temperature shifting, provides higher stability and reliability, and can work in a wider range of temperature.

● ISO9001 and CE certified, achieving world class level of quality, anti-interference ability and safety.

POINTS FOR ATTENTION

● 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 Technical Specification

● **Input type: (Any of below specifications can be used selectively in the same instrument)**
  Thermocouple: K, S, R, E, J, N
  Resistance temperature detector: Cu50, Pt100
  Linear voltage: 0～5V, 1～5V, 0～1V, 0～100mV, 0～20mV, etc.
  Linear current (external precise shunt resist needed): 0～10mA, 0～20mA, 4～20mA, etc.
  Extended input (install I4 module in MIO) : 0～20mA, 4～20mA or two line transmitter.

● **Instrument Input range**
  K(0～1300℃), S(0～1700℃), R(0～1700℃), E(0～1000℃), J(0～1200℃), N(0～1300℃)
  K(32～2372℉), S(32～3092℉), R(32～3092℉), E(32～1832℉), J(32～2192℉), N(32～2372℉)
  Cu50(-50～+150℃), Pt100(-200～+800℃)
  Cu50(-58～+302℉), Pt100(-328～+1472℉)
  Linear Input: -9990～+30000 units defined by user.

● **Measurement accuracy :** 0.3%FS ± 0.1℃

● **Resolution :** 0.1℃ for K, E, T, N, J, Cu50, Pt100; 1℃ for S, R

● **Temperature shift :** ≤0.015%FS /℃   (typical value is 70ppm/℃)

● **Sampling period :** read A/D converter 8 times per second

● **Response time :** ≤1s (when digital filter parameter FILt=1)

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

● **Control mode:**

On-off control mode (Hysteresis adjustable)

Standard PID with auto tuning

AI PID with auto tuning, adopting AI artificial intelligence algorithm.

- **Control period :** 0.5~120.0 seconds selectable, and it should be integer times of 0.5 second.
- **Output mode (modularized)**

  Relay output (NO+NC): 250VAC/2A 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 (used to drive SSR).

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

  Linear current output: 0~20mA, 4~20mA (Output voltage ≥11V, maximum load resistor 500ohm, output precision 0.2%FS)

- **Electromagnetic compatibility (EMC) :** ±4KV/5KHz according to IEC61000-4-4; 4KV according to IEC61000-4-5.
- **Isolation withstanding voltage :** between power, relay contact or signal terminal ≥2300VDC; between isolated electroweak terminals ≥600VDC
- **Power supply :** 100~240VAC, -15%, +10% / 50-60Hz; 120~240VDC; or 24VDC/AC, -15%, +10%.
- **Power consumption:** ≤6W
- **Operating Ambient :** temperature -10~60℃; humidity ≤90%RH
- **Front panel dimension:** 96×96mm, 160×80mm, 80×160mm, 48×96mm, 96×48mm, 48×48mm, 72×72mm
- **Panel cutout dimension:** 92×92mm, 152×76mm, 76×152mm, 45×92mm, 92×45mm, 45×45mm, 68×68mm
- **Depth behind mounting surface:** 100mm

1.3 Ordering Code Definition

AI series instruments adopt advanced modularized hardware design. There are maximum five module slots: multi-function input/output (MIO), main output (OUTP), alarm (ALM), auxiliary output (AUX) and communication (COMM). The modules can be purchased together with or separately from the instrument, and can be assembled freely. The input type can be freely set to thermocouple, RTD, or linear current/voltage.

The ordering code of AI-508 series instrument is made up of 8 parts. For example:

<div align="center">

AI-519   A   N   X3   L5   N   S4 — 24VDC

①   ②   ③   ④   ⑤   ⑥   ⑦   ⑧

</div>

It shows that the model of this instrument is AI-519, front panel dimension is 96×96mm, no module is installed in MIO (Multi-function I/O) slot, X3 linear current output module is installed in OUTP (main output), ALM (alarm) is L5 (dual relay contact output module), no module is installed in AUX (auxiliary output), a RS485 communication interface with photoelectric isolation is installed, and the power supply of the instrument is 24VDC.

The following is the meanings of the 8 parts:

① **shows the model of the instrument**

  AI-519 economical type instrument with measurement accuracy 0.3%F.S. It adopts artificial intelligent control technology, and has the functions of auto/manual bumpless switch.

② **shows the front panel dimension.**

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

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

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

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

D2 front panel 48×48mm(width×height), cut out 45×45mm, depth behind mounting surface 95mm`

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

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

③ **shows the module type of multiple function I/O (MIO).   N means none, no module installed.**

V24/V12/V10   Isolated 24V/12V/10V DC voltage output module with maximum current of 50mA, can supply power for external transmitter.

I2   On-off signal input module, can connect an external switch to switch between dual setpoints.

I4   4-20mA/0-20mA analogue input module, has a 24VDC/24mA power supply, and can connect to 2-wire transmitter.

④ **shows the module type of main output (OUTP).   For control output or SV/PV retransmission.**

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

L1/L4   Large capacity normal open relay output module (large volume, Capacity: 30VDC/2A, 250VAC/2A)

W1   TRIAC no contact normal open discrete output module (Capacity: 100-240VAC/0.2A, burnt free)

W2   TRIAC no contact normal closed discrete output module (Capacity: 100-240VAC/0.2A, burnt free)

G   SSR voltage output module (DC12VDC/30mA)

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

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

K5   Single-phase thyristor phase-shift trigger output module, suitable for 200～240VAC power.

K6   Single-phase thyristor phase-shift trigger output module, suitable for 340～415VAC power.

X3   Electric isolated linear current output module, support outputs of 0-20mA and 4-20mA etc, and use internal 12VDC power supply.

X5   Electric isolated linear current output module, support outputs of 0-20mA and 4-20mA etc.   X5 is equipped with photoelectric isolated power supply and doesn't interfere with the internal power of the instrument.

⑤ **shows the module type of alarm (ALM).   For AL1 and AL2 alarm outputs.**

L1/L2/L4   Single relay output alarm, support AL1.

L5   Dual normal open relay output module, support AL1 and AL2.

⑥ **shows the module type of auxiliary output (AUX).   For AU1 and AU2 alarms and control auxiliary output.**

L1/L2/L4   Single relay output alarm, support AU1 alarm or auxiliary output of refrigerating/heating control.

L5   Dual normal open relay output module, support AU1 and AU2 alarm.

W1   TRIAC no contact normal open discrete output module (Capacity: 100-240VAC/0.2A, burn proof)

W2   TRIAC no contact normal closed discrete output module (Capacity: 100-240VAC/0.2A, burn proof)

G   SSR voltage output module (DC12V/30mA time proportional output)

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

X3   Electric isolated linear current output module, support outputs of 0-20mA and 4-20mA etc, and use internal 12VDC power supply.

X5   Electric isolated linear current output module, support outputs of 0-20mA and 4-20mA etc.   X5 is equipped with photoelectric isolated power supply and doesn't interfere with the internal power of the instrument.

R   RS232 communication interface module, use the internal 12VDC power supply.

⑦ **shows the module type of communication (COMM).**

S   RS485 communication interface module, use the internal 12VDC power supply.

S4   RS485 communication interface module.   S4 is equipped with photoelectric isolated power supply, and doesn't interfere with the internal power supply of the instrument.

⑧ **shows the power supply of the instrument.** If left blank, the power of the instrument is 100-240VAC. "24VDC" means the power supply of 24V direct current.

Module K3: K3 module will take OUTP and MIO two slots. So if K3 is installed, installing I2 module in COMM slot and setting parameter bAud to 1 can realize two setpoints switching function.

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

Voltage output module: The voltage output modules like V24, V10 or V12 are often used for supplying power for external transducer or feedback resistance of transmitter. These modules can be installed in any slot except that of D2 dimension instrument. To standardize the wiring, it is recommended to be installed in the first idle slot in the order of MIO, AUX, and COMM.

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 module), I2 (on-off signal input module) and I4 (linear current input module). The 12V power is commonly supplies output or communication module. Generally, the relay contact output and TRIAC no contact discrete output are self insulated from the other circuit, no matter whether other modules are installed or not. SSR voltage output do not need to be insulated from input circuit, because SSR itself has isolation function. Therefore, only the electric isolation between the communication interface and the current output should be considered. Those modules, for example, S (RS485 communication interface), R (RS232 communication interface) and X3 (linear current output), all need the 12V power supply. If more than one of the above modules are installed, in order to be electric isolated, only one of them can be module without electric isolation, the other modules should be S4 or X4, which has its own isolated power supply. For example, if an X module is installed in OUTP (main output) slot, and an S or X module is installed in COMM (communication interface) slot, then OUTP and COMM can not be electric isolated, so S or X should be replaced with S4 or X4.

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

Relay Module: The relay modules are widely used in industrial control. However, they are the only modules with life time limit and volume limit and have much electromagnetic interference. There are four types of relay modules: L1, L2, L4 and L5. For control output, L1 or L4 large capacity module is recommended. L4 is equipped with high performance relay with small volume and large capacity but is expensive. L2 module is small, and both its normal open and normal close terminals have the function of varistor spark absorption, but the capacity is small. It is suitable for alarm output. L1 and L5 have big volume and big capacity. In the 48mm dimension instrument (for example, D2, E, F and E5), only one of L1 or L5 can be installed. L5 has dual output, can be used to support two loops of alarm, for example, AL1+AL2. If you don't like mechanical switch, you can choose G5 (dual SSR voltage driver) and connect with external SSR instead.

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

Warranty and maintenance: Free repair and maintenance will be given in 36 months since the delivery. In order to get full and correct repair, write the phenomena and causes of the malfunction of the instrument.

1.4 Rear Terminal Layout and Wiring

**Wiring graph for instruments except D and D2 dimension.**
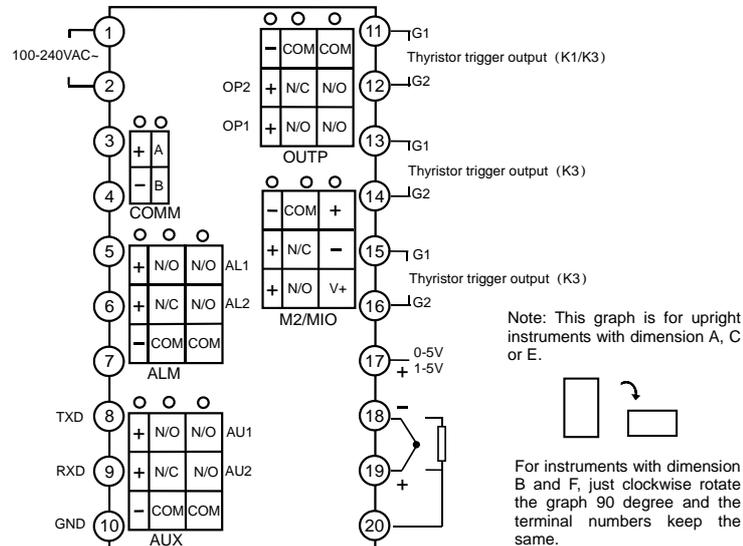
Note 1: For linear voltage input, if the range is below 500mV, connect to terminals 19 and 18. 0～5V or 1～5V signal can be inputted from terminals 17 and 18.

Note 2: 4～20mA signal can be converted to 1～5V signal by a 250 ohm resistor and inputted from terminals 17 and 18. If I4 module is installed in MIO slot, 4～20mA signal can be inputted from terminals 14+ and 15-, and 2-wire transmitter can be inputted from terminals 16+ and 14-.

Note 3: The compensation wires for different kinds of thermocouple are different, and should be directly connect to the terminals. When the internal auto compensation mode is used, connecting the common wire between the compensation wire and the terminals will cause measurement error.

Wiring graph of D dimension instruments (72×72mm)
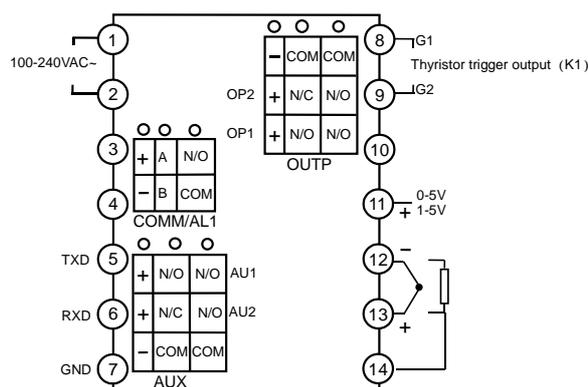
Note 1: Linear voltage signal of range below 500mV should be inputted from terminals 13 and 12, and signal of 0～5V and 1～5V should be inputted from terminals 11 and 12.

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

Note 3: S or S4 module can be installed in COMM slot for communication. If relay, TRIAC no contact switch, or SSR driver voltage output module is installed in COMM, it can be used as alarm output. If I2 module is installed in COMM and parameter "bAud" is set to 1, then on-off signal can be inputted, and setpoints SV1 and SV2 can be switched by

connecting a switch between terminals 3 and 4.

Wiring graph of instruments with D2 dimension as below:
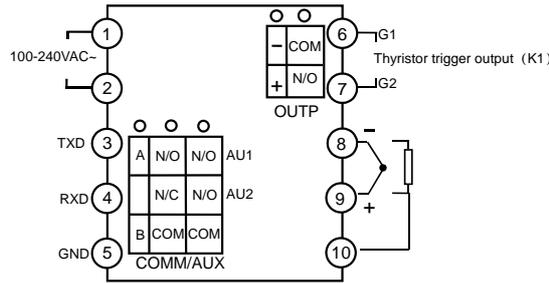
Note 1: D2 dimension instruments don't support 0～5V or 1～5V linear voltage input. However, 0～5V or 1～5V signal can be converted to 0～500mV or 100～500mV by connecting external precise resistors, 4～20mA can be converted to 100～500mV by connecting a 25ohm resistor, then be inputted from terminals 9 and 8.

Note 2: For COMM/AUX slot, if S or S4 communication module is installed in, it can be used for communication; if L2 or L5 module is installed in, and parameter bAud is set to 0, it can be used for AU1 or AU1+AU2 alarm output; if L1, L2, L4, G, K1, W1 or W2 is installed, it can be the auxiliary output in bidirectional (heating/refrigerating) control (Auxiliary output doesn't support analog current output); if I2 is installed and bAud is set to 1, then it can input on-off signal to switch SV1 and SV2 by connecting a switch between terminals number 3 and 5.
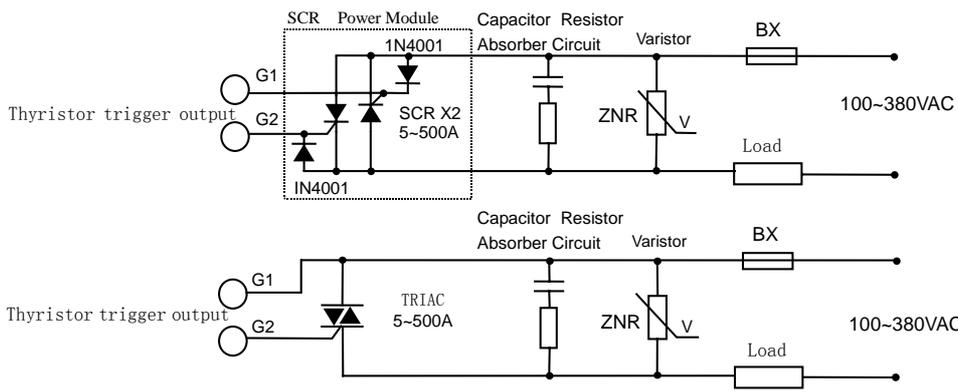
Note 1: According to the voltage and current of load, choose suitable varistor to prevent the thyristor. Capacitor resistor absorber is needed for inductance load or phase-shift trigger output.

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

Note 3: K5 phase-shift trigger module only support 200～240VAC / 50Hz power, and K6 phase-shift trigger module only support 340～415VAC / 50Hz power.

2. DISPLAYS AND OPERATIONS

2.1 Front Panel Description

① Upper display window, displays PV, parameter code, etc.

② Lower display window, displays SV, parameter value, or alarm code.

③ Setup key, for accessing parameter table and conforming parameter modification.

④ Data shift key, and also for auto tuning, auto/manual switch.

⑤ Data decrease key, and also run/pause switch

⑥ Data increase key, and also stop key

⑦ LED indicator. PRG indicator is non-applicable for AI-519.
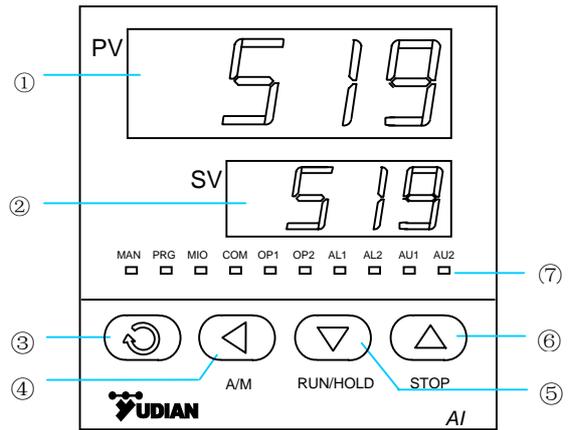
The lighting of MAN means in manual output status. MIO, OP1, OP2, AL1, AL2, AU1 and AU2 indicate I/O operation of the corresponding module. For example, That the COMM indicator is lighting means that the instrument is communicating with computer.

Basic display status : When power on, the upper display window of the instrument shows the process value (PV), and the lower window shows the setpoint (SV). This status is called basic display status. When the input signal is out of the measurable range (for example, the thermocouple or RTD circuit is break, or input specification sets wrong), the upper display window will alternately display "orAL" and the high limit or the low limit of PV, and the instrument will automatically stop output. If the lower display window alternately display "HIAL", "LoAL", "HdAL" or "LdAL", it means high limit alarm, low limit alarm, deviation high alarm, and deviation low alarm happening. The alarm display can also be turned off by setting parameter AdIS to oFF. If "EErr" is displayed, it means internal self-test error, and the instrument should be sent back for repair.

2.2 Parameter Setting Flow Chart
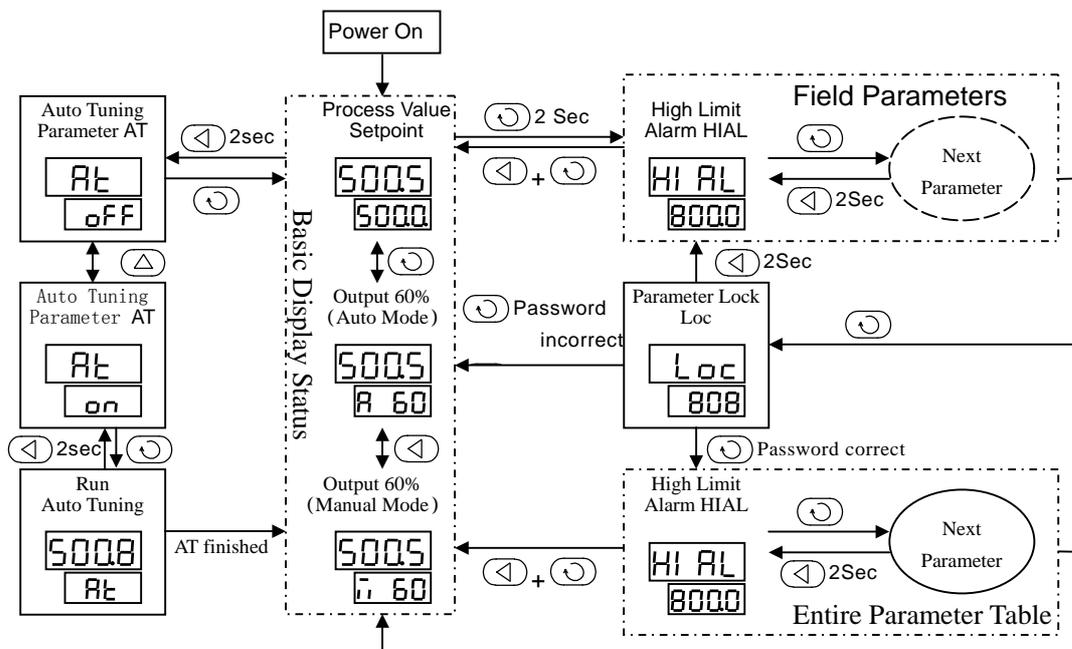
2.3 Operation Description

2.3.1 Set Value Setting

In basic display status, if the parameter lock "Loc" isn't locked,　we can set setpoint (SV) by pressing ⧉、⧉ or ⧉. Press ⧉ key to decrease the value, ⧉ key to increase the value, and ⧉ key to move to the digit expected to modify.　Keep pressing ⧉ or ⧉, the speed of decreasing or inscreasing value gets quick.　The range of setpoint is between the parameter SPL and SPH.

2.3.2 Parameter Setting

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

In Field Parameter Table, press ⧉ till the last field parameter Loc appears.　Setting Loc=password and then press ⧉ can access System Parameter Table.

2.3.3 Setpoint / Output Value Switch

In the basic display status, pressing ⧉ can switch lower display window between displaying setpoint and displaying output value.　If the instrument is in manual operating mode, when the lower display window is switched to setpoint display, it will auto return to output value display after a period of time.

2.3.4 Auto / Manula Control Mode Switch

When output value is displayed in lower display window, pressing A/M (⧉) key can switch between auto control and manual control.　If the instrument is in manual control mode and the lower display window is displaying output value, the output value can be modified by pressing ⧉ or ⧉.　By setting M-A parameter, the instrument can be fixed at auto or manual control mode, and avoid mistaken switch.

2.3.5 Auto Tuning

When artificial intelligence PID control or standard PID control is chosen (CtrL=APId or nPId),　the PID parameters can be obtained by running auto-tuning.　In basic display status, press ⧉ for 2 seconds,　the "At" parameter will appear. Press ⧉ to change the value of "At" from "oFF" to "on", then press ⧉ to active the auto-tuning process.　During auto tuning, "At" will flash at lower display window and the instrument executes on-off control.　After 2 cycles of on-off action, the instrument will obtain the values of PID control parameters.　If you want to escape from auto tuning status, press and hold ⧉ for about 2 seconds until the "At" parameter appears again.　Change "At" from "on" to "oFF", press ⧉ to confirm, then the auto tuning process will be cancelled.　After satisfying PID parameters are obtained, At is recommended to be "FoFF" which prevents activating auto tuning in basic display status.

Note 1: AI-519 instruments apply the advanced artificial intelligence algorithm, which has avoided the overshoot problem of standard PID algorithm, and achieve precise control.

Note 2: If the setpoint is different, the parameters obtained from auto-tuning are possibly different.　So you'd better set setpoint to an often-used value or middle value first, and then start auto-tuning.　For the ovens with good heat preservation, the setpoint can be set to the highest applicable temperature.　It is forbidden to change SV during auto tuning.　Depending on the system, the auto-tuning time can be from several seconds to several hours.

Note 3: Parameter CHYS (on-off differential, control hysteresis) has influence on the accuracy of auto-tuning. Generally, the smaller the value of CHYS, the higher the precision of auto tuning.　But the value of CHYS parameter should be large enough to prevent the instrument from error action around setpoint due to the oscillation of input.　CHYS is recommended to be 2.0.

Note 4: In a heating/refrigerating dual output system, auto tuning should be executed at the main output (OUTP).

Note 5: AI series instrument has the function of self-adaptation.　It is able to learn the process while working. The control effect at the first run after auto tuning is probably not perfect, but excellent control result will be obtained after a period of time because of self-adaptation.

3. PARAMETERS AND SETTINGS

3.1 Parameter Lock (Loc) and Field Parameters

In order to protect important parameters from being modified by mistake, but also offer enough flexibility for field control, parameter lock (Loc) and field parameters are introduced.

The parameters need to be displayed and modified in the work field are called Field Parameters. The set of field parameters is a subset of the whole parameter set, and can be freely chosen by user.

Loc can authorize different security right as below:

Loc=0～1, allowed to modify field parameters and setpoint, and execute auto tuning;

Loc=2, allowed to modify field parameters, but can't modify setpoint.

Loc=3～255: can only modify "Loc"

Setting Loc=PASd (Password, a number between 256 and 9999. The initial value is 808) and then pressing ⊙ to confirm, can enter the whole parameter table and modify all parameters.

1 to 8 field parameters can be defined by parameters EP1to EP8. If the number of the field parameters is less than 8, the first idle EP parameter should be set to "nonE". The initial values of EPs and Loc are EP1=HIAL, EP2=LoAL, EP3=HdAL, EP4=LdAL, EP5=nonE, EP6=nonE, EP7=nonE, EP8=nonE and Loc=0.

You can redefine field parameters and Loc to change operation style. For example, you can execute auto tuning from field parameter instead of by pressing ⊘ in basic display status, and only take HIAL and HdAL as field parameter. The EP paramters and Loc should be set as below:

EP1=HIAL, EP2=HdAL, EP3=At, EP4=nonE, Loc=0, At=FoFF

3.2 The Entire Parameter Table

The parameters can be divided to 8 groups including alarm, control, input, output, communication, system, setpoint and field parameter definition.   They are listed as below in sequence:

Code	Name	Description	Setting Range
HIAL	High limit alarm	Alarm on when PV (Process Value) >HIAL; alarm off when PV<HIAL-AHYS Alarm output action can be defined by parameter AOP.	-9990～ +30000 units
LoAL	Low limit alarm	Alarm on when PV<LoAL; alarm off when PV>LoAL+AHYS	
HdAL	Deviation high alarm	Alarm on when PV-SV>HdAL; alarm off when PV-SV<HdAL-AHYS	
LdAL	Deviation low alarm	Alarm on when PV-SV<LdAL; alarm off when PV-SV>LdAL+AHYS HdAL and LdAL can also be used as high limit and low limit alarms when needed. (Refer to the description of parameter AF)	
AHYS	Alarm hysteresis	Avoid frequent alarm on-off action because of the fluctuation of PV	0～2000 units
AdIS	Alarm display	oFF : don't display AdIS in the lower display window when alarming; on : alternately display AdIS in the lower display window when alarming.	oFF on
AOP	Alarm output allocation	From right side to left side, the first, second, third and fourth digit of AOP individually indicate the alarm output terminal of HIAL, LoAL, HdAL, and LdAL. 0 shows no output. 1,2,3 or 4 indicates alarm outputted to AL1, AL2, AU1 or AU2. For example, $$AOP = \underset{LoAL}{3} \quad \underset{HdAL}{3} \quad \underset{LoAL}{0} \quad \underset{HIAL}{1}$$ It shows that HIAL is sent to AL1, LoAL has no output, HdAL and LdAL are sent to AU1. Note 1: When AUX is used as auxiliary output in bidirectional (heating/refrigerating) control, alarm to AU1 and Au2 won't work. Note 2: Installing L5 dual relay output module in ALM or AUX can implement AL2 or AU2 alarm.	0～4444
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 (no integral when PV-SV > proportional band); POP: output PV. The instrument works as a temperature retransmitter.	onoF APId nPId POP SOP

		SOP: output SV.　The instrument works as a set current output.	
Act	Acting method	rE: Reverse acting.　Increase in measured variable causes an decrease in the output, such as heating control. dr: Direct acting.　Increase in measured variable causes an increase in the output, such as refrigerating control. rEbA: Reverse acting with low limit alarm and deviation low alarm blocking at the beginning of power on. drbA: Direct acting with high limit alarm and deviation high alarm blocking at the beginning of power on.	rE dr rEbA drbA
A-M	Auto/Manual Control Mode Selection	Man: Manual control mode.　Manually adjust output value of OUTP. Auto: Auto control mode.　The instrument calculate and control the output value. FMAn: Fixed in manual control mode.　Forbidden to switch to auto mode by pressing A/M ($\lessdot$) key in basic display status. FAut: Fixed in auto control mode.　Forbidden to switch to manual mode by pressing A/M key in basic display status.	MAn Auto FMAn FAut
At	auto tuning	oFF: Auto tuning function is disable on: Active auto turning function to calculate the values of parameters P, I, d and CtI. After auto tuning is accomplished, "At" will be automatically changed to oFF. FoFF: Auto tuning is disable, and activating auto tuning from basic display status is forbidden.	
P	Proportional band	Proportional band in PID and APID control.　Instead of percentage of the measurement range, the unit is the same as PV. Generally, optimal P, I, D and CtI can be obtained by auto tuning.　They can also be manually inputted if you already know the correct values.	10～9999 units
I	Time of Integral	No integral effect when I=0	0～9999 seconds
d	Time of Derivative	No derivative effect when d=0	0～999.9 seconds
CtI	Control period	Small value can improve control accuracy. For SSR, thyristor or linear current output, generally 0.5 to 3 seconds. For Relay output or in a heating/refrigerating dual output control system, generally 15 to 40 seconds, because small value will cause the frequent on-off action of mechanical switch or frequent heating/refrigerating switch, and shorten its service life. CtI is recommended to be 1/4 – 1/10 of derivative time.　(It should be integer times of 0.5 second.) When output type is set to relay (OPt or Aut is set to 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.	0.5～120.0 seconds
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 (refrigerating) system, when PV<SV, output turns off; when PV>SV+CHYS, output turns on.	0～2000 units

InP	Input spec.	**InP**	Input spec.
0	K	**26**	0～80ohm resistor input
1	S	**27**	0～400ohm resistor input
2	R	**28**	0～20mV voltage input
3	Spare	**29**	0～100mV voltage input
4	E	**30**	0～60mV voltage input
5	J	**31**	0～500mV voltage input
7	N	**32**	100～500mV voltage input
10	extended input specification	**33**	1～5V voltage input
15	4～20mA (installed I4 in MIO)	**34**	0～5V voltage input
16	0～20mA (installed I4 in MIO)	**35**	0～10V
20	Cu50	**36**	2～10V
21	Pt100	**37**	0～20V

InP — Input specification Code — Range: 0～37

Note 1: If specified when ordering, an additional input specification, for example, WRe32, WRe526, WRe520, JPt100 (BA2), G(Cu53), F2, or Square root of 0～5V or 1～5V, can be provided by setting InP to 10.

Note 2: If the input specification has been specified, then InP has been correctly set before delivery.

| **dPt** | Radix point | Four formats (0, 0.0, 0.00, 0.000) are selectable | 0, 0.0, |

	position	Note 1: For thermocouples or RTD input, only 0 or 0.0 is selectable, and the internal resolution is 0.1. When S or R thermocouple is used, dPt is recommended to be 0.	0.00, 0.000
ScL	Signal scale low limit	Define scale low limit of input. It is also the low limit of transmitter output (CtrL=POP or SOP) and light bar display.	-9990∼ +30000 units
ScH	Signal scale high limit	Define scale high limit of input. It is also the high limit of retransmission output (CtrL=POP or SOP) and light bar display.	
Scb	Input Shift Adjustment	Scb is used to shift input to compensate the error caused by transducer, input signal, or auto cold junction compensation of thermocouple. PV_after_compensation=PV_before_compensation + Scb	-1999∼ +4000 units
FILt	PV input filter	The value of FILt will determine the ability of filtering noise. When a large value is set, the measurement input is stabilized but the response speed is slow. Generally, it can be set to 1 to 3. If great interference exists, then you can increase parameter "FILt" gradually to make momentary fluctuation of measured value less than 2 to 5. When the instrument is being metrological verified, "FILt" s can be set to 0 or 1 to shorten the response time.	0∼40
Fru	Selection of power frequency and temperature scale	50C: 50Hz, ℃. Input has maximum anti-interference ability to 50Hz frequency; 50F: 50Hz, °F. Input has maximum anti-interference ability to 50Hz frequency; 60C: 60Hz, ℃. Input has maximum anti-interference ability to 60Hz frequency; 60F: 60Hz, °F. Input has maximum anti-interference ability to 60Hz frequency;	50C, 50F, 60C, 60F
OPt	main output type	SSr: to output SSr driver 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 (Ctl) is generally 0.5∼4 seconds. rELy: for relay contact output or for execution system with mechanical contact switch. To protect the mechanical switch, the output period (CtI) is limited to 3∼120 seconds, and generally is 1/5 to 1/10 of derivative time. 0-20: 0∼20mA linear current output. X3 or X5 module should be installed in OUTP slot. 4-20: 4∼20mA linear current output. X3 or X5 module should be installed in OUTP slot. PHA: single-phase phase-shift output. K5 module should be installed in OUTP slot. PHA is only for 50Hz power supply, and don't support bidirectional control system.	SSr rELy 0-20 4-20 PHA
Aut	Auxiliary output type	Define Aut only when AUX is worked as the auxiliary output of a heating/refrigerating bidirectional systerm. SSr: to output SSr driver voltage or thyristor zero crossing trigger signal. G, K1 or K3 module should be installed. The output power can be adjusted by adjusting the on-off time proportion. The period (Ctl) is generally 0.5∼4 seconds. rELy: for relay contact output or for execution system with mechanical contact switch. To protect the mechanical switch, the output period (CtI) is limited to 3∼120 seconds, and generally is 1/5 to 1/10 of derivative time. 0-20: 0∼20mA linear current output. X3 or X5 module should be installed in OUTP slot. 4-20: 4∼20mA linear current output. X3 or X5 module should be installed in OUTP slot. Note: In a heating/refrigerating bidirectional control system, if any of OPt or Aut is set to rELy, then Ctl is limited to 3∼120. For single output control, please set Aut to SSr.	SSr rELy 0-20 4-20
OPL	Output low limit	0∼100%: OPL is the minimum output of OUTP in single directional control system. -1 ∼ -120%: the instrument works for a bidirectional system, and has heating/refrigerating dual outpoust. When ACt=rE or rEbA, OUTP (main output) works for heating, and AUX (Auxiliary output) works for refrigerating. When Act=dr or drbA, OUTP works for refrigerating, and AUX works for AUX. In a bidirectional system, the heating and refrigerating ability are generally different. OPL = -(power when AUX output is maximum /power when OUTP output is maximum) x 100%. For example, for a heating/refrigerating air condition, its maximum power of refrigerating is 4000W, and maximum power of heating is 5000W, and AUX works for refrigerating, then OPL=- (4000/5000)x100% = -80% The range of AUX output can't be freely defined by user. If the internal calculation requires maximum output of AUX (AUX output=OPL), then in 4∼20mA output, the AUX output is 20mA, and user can't limit the maximum AUX output to 10mA.	-120∼ +100%
OPH	Output upper limit	OPL limits the maximum of OUTP (main output) when PV<OEF. OPH should be greater than OPL.	0∼110%
OPrt	Soft start time	At the beginning of power on, if PV<OEF, it takes OPrt for the output value of OUTP to rise to OPH; if PV>OEF, then the time for output value of OUTP to rise to 100% is not	

		more than 5 seconds. This function is only needed by special requirement. Soft start function doesn't affect the maximum output at auto tuning or manual control. If it is needed to lower the impulse current of induction load, Ctl can be set to 0.5 second, and OPrt 5 seconds.	
OEF	Work range of OPH	When PV<OEF, the upper limit of OUTP is OPL; when PV>OEF, the upper limit of OUTP is 100%. For example, to avoid that the temperature raises too quickly, under 150℃, a heater can work only under 30% of power, then we can set OEF=150.0 (℃), OPH=30 (%)	-9990～ +30000 units
Addr	communication address	In the same communication line, different instrument should be set to different address.	0～80
bAud	baud rate	the range of baud rate is 1200～19200bit/s. For D2 dimension instrument, when COMM/AUX slot is used as AUX, bAud should be set to 0.	0～19200
AF	advanced function	AF is used to select advanced function. The value of AF is calculated as below: AF=Ax1 + Bx2 + Cx4 + Dx8 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. For instruments with light bar, when C=0, the light bar indicates the output value; when C=1, the light bar indicates the process value. D=0, Loc=808 can access the whole parameter table; D=1, Loc=PASd can access the parameter table. Note: AF=0 is recommended.	0～15
PASd	password	When PASd=0～255 or AF.D=0, setting Loc=808 can enter the whole parameter table. When PASd=256～9999 and AF.D=1, only setting Loc=PASd can access the whole parameter table. Please setting PASd cautiously, if the password is lost, you can't access the parameter table again.	0～9999
SPL	Low limit of SV	Minimum value that SV is allowed to be.	-9990～ +30000 unit
SPH	Upper limit of SV	Maximum value that SV is allowed to be.	
SP1	setpoint 1	Generally, SV=SP1	SPL～ SPH
SP2	setpoint 2	when I2 is installed in MIO slot, SP1 and SP2 can be switched by an external switch. If the switch is off, SV=SP1; if the switch is on, SV=SP2.	
EP1～ EP8	Field parameter definition	Define 0～8 of the parameters as field parameters.	nonE and all parameter codes

Note : When indicating temperature, the unit of PV and the parameters is 0.1℃ or 0.1℉ according to parameter Fru.

For example, the range of -9990～+30000 means –999.0℃～+3000.0℃ or –999.0℉～+3000.0℉, and the display of

number greater than 999.9 will automatically cut the decimal fraction. For the unit of other linear signals, the radix point

position is used only for display, and doesn't affect the resolution and range of the internal calculation.

3.3 Additional Remarks of Special Functions

3.3.1 Single-phase phase-shift trigger output

When OPt is set to PHA, installing a K5 module in OUTP slot can single-phase phase-shift trigger a TRIAC or 2 inverse

parellel SCRs. It can continuously adjust heating power by control the conduction angle of thyristor. With non-linear

power adjustment according to the characters of sine wave, it can get ideal control. The trigger adopts self-synchronizing

technology, so it can also work even when the power supplies of the instrument and the heater are different. Phase-shift

trigger has high interference to the electric power, so user should pay attention to the anti-interference ability of other

machines in the system. Now the K5 module can be only used in 50Hz power supply.

3.3.2 Alarm blocking at the beginning of power on

Some unnecessary alarms often occur at the beginning of power on. In a heating system, at the beginning of powers on,

its temperature is much lower than the setpoint. If low limit and deviation low limit are set and the alarm condition 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 Setpoints switch

If an I2 module is installed in MIO slot, a switch can be connected to terminal number 14 and 16 to switch between two different setpoints SP1 and SP2.

3.3.4 Communication function

S or S4 module can be installed at COMM slot to communicate with a computer.   The instrument can be controlled by computer.   A RS232C/RS485 or USB/RS485 converter can enable a computer connect to AI instruments through RS232 or USB communication port.   Every communication port of a computer can connect up to 60 AI instruments, or 80 AI instruments if a repeater is installed.   A computer with 2 communication ports can connect to up to 160 instruments. Please note that every instrument connecting to the same communication line should be set to a unique communication address.   When number of the instruments is big enough, 2 or more computers can be used and built into a local network.

AIDCS application software, a distributed control system software developed by Yudian, can control and manage $1\sim160$ AI instruments, record the data, generate and print reports.   If users want to develop their own distributed control system by themselves, the communication protocol of AI instruments can be free offered.   There are already many famous distributed control system software support AI instruments.

3.3.5 Temperature retransmitter / set current output

Besides AI PID, stand PID control and on-off control, if the output is defined as current output, the instrument can also retransmit PV (process value) or SV (setpoint) into linear current and output from OUTP.   The precision of current output is 0.2%FS.   The corresponding parameters are set as below:

When CtrL=POP, PV is retransmitted to linear current, the instrument works as temperature retransmitter.   When CtrL=SOP, SV is transmitted and outputted, and the instrument works as an set current output.

OPt is used to choose output type, generally $4\sim20$mA or $0\sim20$mA output.

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

For example, in order to retransmit temperature read from K thermocouple, range $0\sim400$℃, to current $4\sim20$mA, the parameters are set as below: CtrL=POP, InP=0, ScL=0.0, ScH=400.0, OPt=4-20, and X3 or X5 linear current module is installed in OUTP slot.   When the temperature is less than or equal to 0℃, the output is 4mA.   When the temperature equals to 400℃, the output is 20mA.   The upper limit of transmitter output can be high up to 110% of the range, which means when PV is $0\sim440$℃, output current is $4\sim21.6$mA.