UDIAN

AI-710JM

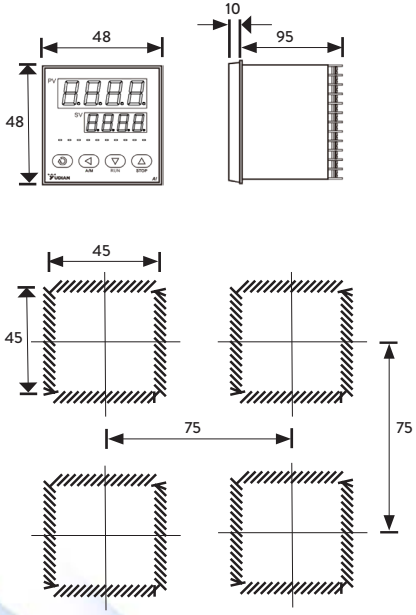
Artificial Intelligent Temperautre Controller / Industrial Regulator

INSTALLATION AND OPERATION MANUAL

Software Version 8.2
Revise Date: May 2020

1. INSTALLATION

Dimensions and cut-out; panel mounting



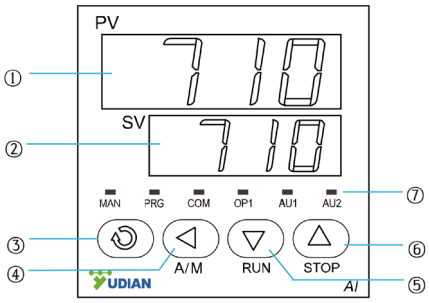
Panel Mounting:
Remove the square anchor from the instrument.
Insert the instrument from panel front.
To fasten the instrument, put the anchor back before wiring. The screws may be used for further tightening.

2. TECHNICAL SPECIFICATIONS

Display	2*4 digit LED, Red and Green
Keys	4 mechanical keys
Accuracy	0.1% full scale (FS)±1 digit
Input (adustable digital filter)	Pt100 Sampling time 80ms
Measurement Range	-100...+300°C
Cold Junction Error	0.05°C for each 1°C variation
Safety	Detection of opening of probe
Temperature Shift	≤35ppm/°C
Regulating Method	On/Off (adjustable hytersis) Artificial Intelligent Regulating with auto-tuning
Main Output	SSR Voltage output 12VDC/30mA (used to drive solid-state relay)
Action	Main output (OUTP) with direct (heating).
Configuration alarm	4 type of alarm, high limit, low limit, deviation high limit and deviation low limit compared to setpoint. Maximum 2 loops. Temporarily disable during first power on.
Power Supply	100~240VAC, -15%, +10% / 50~60Hz; 120~240VDC; or 24VDC/AC, -15%, +10%.
Power Consumption	≤0.5W (no output or alarm); ≤4W (Maximum)
Opearating and Storage Environment	Temperature -10~60°C Humidity ≤90%RH

3. DESCRIPTION OF FACEPLATE

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 Cursor shifting (or control operation)
5 Value down key
(or switch between RUN/HOLD)
6 Value uo key (or STOP)
These value down and up keys raise or lower the value of the displayed function. The raising (lowering) speed is proportional to the time the key is pushed. The procedure is not cyclical. When the maximum (minimum) of the setting range is reached with the key pushed, the raise (lower) function stops.
7 Six LED indicating lights:
MAN – Not used
PRG – Control is in action
COM - Communiction with host device in action
OP1 - Main output in action
AU1 - Alarm at AU1 on
AU2 - Alarm at AU2 on



4. CONNECTIONS

The connections may be varied due to firmware upgrade or tailor-made order. Please follow the connection diagram attached to the instrument.

Signal input

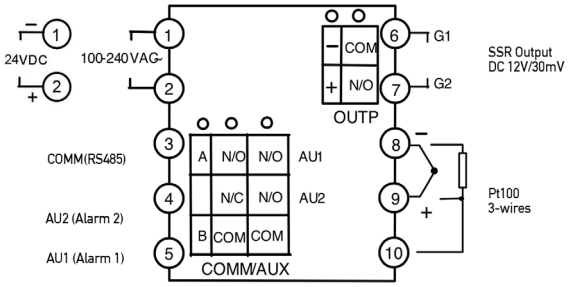
Input from TC is connected to 9 (positive) and 10 (negative).

Control Output

Solid-state relay (SSR) output of 12VDC/30mA is connected to 7 (positive) and 6 (negative).

Alarms

Alarm 1 (coded as AU1) is connected to 3 (NO) and 5 (common).
Alarm 2 (coded as AU2) is connected to 4 (NO) and 5 (common).



5. DISPLAY

Basic Display

When the instrument is powered, the upper display and lower display show the model number and firmware version respectively. After around 3 seconds, the displays show the process value (PV) and set value (SV) respectively. This basic display remains until there is a key pressed.

System Message

Following warning or status message may show up.

Symbol	Description
orAL	Out-of-range alarm due to incorrent input specification / Input wires disconnected / Broken thermocouple / Short-circuited input #
HIAL	High limit alarm*
LoAL	Low limit alarm*
HdAL	Deviation high alarm*
LdAL	Deviation low alarm*
EErr	Internal data lost. Factory repair required.
StoP	The instrument is in STOP status. No output is given out.

* The alarm messages can be turned off by setting parameter AdIS to oFF.
# When orAL appeared, the instrument will cut off the output after a while.

6. OPERATION

Parameter Setting

At the basic display, press ⊙ and hold for about 2 seconds to access **Field Parameter Table**. Press ⊙ to proceed to next parameter. Press ◀ , ▲ or ▼ to modify values. Press ▼ to decrease the value. Press ▲ to increase the value. There is a dot flashing while the value is changing just like a cursor. Hold the keys will speed up the value changing speed, as well as the flashing frequency of the cursor. Press ◀ to move the designated digit position. Press ⊙ to save and proceed to the next parameter. Hold ⊙ to scroll down the parameter table quickly. Press and hold ◀ more than 2 seconds goes back to the previous parameter. Press and hold ◀ (don't release) plus ⊙ simultaneously escape parameter setting back to **Basic Display**. The instrument will automatically escape to **Basic Display** if no key is pressed for 25 seconds but any change made to the last parameter will not be saved.

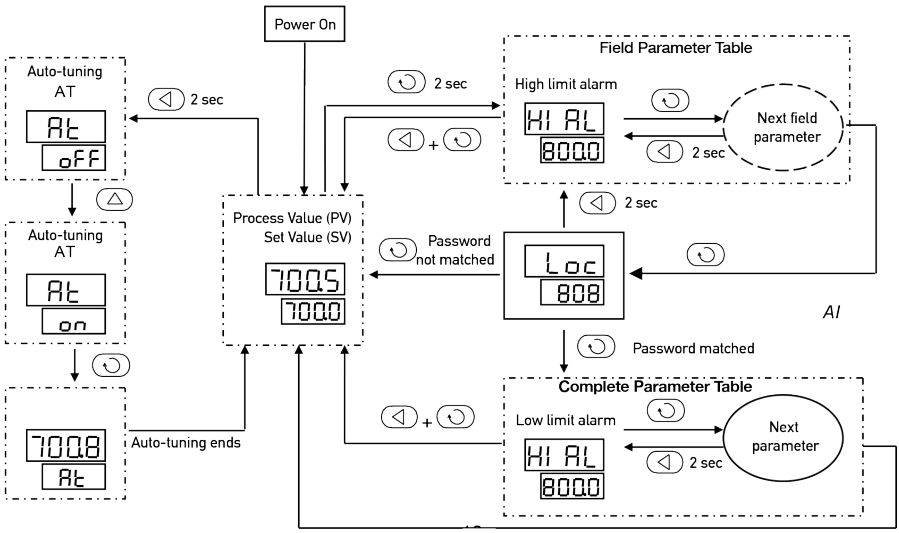
Short-cut Keys

Certain frequently used operations can be done by short-cut keys. Those keys can be disabled.
Changing SV: Press ◀ , ▲ or ▼ to change.
Auto-tuning (AT): Press ◀ and hold for about 2 seconds until "At" shows up. Press ▲ to toggle "oFF" to "on" in the lower display. Press ⊙ to start auto-tuning. The lower display will flash "At". After two oscillating cycles in "ON-OFF" control mode, PID parameters will be calculated. To quit auto-turning, perform the same operation by pressing ◀ for 2 seconds. Change "on" to "oFF" and press ⊙ to confirm to quit.

Note

1. Advanced artificial intelligent technology and PID regulating algorithm by AI-710JM, which is named as "APID" is able to overcome the overshoot issue by standard PID algorithm.
2. PID values vary from different system. Before activating the auto-tuning, set point value, SV, should be set at the commonly used value or mean value. Set the SV to a maximum one if the heat isolation of a furnace is good. SV value is not allowed to be changed during auto-tuning. The time required for this process may takes seconds to hours.
3. Control Hysteresis, CHYS, affects the result of auto-tuning too. Generally the least the CHYS, the higher is the PID auto-tuning accuracy. However low CHYS value may cause incorrect ON-OFF output during fluctuating input. CHYS=2.0 is recommended.
4. The PID values may not give the best performance immediately after the auto-tuning is finished. The performance will gradually improve over some time because there is a learning feature.
5. Regardless of auto-tuning or manual tuning, the control period, Ctl, will be limited not longer than 3 seconds, no matter what value it is set previously, to increase the accuracy and to provide better response time (manual tuning).

7. FLOWCHART



8. PARAMETER SETTING

Customization of Field Parameters

Field Parameter Table is a subset of the Complete Parameter Table. Maximum 8 Field Parameters can be extracted to access directly without entering the password (*PASd*) in parameter lock (*Loc*) to speed up operation workflow in the field.

If not all 8 field parameters are used, the first idle parameter is recommended to be "*nonE*".

Field Parameters	Default Setting *
EP1	*HI AL*
EP2	*LoAL*
EP3	*HdAL*
EP4	*LdAL*
EP5	*nonE*
EP6	*nonE*
EP7	*nonE*
EP8	*nonE*
Loc	*0*

Example: If fast access to high limit alarm, high deviation alarm and auto-tuning is needed, set *EP1=HIAL*, *EP2=HdAL*, *EP3=At*, *EP4...EP8=nonE*.

* The default settings may vary due to minor firmware version update or order request.

Master password is stored in *PASd*. By default, *PASd* =808. There is no password reset feature. If the password is lost, only firmware reload in factory can reset the password.

Loc defines different access levels of Field Parameters.

Loc	SV	*At*, Auto -tuning	Field Parameter Table	Complete Parameter Table	Short-cut (Program *run/ HoLd/ StoP*)
0	√	√	√	X	√
1	√	X	√	X	X
2	X	X	√	X	√
3	X	X	√	X	X
4...255	X	X	X	X	X
PASd	√	√	√	√	√

√: Allowed to modify or execute

X: Prohibited to modify or execute

Complete Parameters Table

The parameters is listed under 8 groups which is alarm, control, input, output, communication, system, set point and Field Parameters.

	Parameter	Parameter Ttile	Description	Range of Setting
ALARM	HI AL	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
	Adi S	Alarm Display	oFF: Hide alarm messages in the lower display on: Alternately display alarm message in the lower display [Recommended]	oFF / on
	AOP	Alarm Output Position	Assign alarm (HdAL/LdAL/LoAL/HiAL) to different module slot position (AL1/AL2/AU1/AU2) AOP Code: 0: Disabled; 1: AL1 (ALM slot) N/A N/A N/A N/A; 2: AL2 (ALM slot) N/A N/A N/A N/A; 3: AU1 (AUX slot); 4: AU2 (AUX slot)* Example: AOP=3303 HdAL and LdAL are sent to AU1. LoAL is disabled. HiAL is sent to AU1. L3 dual relay output module must be install in AUX slot to use AU2.	0~6666
	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)	onoF/ APId/ nPId
	Srun	Running Status	run: Control is in effect. “PRG” indicator lights up. StoP: Control is stopped. Lower display keeps flashing StoP. “PRG” indicator goes off. HoLd: Control is paused.	StoP / run / HoLd

	Parameter	Parameter Ttile	Description	Range of Setting
CONTROL	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: Autotuning function (At) is disabled. on: Activate auto-turning (automatically adjust P, I , d and CtI parameter). It will switch to oFF when auto-tuning is completed. FoFF : Auto-tuning function is disabled and prohibited to activate by short-cut key directly from panel .	oFF On FoFF
	P	Proportional Band	Proportional band in PID and APID control. Instead of taking the percentage of the measurement range, the unit is the same as PV. Generally, optimal P, I , d and CtI are calcuated by auto-tuning. These parameters can be manually entered if the system is known before such as the manufacturing process of heating machines.	1~32000 units
	I	Time of Integral	Defines the integral time, in unit of second. I =0 disables the effect of integration.	0~9999 seconds
	d	Time of Derivative	Defines the derivative time, in unit of 0.1 second. d=0 disables the effect of derivation.	0~999.9 seconds
	CtI	Control Period	For solid-state relay (SSR) output, it is generally set to 5 ~ 3.0 sec.	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
INPUT	InP	Input Specification Code	Select input specification. Inut is fixed in this instrument with corresponding range of measurement 22 : Pt100(-100~+300.00°C)	22
	dPt	Display Resolution	Four display formats (0, 0.0, 0.00, 0.000) are selectable. When inP=22, the internal resolution is 0.01°C. Display format 0.0 or 0.00 are available.	0.0 0.00
	SCL	Source Low Limit	Define scale low limit of input. .	-9990~ +32000 units
	SCH	Souce High Limit	Define scale high limit of input.	
	Scb	Source Bias	Scb is used to shift input to compensate the error caused by transducer, input signal. PV after compensation=PV before compensation + Scb It is generally set to 0. The incorrect setting will cause measurement inaccuracy.	-1999~ +4000 units
	FILt	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
OUTPUT	OPt	Main Output Type	SSr: Output SSR drive voltage. Module G should be installed. The output power can be adjusted by the on-off time proportion. The period (CtI) is generally 0.5~3.0 seconds.	SSr
	OPH	Output Upper Limit	OPH limits the maximum of OUTP (main output) when PV<OEF. The system automatically adjust OPH to 100% when PV>OEF.	0~110%
	OEF	Effective Range of OPH	When PV<OEF, the upper limit of OUTP is OPH; when PV>OEF, the upper limit of OUTP is 100%. Example: This applies to the scenario of low temperature and heating is not in full power, such as drying the furnace internal chamber or low rate of heating, Certain heating elements are allowed to use up to 30% heating power below 150°C, set OEF=150.0, OPH=30 (%)	-999~ +3200

	Parameter	Parameter Ttile	Description	Range of Setting
COMMUNICATION	Addr	Communication address	In the same communication line, different instrument should be set to different address.	0~80
	bAud	Baud rate	Define baud rate within 1200~19,200bit/s	0~19.2K
SYSTEM	AF	Advanced function	AF is used to select advanced function. The value of AF is calculated as below: AF=A x 1 + B x 2 + C x 4 + D x 8 + E x 16 + F x 32 + G x 64 + H x 128 A=0*: HdAL and LdAL work as deviation high and low limit alarms; A=1: HdAL and LdAL work as high and low limit alarms, and the instrument can have two groups of high and low limit alarms. B=0: Alarm and control hysteresis work as unilateral hysteresis; B=1: As bilateral hysteresis. C=0: The light bar indicates the output value; C=1: The light bar indicates the process value (for instruments with light bar only); D=0: The common password “808” can access full parameter table; D=1: The password to access parameter table will be “PASd” value; E=0: Normal application on HIAL and LoAL; E=1: HIAL and LoAL changed to deviation high alarm and deviation low alarm; F=0: Fine control mode. The internal control resolution is 10 times as much as that of display, but the maximum display value during linear input is 3,200 units; F=1: Wide range display mode which is selected when the required display value is larger than 3,200; G=0: When the sensor is broken, PV value will increase and trigger the high limit alarm. (High limit alarm should be set below the input scale high limit.) G=1, When the sensor is broken, PV value will increase and NOT trigger the high limit alarm. Pleaes note that High Limit Alarm will delay for 30 seconds when this feature is activated. H=0, AIBUS communication H=1, MODBUS compatible communication. *AF=0 is recommended.	0~255
	PASd	Password	When PASd=0~255 OR AF.D=0, setting Loc=808 will enter this complete parameter table. When PASd=256~9999 AND AF.D=1, only Loc=PASd can access this complete parameter table. Pay attention to configure PASd. If the password is lost, there is no way to access the parameter table again until it is sent to factory reset.	0~9999
SET POINT	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.	
FIELD PARAMETER	EP1	Customized Field Parameter	Field Parameters 1~8 can be configured for commonly used parameters without entering lock password. Set nonE to hide the particular EP parameter.	HIAL (Default)
	EP2			LoAL (Default)
	EP3			HdAL (Default)
	EP4			LdAL (Default)
	EP5			nonE (Default)
	EP6			nonE (Default)
	EP7			nonE (Default)
	EP8			nonE (Default)

9. Advance Function

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.

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 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 up to 160 instruments. Please note that every instrument connecting to the same communication line should be set to a unique communication address. If the number of instrument are enough, 2 or more computers can be used and a local network can be set up.

If users want to develop their own distributed control system by themselves, the communication protocol of AI instruments can be freely offered. There are many distributed control system software support AI instruments.

Fine control

Fine control means that the PID operating resolution is ten times as high as the display resolution. For example, the temperature signal of the instrument displays 1°C, but the internal PID still operate and control as per 0.1°C resolution, thus can realize the control accuracy much higher than the display resolution. In former AI series instruments, only temperature signal adopts fine control mode. The new edition approves default fine control mode when the displayed value range is below 3,000 characters (on most of industrial application occasions, the value should not exceed 3,000 characters) during linear input, so as to get higher control accuracy and more stable output. When the required display value range is larger than 3,000, AF.F=1.

User-defined input specifications

When INP is set to 64 larger than preset value, the input specification of the instrument switches to user-defined input. Set INP=22+64=86. The linear table can be edited, the setup method is as follows: set Loc parameter as 3698, and then enter the table setup status (if the original Loc=808, the Loc shall be zeroed, exit the parameter setting status, and then reenter the parameter setting status and set Loc as 3698). Of which the parameter A 00 defines the use of the table, 0 is used to input non-linear measuring, 1 is used to high temperature furnace non-linear control, with parameters of A01~A04 and d00~d60 respectively set as follows:

A 00=0 (fixed)

A 01 defines input specfication

Formula: **A 01=A*1+E*16+G×*64**

A is the range of measurement:

A=0: 0~20mV (0-80Ω);

A=1: 0~60mV (0-240Ω);

A=2: 0~100mV (0-400Ω);

A=3: 0~1V;

A=4: 0~5V,

A=10, 0~20mA or 0~10V (MIO position installed with I4 or I31 module)

E=0: Output value still should be determined as per ScH/ScL parameters during linear input of signals.

E=1: The table output value is the displayed value.

G is the type of sensor.

G=0: thermocouple;

G=1: thermal resistance;

G=2: linear voltage (current);

G=3: linear resistance

For instance: Pt100 input; range 30~40°C; every adjustment section at one degree

Long press Setup. Set InP=86. Set dPt=0.0.

LOC=3698 (Enter user-defined multi-section adjustment)

A00 = 0

A01 = 82 (Function setup. Set Pt100 configuration 82)

A02 = 300.0 (Initial temperature at 30°C)

A03 = 100.0

A04 = 10.0

d00 = 30.00	d01 = 31.00	d02 = 32.00
d03 = 33.00	d04 = 34.00	d05 = 35.00
d06 = 36.00	d07 = 37.00	d08 = 38.00
d09 = 39.00	d10 = 40.00	

Set the deivation directly to the particular temperature. If it is showing 37oC but it is found higher, set d07 a little bit lower than 37.00.

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