AI-526 / AI-526P ARTIFICIAL INTELLIGENCE INDUSTRIAL CONTROLLER

(Applicable for accurate controls of Temperature, Pressure, Flow, Level and Humidity etc.)

Operation Instruction

（ver.8.3）

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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-526/AI-526P Version 8.3. 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: multi-function input/output (MIO), main output (OUTP), alarm (ALM), auxiliary output (AUX) and communication (COMM). The modules can be purchased together or individual, and can be assembled freely. The input type can be set to thermocouple, RTD, or linear current/voltage.

The ordering code of AI-526/AI-526P series instrument is made up of 9 parts. For example:

AI – 526	A	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 AI-526, front panel dimension is A size(96×96mm), no module is installed in MIO slot, X3 linear current output module is installed in OUTP (main output), ALM (alarm) is L5 (dual relay contact output module), no module is installed in AUX (auxiliary output), S4 (RS485 communication interface module) is installed at COMM , and the power supply of the instrument is 24VDC, an extended input type (F2 radiation type pyrometer) is available

The following is the meanings of the 9 parts:

① Instrument Model

AI-526 Economical temperature controller with measurement accuracy 0.25%F.S, with artificial intelligent

controlling technology, various types of alarm, retransmission and communication.

AI-526P On top of AI-526, providing 30 segments of time-procedure programmable function.

② Panel Dimension

A Front panel 96x96mm, cut-out 92x92mm, depth behind mounting surface at 100mm.

A2 On top of A2, a light bar with 25 segments in 4 levels luminosity is added. Front panel 96x96mm, cut-out 92x92mm, depth behind mounting surface at 100mm.

B Front panel 160x80mm (widthxheight), cut-out 152x76mm, depth behind mounting surface 100mm.

C Front panel 80x160mm(widthxheight), cut out 76x152mm, depth behind mounting surface 100mm.

C3 On top of C, a light bar with 50 segments and 2 levels of luminosity is added. Dimension are the same as C.

D Front panel 72x72mm, cut-out 68x68mm, depth behind mounting surface 95mm.

D2 Front panel 48×48mm, cut out 45×45mm, depth behind mounting surface 95mm.

D5 Width at 22.5mm only, DIN rail mount, optional external E8 keypad is required to plugged for parameter setting and operation.

D6 Front panel 48x48mm, cut out 45x45mm, depth behind mounting surface 95mm.

D7 Width at 22.5mm only, DIN rail mount, specially designed compact dual LED display with operation buttons, power and communication lines are grouped in hot-plugged terminals.

E Front panel 48x96mm (widthxheight), cut-out 45x92mm, depth behind mounting surface 100mm.

E2 On top of E, a light bar with 25 segments and 4 levels of luminosity is added. Dimension are the same as E.

E5 Size at 48x96mm (widthxheight), DIN rail mount, optional external E8 keypad is required to plugged for

parameter setting and operation.

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

③ **Module available in multiple functions I/O (MIO):** I2, I4, 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, L1, L2, L3, L4, W1, W2, G, K1, X3, X5, 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 is 100~240VAC. "24VDC" means the power supply of 20~32V DC or AC power (required to be specified upon ordering).

⑨ **Extended graduation specification:** (If there is none, leave it blank). AI-526 series instruments input is already universal supporting common thermocouples, RTDs, linear voltage, current and resistance inputs (Please refer to the latter part of technical specification). If it is required, an additional specification can be extended.

Note 1: The instrument applies the technology of automatic zero and digital calibration, and is free of maintenance. If the error exceeds certain range, 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.

Note 2: Please specify the error phenomenon and reason to ensure proper and complete repair if it is sent back for repair.

1.3 Modules

1.3.1 Slots of modules

There are 5 module slots in AI-526/526P series instruments. (3 slots, OUTP, AUX and COMM/AL1 for D-sized. 2 slots, OUTP and COMM/AUX for D2-sized). Different modules installed will provide different functions and output types.

- **Multiple function Input / Output (MIO):**

  By installing I4 module with 24VDC loop power, the instrument reads input signal from 2-wire transmitter or 4-20mA signal. If a I2 (on-off signal input) module is installed, the instrument can switch between set points SV1 and SV2 by an external switch. On top of that, 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):**
  In a heating/refrigerating dual output system, module X3, X5, L1, L4, G, W1, W2, etc can be installed for the second control output. In a system which does not require second output, installing L0, 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:

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) discrete 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 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)

K5/K6 Single channel 220VAC/380VAC thyristor phase-shift trigger output module (Each channel triggers one loop of TRIAC or a pair of inverse parallel SCR with current of 5~500A). Only 50Hz power is allowed.

X3 Photoelectric programmable linear current output module

X5 Photoelectric programmable linear current output module with own photoelectric isolated power supply.

S Photoelectric RS485 communication interface module.

S1 Photoelectric RS485 communication interface module. (Uses internal 24V isolated power)

S4 Photoelectric RS485 communication interface module with own photoelectric isolated power supply.

R Photoelectric RS232C communication interface module.

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.

R 4-20mA/0-20mA analogue input interface with 24VDC/25mA power supply for 2-wire transmitter.

1.3.3 Installation and replacement of modules

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

1.3.4 Electric isolation of the modules

There are a group of 24V and a group 12V power supply built in the instrument and isolated to the main circuit. The 24V power commonly supplies voltage output module, such as V24/V12/V10 (24V/12V/10V voltage output), I2 (frequency/on-off input, with 12V isolated voltage output) and I4, etc. The 12V power commonly supplies power for output or communication module. Generally, the relay contact output and TRIAC no contact discrete output are self-isolated from the other circuit or does not require isolated power. Therefore, only the electric isolation between the communication interface and the current output should be considered. S (RS485 communication interface), R (RS232 communication interface) and X3 (linear current output) all draws from the internal 12V power supply. If more than one of the above modules are installed, they will be not electrically isolated because they share the same power supply. To avoid interference, S4 (RS485 communication interface) or X5 (linear current output) is designed. They have their own isolated power supply, without drawing from instrument internal power. For example, if an X3 module is installed in main output (OUTP) slot, 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.

1.3.5 Further descriptions about module applications

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

- **No contact switch module:** W1/W2 are newly developed non-contact switch module with advanced “burn proof” technology and zero-crossing conduction. It can replace the relay contact switch to control AC contactor actuator or electric servo motor. Compared to the relay contact output module, W1/W2 have longer life span and able to lower the interference spark. This improves the stability and reliability of the system. Since the driving component is thyristor, it is suitable to control100~240VAC but no DC. Since output terminals are connected in series with protection components, the allowed continuous current for control is up to 0.2A with allowed maximum instantaneous current up to 2A.This driving power can directly control AC contactor of 220VAC with current below 80A. For the load larger than 80A, an intermediate relay is needed.

- **Relay switch module:** The relay modules are widely used in industrial control. However, they are the only modules with life time limit and size limit and also bringing large amount of electromagnetic interference. It is important to choose a suitable relay module. To control equipment with 100~220VAC supply, such as AC contactor and electromagnetic valve, W1 module is recommended. To control DC or AC above 50VAC, relay module L1, L4, etc can only be chosen. L2 module is small without size limitation and both of its normal open and

normal close terminals have varistor spark absorption. But the capacity is small therefore It is suitable for alarm output. L1 and L3 are larger in size and higher in capacity. In the 48mm dimension instrument (for example, D2, E, F, E5, etc), either main board or side board can be installed. Otherwise the modules will collide to one another. If either main or side board is L1 or L3 installed, another board cannot have L1 or L3 installed at the same time. L3 module provides dual relay outputs. It can be used to support two loops of alarm, for example, AL1+AL2. 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: 0～5V, 1～5V, 0～1V, 0～100mV, 0～20mV, 0~500mV etc.
  Linear current (external current divider required): 0～10mA,0～20mA, 4～20mA, etc.
  Extended specification: Apart from the above-mentioned Input speficiation, 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～+600℃)

Linear Input: -9990～30000 defined by user

- **Measurement accuracy :** 0.25%FS ± 1 measurement unit
- **Control period :** 0.24～300.0 seconds selectable, and it should be integer times of 0.5 second.
- **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: 0~10mA 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
- **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

1.5 Wiring Diagram

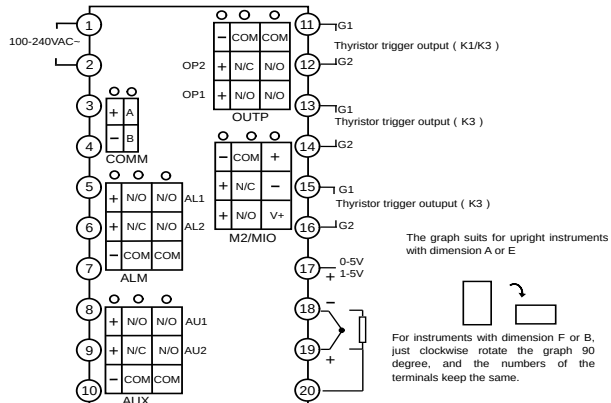
Wiring diagram of rear terminals

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 linear current signal can change to 1～5V voltage signal by connecting a 250 ohm resistor, and then be 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.

Note 4: When main output selected linear current or SSR voltage, output form terminal 13+, 11-,

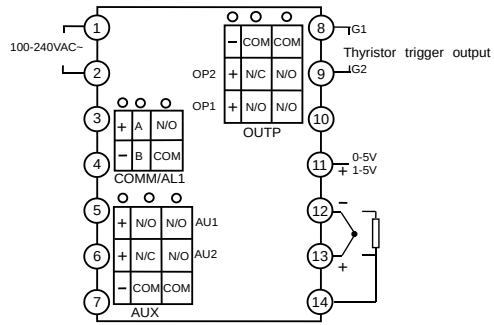


Wiring diagram of dimension D (72×72mm)

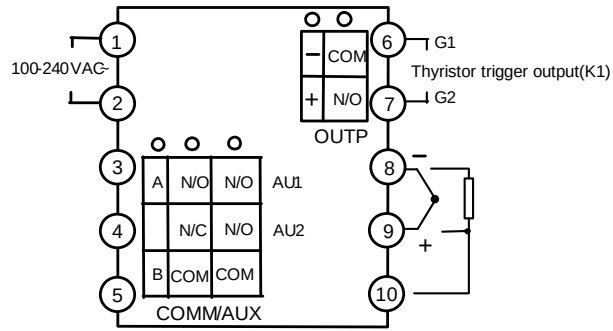
Note 1: Linear voltage signal of range below 500mV should be inputted from terminals 13 and 12, and signal of 0～5V and 1～5V should be inputted from terminals 11 and 12.

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 drive voltage output module is installed in COMM, it can be used as alarm output. If I2 module is installed in COMM and parameter “bAud” is set to 1, SV1 and SV2 can be switching by connecting a switch between terminals 3 and 4.



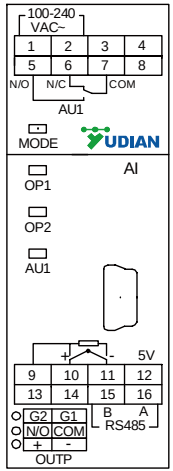
Wiring diagram of dimension D2 (48x48mm)



Note 1: Dimension D2 instruments do not support 0~5V nor 1~5V linear voltage input. Instead, 0~5V or 1~5V signal can be converted to 0~500mV or 100~500mV respectively by voltage divider while 4 ～ 20mA can be converted to 100~500mV by connecting a 25ohm resistor in parallel, then be inputted from terminals 9 and 8.

Note 2: In COMM/AUX slot, S or S4 communication module provides RS485 communication. If L2 module is installed in, it acts as alarm at AU1. If L3 dual relay module is installed with parameter bAud = 0, it acts as AU1 and AU2 alarm output. If parameter bAud = 2, it acts as alarms at AU1 and AL1. L1, L2, L4, G, K1, W1 or W2 modules can be installed as the auxiliary output in bidirectional (heating/refrigerating) control. If I2 module is installed with bAud = 1, it simulates MIO slot to read on-off input (terminals 3 and 5) to switch between SP1/SP2 or switch the program status RUN / Stop (AI-526P).

Wiring diagram of dimension D5



Note: Dimension D5 instruments are fixed with one loop of alarm and communication feature. Available main output module are G, X5, L2, K1, K5, K6 and W1.

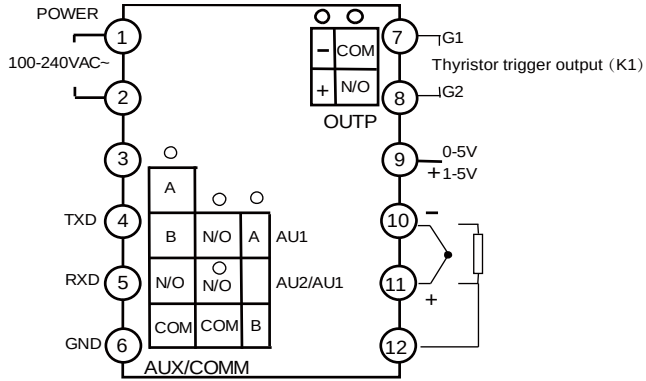
Wiring diagram of dimension D6 (48×48mm)

Note 1： Linear voltage 0~5V or 1~5V input from 9+ and 10-

Note 2： 500mV or below input from 11+ and 10-

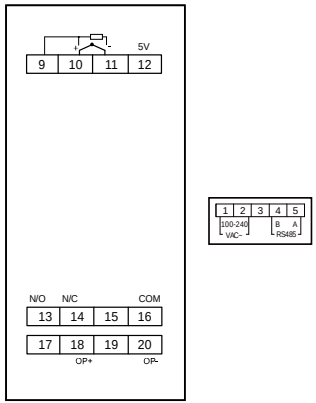
Note 3： External precise resistor 250ohm can be paralleled shunt to convert 4~20mA to 1~5V then input from 9+ and 10-

Note 4： In COMM/AUX slot, installing L3 dual relay module provides two alarms while installing SL module provides RS485 communication and one alarm.



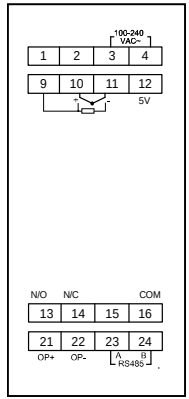
Wiring diagram of dimension D7 (22.5 x 100mm)

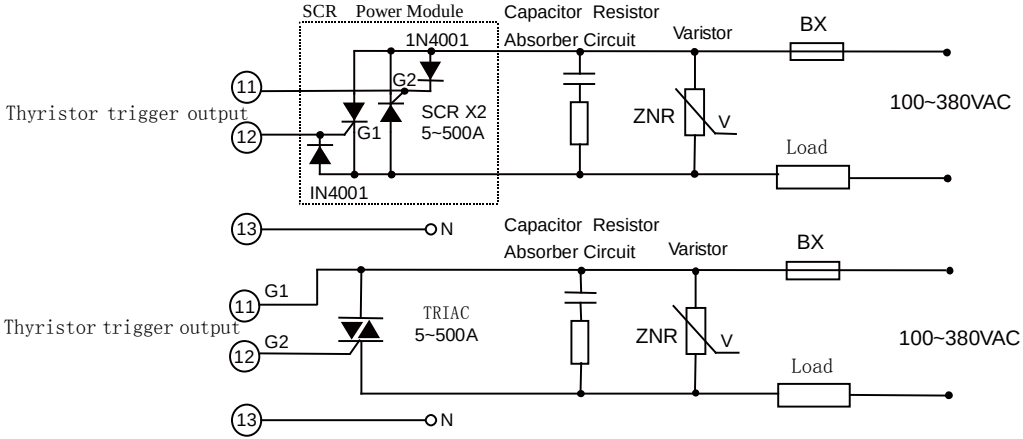
Note 1: Input
0~5V/1~5V input from 12+, 11-
500mV below input from 10+, 11-
4~20mA with 250ohm shunt resistor converted to 1~5V, input from 12+, 11-
Note 2: Fixed with one channel alarm and communication
Note 3: Main output can be selected among G, X3, L2, K1, K5, K6 or W1. Alarm is mandatorily defined as AU1
Note 4: Instrument power and communication wires are connected to the back side connectors along the rail.



Wiring diagram of E7 size instruments (22.5 x 100mm)

Note 1: Input
0~5V/1~5V input from 12+, 11-
500mV below input from 10+, 11-
4~20mA with 250ohm shunt resistor converted to 1~5V, input from 12+, 11-
Note 2: Fixed with one channel alarm and communication
Note 3: Main output can be selected among G, X3, L2, K1, K5, K6 or W1. Alarm is mandatorily defined as AU1





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.

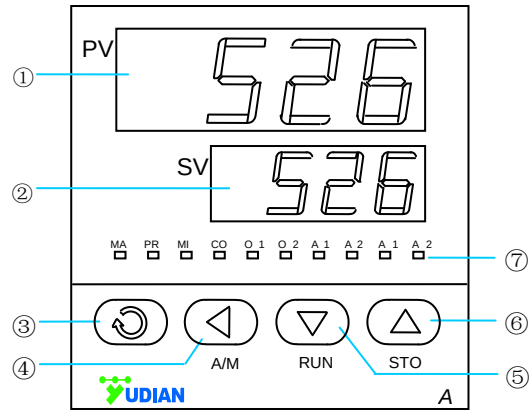
Note 2: SCR power module is recommended. A power module includes two SCRs, is similar to the above dashed square.

Note 3: K5 and K6 TRAIC trigger module only support 220～380VAC and 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 message
③ Setup key: For accessing parameter table and conforming parameter modification.
④ Data shift key(cursor pointer)
⑤ Data decrease key(RUN/HOLD button)
⑥ Data increase key (STOP button)
⑦ 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



Basic display status : When power is on, the upper display shows the process value (PV) and the lower display shows the set point (SV). At certain circumstances, the lower display blinks SV and the following status message. The symbol message.

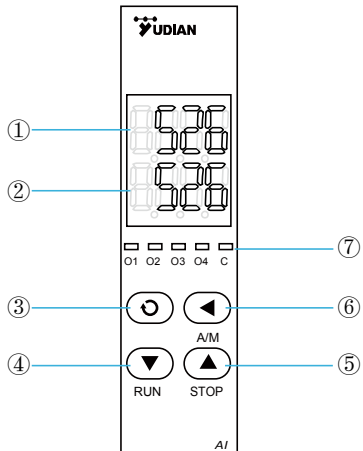
Symbol	Description
orAL	Input measurement value is out of range. The possible reasons are incorrect input specification, disconnected thermocouple or short circuited.
HIAL	High limit alarm
LoAL	Low limit alarm
HdAL	Deviation high alarm
LdAL	Deviation low alarm
StoP	Program is in stop status
Hold	Program is in hold status
rdy	Program is in ready status (Only available in AI-526P)

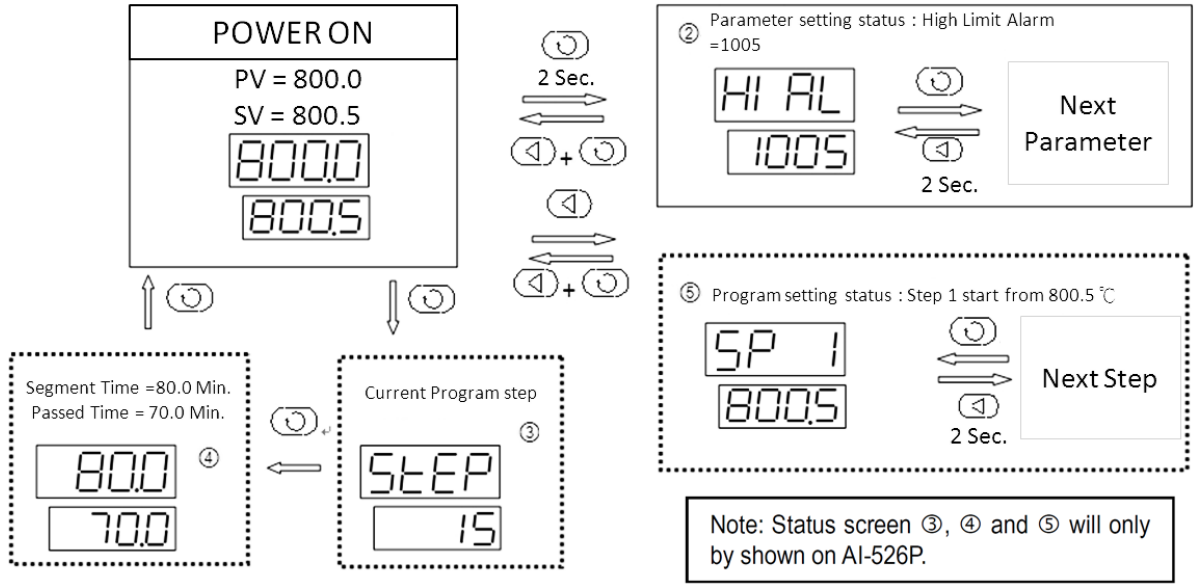
Note : The alarm message can be turned off by setting parameter AdIS to oFF.

2.2 D7/E7 Rail mount Panel Description

①Upper display window, displays PV, parameter code, etc.
②Lower display window, displays SV, parameter value, or alarm code.
③ Setup key, for accessing parameter table and conforming parameter modification.
④Data decrease key (RUN/HOLD button)
⑤Data increase key (STOP button)
⑥Data shift key (set point cursor)
⑦Five 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 basic display are the same as other panels which is explained in the previous section.




POWER ON
PV = 800.0
SV = 800.5
800.0
800.5
2 Sec.
② Parameter setting status : High Limit Alarm =1005
HI AL
1005
2 Sec.
Next Parameter
⑤ Program setting status : Step 1 start from 800.5 ℃
SP 1
800.5
2 Sec.
Next Step
Segment Time =80.0 Min.
Passed Time = 70.0 Min.
80.0
④
70.0
Current Program step
③
StEP
15
Note: Status screen ③, ④ and ⑤ will only by shown on AI-526P.

2.4 Operation Description

2.4.1 Parameter Setting

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

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

2.4.2 Short-cut operation

All function in AI-526/526P 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 point editing: Press ◁ to start to edit set point. Then press ◁ , ▽ or △ to adjust SV value.

Program segment setting (AI-526P only): Press ◁ once to enter program setting status. The set point of the current program StEP will be displayed. Press ⟲ to go to the next parameter and value. Every StEP is based on the sequence in “setpoint1- time1-setpoint2- time2, etc”. Program StEP can modify anytime even the program still

in running.

RUN the program: Press and hold ▽ key for about 2 seconds until the lower display window displays the "run" message. AI-526P will start the program from STOP status. If parameter “PAF.F =1” and program status is RUN, this operation will HOLD the program. The timer will be paused. Perform RUN operation again will resume the program.

STOP the program: Press and hold △ key for about 2 seconds until the lower display window displays the "StOP" message. The instrument output will be stopped. AI-526P will stop the program and restore the current StEP number to 1.

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 the instrument is at the limit of increasing rate, auto-tuning will be paused temporary.) 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 ◁ key for about 2 seconds until the "At" parameter appear again. Change “At” from “on” to “oFF”, press ↺ to confirm, then the auto tuning process will be cancelled. If the instrument is running the program, the program timer will be paused to avoid changing SV. If the controller was applied on heat/cooling dual output system, those two set of PID parameters are required to be calculated separately. When the controller was performing cooling control from AUX, enable auto tuning to obtain P2, I2, d2

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

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

Note 3: Parameter CHYS (on-off differential, control hysteresis) 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: AI series instrument has the function of self-adaptation. It will learn and refine the configuration. The outcome from at the first run after auto-tuning may not be perfect but it will come to the best after a period of usage.

3.PARAMETERS AND SETTINGS

3.1 Parameter Lock (Loc) and Field Parameters

The parameters table can be customized. Those parameters required to be edited are grouped as “Field Parameter”. Field Parameter is a sub-table from the full parameter table. This sub-table can be defined by user. Access to full parameter table requires a password. Parameter lock (Loc) provides different operation privilege and access control to the parameter table. The explanation of Loc function was shown as below:

√ : Allowed to modify data or execute

X :Not allowed to modify data or execute

Loc	SV Set Point	AT Auto-tune	Field Parameter	Full Parameter	Short-cut (Program RUN/HOLD/STOP)	Program Step Time & Temp.
0	√	√	√	X	√	√
1	√	X	√	X	X	√
2	X	X	√	X	√	X
3	X	X	√	X	X	X
4~255	X	X	X	X	X	X
808	√	√	√	√	√	√

Loc 808 is the master password, this valve can be change by parameter PASd. **Please set PASd cautiously, if the password lost,**

There are 8 field parameters can be defined by as EP1~EP8. If the quantity 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 follows: EP1=HIAL, EP2=HdAL, EP3=At, EP4=nonE.

3.2 The Parameter Table

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

Code	Name	Description	Setting Range
HIAL	High limit alarm	Alarm turns on when PV>HIAL Alarm turns off when PV<HIAL-AHYS, Set to the maximum value to disable the alarm. 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. 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. 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 : No alarm message shown in the lower display even there is an alarm on : Alternately showing alarm message and value in the lower display when there is an alarm	oFF / on

<table>
<tr><td>AOP</td><td>Alarm output allocation</td><td>
<table>
<tr><th>Alarm / Output to</th><th>LdAL (x 1000)</th><th>HdAL (x100)</th><th>LoAL (x10)</th><th>HIAL (x1)</th></tr>
<tr><td>None</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>AL1</td><td>1</td><td>1</td><td>1</td><td>1</td></tr>
<tr><td>AL2</td><td>2</td><td>2</td><td>2</td><td>2</td></tr>
<tr><td>AU1</td><td>3</td><td>3</td><td>3</td><td>3</td></tr>
<tr><td>AU2</td><td>4</td><td>4</td><td>4</td><td>4</td></tr>
</table>
Example:
AOP = 3 3 0 1
LdAL HdAL LoAL HIAL
It shows that HdAL and LdAL are sent to AU1, LoAL has no output, HIAL is sent to AL1.
Note 1: When AUX is used as auxiliary output in bidirectional (heating/refrigerating) control, alarms assigned to AU1 and AU2 does not take in effect.
Note 2: Installing L3 dual relay output module in ALM or AUX, AL2 or AU2 can be used.
</td><td>0～4444</td></tr>
<tr><td>CtrL</td><td>Control mode</td><td>onoF: on-off control, for situation not requiring high precision
APId: advanced artificial intelligence PID control. (Recommended)
nPId: standard PID algorithm with anti integral-saturation function (no integral when PV-SV > proportional band)
POP: Direct PV retransmission, working as a temperature re-transmitter.
SOP: Direct SV retransmission, working as a program generator (AI-526P).</td><td>onoF
APId
nPId
POP
SOP</td></tr>
</table>

Srun	Running Status	run: Control or program is in effect. “PRG” indicator lights up. StoP: Control or program is stopped. Lower display keeps flashing “StoP”. “PRG” indicator goes off. HoLd: Control or program is paused. If the controller is a constant temperature controller without time limit, (AI-526 or AI-526P with parameter Pno=0), this HoLd status is equal to normal status but panel shortcut to RUN or STOP operation is prohibited. in this status, for the controller works as program control (Pno>0), the output keeps going but the program timer is paused. At the same time, lower display flashes “HoLd” and PRG blinks. Panel shortcut to RUN or STOP is allowed to change this status. Remark: Using panel shortcut key is unable to activate HoLd status but only through changing Srun parameter or programmed in the program steps.	StoP / run / HoLd
Act	Acting method	rE: Reverse acting. Increase in measured variable causes a decrease in the output, such as heating control. dr: Direct acting. Increase in measured variable causes an increase in the output, such as refrigerating control. rEbA: Reverse acting with low limit alarm and deviation low alarm blocking at the beginning of power on. drbA: Direct acting with high limit alarm and deviation high alarm blocking at the beginning of power on.	rE dr rEbA drbA
At	Auto tuning	oFF: Auto tuning function was off. on: Active auto turning function to calculate the values FoFF : Auto tuning function was off, cannot activate again by pressing key from panel .	oFF / On / FoFF

P	Proportional band	Proportional band in PID and APID control. Instead of percentage of the measurement range, the unit is the same as PV. Generally, optimal P, I, D and CtI can obtained by auto tuning. Those values can be manually entered if they are known already.	1~32000 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, 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 suit for compressor protection.	0.2～300.0 Sec

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

InP	Input specification Code	**InP**	**Input spec.**	**InP**	**Input spec.**	0～37
		0	K	**20**	Cu50	
		1	S	**21**	Pt100	
		2	R	**22**	Pt100 (-80～+300.00℃)	
		3	T	**25**	0~75mV voltage input	
		4	E	**26**	0～80ohm resistor input	
		5	J	**27**	0～400ohm resistor input	
		6	B	**28**	0～20mV voltage input	
		7	N	**29**	0～100mV voltage input	
		8	WRe3-WRe25	**30**	0～60mV voltage input	
		9	WRe3-Wre26	**31**	0～500mV voltage input	
		10	Extended input specification*	**32**	100～500mV voltage input	
		12	F2 radiation type pyromter	**33**	1～5V voltage input	
		15	4～20mA (installed I4 module in MIO)	**34**	0～5V voltage input	
		16	0～20mA (installed I4 module in MIO)	**35**	0～10V	
		17	K (0～300.00℃)	**36**	2～10V	
		18	J (0～300.00℃)	**37**	0～20V	
		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 1: For thermocouples or RTD input, only 0 or 0.0 is selectable, and the internal resolution is 0.1. When S type thermocouple is used, dPt is recommended to be 0. If Inp= 17,18 or 22, resolution will support display 0.0 or 0.00	0 / 0.0 / 0.00 / 0.000
ScL	Signal scale low limit	Define scale low limit of input. It is also the low limit of transmitter output (CtrL=POP or SOP) and light bar display.	-9990～ +32000 units
ScH	Signal scale high limit	Define scale high limit of input. It is also the high limit of retransmission output (CtrL=POP or SOP) and light bar display.	
Scb	Input Shift Adjustment	Scb is used to shift input to compensate the error caused by transducer, input signal, or auto cold junction compensation of thermocouple. PV after compensation=PV before compensation + Scb It is generally set to 0. The incorrect setting will cause measurement inaccurate.	-1999～ +4000 units
FILt	PV input filter	The value of FILt will determine the ability of filtering noise. When a large value is set, the measurement input is stabilized but the response speed is slow. If high interference exists, you can increase parameter “FILt” gradually to make momentary fluctuation of measured value less than 2 to 5 digits. When the instrument is being metrological verified, FILt can be set as 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**: 50Hz,display ℃. , **50F**: 50Hz, display ℉ **60C**: 60Hz,display ℃. , **60F**: 60Hz, display ℉. Input has max. anti-interference ability to 50Hz or 60Hz frequency when parameter set;	50C, 50F, 60C, 60F
OPt	Main output type	SSr: Output SSr drive voltage or thyristor zero crossing trigger signal. G, K1 or K3 module should be installed. The output power can be adjusted by the on-off time proportion. The period (CtI) is generally 0.5～4 seconds. rELy: for relay contact output or for execution system with mechanical contact switch. To protect the mechanical switch, the output period (CtI) is limited to 3～120 seconds, and generally is 1/5 to 1/10 of derivative time. 0-20: 0～20mA linear current output. X3 or X5 module should be installed in OUTP slot. 4-20: 4～20mA linear current output. X3 or X5 module should be installed in OUTP slot. (Not applicable for heating/refrigerating bidirectional control.) PHA: Single-phase phase-shift output. K5 module should be installed in OUTP slot. PHA is only for 50Hz power supply. Under PHA mode, AUX is not available as cooling output.	SSr rELy 0-20 4-20 PHA

Aut	Auxiliary output type	Define AUX only when AUX is worked as the auxiliary output of a heating/refrigerating bidirectional systerm. SSr: to output SSr driver voltage or thyristor zero crossing trigger signal. G or K1 module should be installed. The output power can be adjusted by adjusting the on-off time proportion. The period (CtI) is generally 0.5～4 seconds. rELy: for relay contact output or for execution system with mechanical contact switch. To protect the mechanical switch, the output period (CtI) is limited to 3～120 seconds, and generally is 1/5 to 1/10 of derivative time. 0-20: 0～20mA linear current output. X3 or X5 module should be installed in AUX slot. 4-20: 4～20mA linear current output. X3 or X5 module should be installed in AUX slot. (Not applicable for heating/refrigerating bidirectional control.) Note: In a heating/refrigerating bidirectional control system, if any of OPt or Aut is set to rELy, then CtI is limited to 3～120.	SSr rELy 0-20 4-20

OPL	Output low limit	0～100%: OPL is the minimum output of OUTP in single directional control system. -1～-110%: The instrument works for a bidirectional system, and has heating/refrigerating dual output. When ACt=rE or rEbA, OUTP (main output) works for heating, and AUX (Auxiliary output) works for refrigerating. When Act=dr or drbA, OUTP works for refrigerating, and AUX works for heating. In a bidirectional system, OPL for define the limitation of maximum cooling output. So, when the OPL= -100%, means no limitation on cooling output. If set OPL=-110%, it can made current output excess 10% on maximum output. When the output type is SSR output or relay output, maximum of cooling output should not set more than 100%	-110～ +110%
OPH	Output upper limit	OPL limits the maximum of OUTP (main output) when PV<OEF. OPH should be greater than OPL.	0～110%
OEF	Work range of OPH	When PV<OEF, the upper limit of OUTP is OPH; when PV>OEF, the upper limit of OUTP is 100%. For example, to avoid that the temperature raises too quickly, under 150 heater can work only under 30% of power, then we can set OEF=150.0 (OPH=30 (%)	-999～ +3200
Addr	Communication address	In the same communication line, different instrument should be set to different address.	0～80

bAud	Baud rate	The range of baud rate is 1200～19200bit/s. When COMM/AUX slot is used as AUX, bAud should be set to 0. By setting bAud = 1, COMM slot replaces MIO slot as external event input.	0～19.2K
Et	Event input type	When I2 module is installed, the following event input can be executed: **nonE**: Disable event input function **ruSt**: RUN/STOP switch. With MIO is short-connected in a short moment, RUN mode is activated. By MIO is shorted for more than 2 seconds, the program STOP.. **SP1.2**: During fixed point control (Pno=0 in AI-526P), this switches between set point 1 and set point 2. When MIO is open, SV=SP1. When MIO is closed, SV=SP2. **PId2**: During single action control (Not heating/cooling bi-directional control), switching 1st PID and 2nd PID. When MIO is open, P, I, d and Ctl are taken in use for automatic control. When MIO is closed, P2, I2, d2 and Ctl2 are taken in use. **EAct**: External switching heating/cooling. When MIO is open, P, I, d and Ctl are used for heating regulation. When MIO is closed, P2, I2, d2 and Ctl2 are used for cooling regulation. The output is at OUTP slot. **Act** value will be adjusted together with the status of MIO. **Erun**: External switching RUN/STOP. When MIO is open, the instrument STOP. When MIO is closed, the instrument RUN.	nonE / rest / SP1.2 / PId2 / EAct / Erun

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

PASd	Password	When PASd=0～255 or AF.D=0, set Loc=808 can enter the whole parameter table. When PASd=256～9999 and AF.D=1, only Loc=PASd can access the whole parameter table. **Please setting PASd cautiously, if the password is lost, you can't access the parameter table again.**	0～9999
SPL	Low limit of SV	Minimum value that SV is allowed to be.	-999～ +3000 unit
SPH	Upper limit of SV	Maximum value that SV is allowed to be.	
SP1	SetPoint 1	When Pno=0 or 1, SV=SP1 (AI-526 or AI-526P with Pno=0 or Pno=1)	SPL～SPH
SP2	SetPoint 2	When I2 module installed in MIO slot and parameter Et=SP1.2, an external switch can switches the SV between SP1 and SP2. When MIO is open, SV=SP1. When MIO is closed, SV=SP2. (AI-526 or AI-526P with Pno=0 or Pno=1)	
SPr	Ramp Slope limit (Only for AI-526P)	Provided that SPr is set, the program start with the first step of ramp slope limited by SPr value until the temperature reach the first SV, if PV<SV. PRG indicator blinks. For Ramp mode. SPr had effect on first step only. For Soak mode, SPr had effect on each step.	0~3200℃ /minute

Pno	No. of Program step (Only for AI-526P)	To define the quantity of program step to be used and hide the unnecessary ones for ease of configuration and operation. **Pno= 0,** disable the program running mode, then AI-526P will same as AI-526, meanwhile, can set the parameter “SPr” to limit the ramp time. **Pno**=**1~30**, AI-526P working as normal programmable controller	0~30
PonP	Program run mode after power restart (Only for AI-526P)	**Cont :** Continue to run the program from the original break point. If STOP status is activated before power cut, then the program will keep at STOP status after power restarts. **StoP** : Stop the program after power restart **run1** : Start to run the program from step 1 unless the instrument was in “STOP” status before power cut. **dASt** : Continue to run the program from the original break point. If there are any deviation alarm, it will stop the program **HoLd** (AI-526P only): No matter any circumstances, the instrument goese to HoLd status after power resumes. If it is in StoP status before power cut, it will keep in StoP status after power resumes.	Cont / StoP / run1 / dASt / HoLd

PAF	Program Running mode (Only for AI-526P)	PAF = Ax1 + Bx2 + Cx4 + Dx8 + Ex16 + Fx32 When A=0: Enable ready (rdy) function A=1: Disenable ready (rdy) function B=0: Ramp mode. During the program is running and there is temperature difference in SV, the temperature points migrates as a line graph. Various heating mode can be defines, as well as cooling mode. B=1: Soak mode (Constant temperature mode). Each program step defines the set point and soaking time. The rate of increase in temperature can be limited by SPr. Reaching next step is limited by rdy. On the other hand, even B=0, if the last step in the program is not a command for ending, it will go to soak mode. The program stops when the time is up. C=0: Time unit in minute. C=1: Time unit in hour. D=0: Disable PV start up function. D=1: Enable PV start up function. E=0: When the instrument works as a program generator, upper display shows measured value PV. E=1: When the instrument works as a program generator, upper display shows the current step number within the program. F=0: Standard RUN mode F=1: Activate RUN shortcut will enter Hold status when the program is running	

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

3.3 Additional Explanation on Special Functions

3.3.1 Single-phase phase-shift trigger output

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

If an I2 module is installed in MIO slot (or bAud=1 and I2 installed in COMM slot), connecting an external switch can execute control function. Setting Et=ruSt, press the button to run (RUN) while press and hold the button over 2 seconds to stop (STOP). For AI-526 (AI526P with Pno=0) with Et=SP1.2, it can switch between SP1/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. AI instruments 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. If large quantity of instrument is required, 2 or above computers can be used with a local network formed. Please note that every instrument connecting to the same communication line should be set to a unique communication address.

AIDCS application software, a distributed control system software developed by Yudian, can control and manage 1~200 AI instruments, record the data, generate and print reports. If users want to develop their own distributed control system by themselves, the communication protocol of AI instruments can be free offered. There are many famous distributed control system software support AI instruments.

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

Besides AI PID, stand PID control and on-off control, if the output is defined as current output, the instrument can also retransmit PV (process value) or SV (setpoint) into linear current and output from OUTP. The precision of current output is 0.2%FS. Base on that ability, AI-526 can become temperature re-transmitter and AI-526P can become program generator

The corresponding parameters are set as below:

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

When CtrL=SOP, SV is transmitted and outputted, and the instrument works as manual current output controller(AI-526) or program generator(AI-526P) .

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

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

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

4. Program Control (AI-526P Only)

AI-526P program temperature controller is used in the application where the set point to be changed automatically with the time. It provides 30 segments program control which can be set in any slope and the function of jump, run, hold and stop can also be set in the program. Measurement startup function, preparation function and power-cut/power-resume event handling modes also provided.

4.1 Functions and Concepts

StEP:
The number of the program Step can be defined from 1 to 30. The current Step is the program Step being executing.

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

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

Jump:

The program can jump to any other steps in the range of 1 to 30 automatically as you programmed in the program Step, and realize cycle control.

Run/Hold:

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

Stop:

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

Power cut/resume event handling:

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

PV startup and PV preparation function (rdy function) :

At the beginning of starting a program, resuming a program after power cut or continuing to run a program after it is just modified, the PV (process value) are often quite different from the set point. PV startup function and PV preparation function can make PV and set point consistent, and avoid unexpected result. When PV startup function enabled, the instrument will adjust the running time automatically to make the expected set point is the same as the current PV.

For example, the program is set that the temperature will be raised from 25℃ to 625℃ in 600 minutes. But the current PV is 100℃, then the instrument will automatically to run this program start from 75 minutes, that mean changed the temperature raised from 100℃ to 625℃ in 525 minutes (600-75) min.
At the above situation(PV=100, SV=25, first step SV), when PV preparation function is enable, the alarm function will be blocked at that time, and PV will be adjusted to approach SV until the deviation alarm condition is released (PV is between SV-LdAL and SV+HdAL). After deviation alarm was off, the controller starts to run the program again. Preparation function (rdy Function) is helpful to keep the integrity of the program, but it will prolong the program time because the start of the program is postponed.
PV startup function is prior to PV preparation function. If both function are enabled, the system apply PV startup first, if PV startup function works, PV preparation function will not be activated.

Curve fitting:

Curve fitting is adopted as a kind of control technology for AI-526P series instrument. As controlled process often has lag time in system response, by the way of curve fitting the instrument will smooth the turning point of the linear heating-up, cooling-down and constant temperature curves automatically. The degree of the smooth is relevant with the system's lag time t (t=d+CtI) ; the longer of the lag time, the curve will more smooth. On the opposite the smooth function will be weaker. Generally the shorter of the process lag time (such as temperature inertia), the better of the program control on effect. By the way of the curve fitting to deal with the program curves, will avoid overshoot. Note: The characteristic of the curve fitting will force the program control to generate fixed negative deviation during the linear heating-up and fixed positive deviation during the linear cooling-down, the deviation is direct proportional to the lag time and the speed of heating-up (cooling-down). This phenomenon is normal.

4.2. Program Arrangement

4.2.1 Ramp Mode

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

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

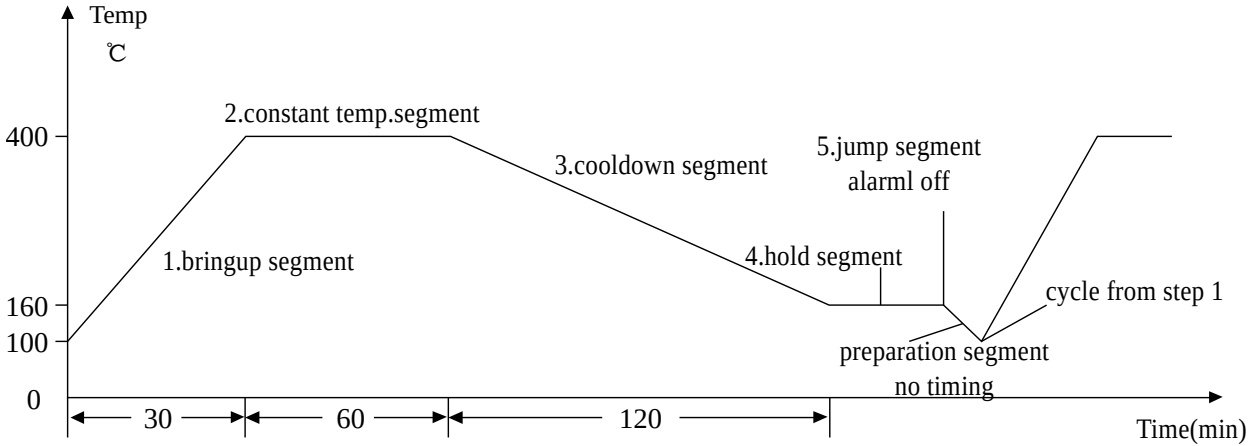
StEP2: **SP 2=400 , t 2=60.0** Temperature raised to 400℃, slope of raising curve is 10℃/minute, The program take 60 minutes to raise temperature to SP3 (400 degree). It means keep the same temperature in 60 minutes.

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

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

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

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


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

4.2.2 Soak Mode

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

4.2.3 Time setting

Set “t-xx” = 0.1～3200 (min)

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

Set “t-xx” = 0.0

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

Set “t-xx” = -121.0

The program stops, and switches to stop status.

Set “t-xx” = -0.1～-122.0

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

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

When set

-XXX.1, AL1 activate, AL2 release

-XXX.2, AL1 release, AL2 activate

-XXX.3, AL1 and AL2 activate

-XXX.4, AL1 and AL2 release

Example:

Example 1 : t -5 = -1.1 ; means when the program arrived step 5, AL1 activate, AL2 release and will jump to step 1 continues running

Example 2 : t-6 = -0.3 ; means when the program arrived step 6, AL1 and AL2 activate and continuous next step.

Note: The program will be held if it jump from a control segment to another control segment (an Hold action will be inserted between two control sections), external run/Hold operation is needed to release the Hold status. It is not allowed that the jump section jump to itself (for example: t -6= -6), otherwise, the Hold status cannot be released.

4.2.4 Set Point Setting

The range of Set Point can be bounded by SPL and SPH which is +999~+3200℃. It represents the temperature to be controlled (℃) or a linear unit.

4.2.5 Program arrangement of multi-curve operation

AI-526P has the advanced function of flexible program arrangement. Normally, when the program stops, the StEP will be automatically set to1. Thus if StEP is not change to other value, a program will start from step1. If multiple curves are defined, the control can jump to different curve by setting step 1 as jump segment.

For example: There are three curves with the length of 3 steps represent three groups of process parameter, they are separately arranged on StEP2-StEP4, StEP5-StEP7, StEP8-StEP10. Settings are as follows:

t- 1=-2.0 Execute the program of curve 1 (StEP2-StEP4)

t- 1=-5.0 Execute the program of curve 2 (StEP5-StEP7)

t- 1=-8.0 Execute the program of curve 3 (StEP8-StEP10)

Note: Can choose the curves by setting the value of StEP “t-1“ set to -2.0, -5.0 or -8.0 before the program startup.