
AI-SERIES MULTI-CHANNEL PID TEMPERATURE CONTROLLER

AI-7028 / AI-7048

Operation Instruction

Ver. 7.8



1. SUMMARY

Multi-channel temperature controller provides thermocouple inputs and solid-state SSR outputs. Each channel can be set as different type of inputs and works independently. This controller can either used independently or used with computer or PLC (Programmable Logic Controller). The supply power can be ordered as 24VDC/AC or 100~240VAC. It complies with ISO9001 quality assurance. It is highly reliable with EMC standard compatible. The power and all I/O terminals has passed 4KV/5KHz EFT test. It is able to be stably working under strong interference. By adopting YUDIAN's new technology, the anti-interference power of multi-channel inputs is as strong as that of single channel measurement.

- Providing up to 4 channels of programmable inputs, supporting multiple thermocouple inputs, K, S, E, J, B, N, T, WRe5-WRe25 and etc, with automatic cold junction compensation and linear voltage (mV) inputs with user defined scale. Individual digital filtering for each channel are possible to be adjusted or disabled.
- High performance hardware design, which greatly decreased temperature drift and the interference among the 4 channels. Therefore, this multi-channel controller obtains the same measurement accuracy and anti-interference ability as that of single channel controller.
- Rail mounted panel with code D5/E5/D7/E7 are available. Those panels without display can be programmed by connecting the external handset display E8.
- Apart from rail mounted panel D5, every channel has independent high/low limit alarm or deviation alarm outputs. Those alarms can be assigned to different alarm output slot (AL1 or AL2) by programming. Alarms from different channels can be assigned to the same alarm slot or different alarm slots.
- There are 12 programmable Field Parameters. Users can tailor-made the parameter table.
- Advanced communication functions, compatible with the communication protocol of other AI series instruments such as AI-708 high precision artificial intelligent regulator/temperature controller. One unit of AI-7048 in communication works as if there are 4 individual units of AI-708 controllers working.
- Among this multi-channel controller series, AI-70482 provides 4 channels of individual inputs with weak electronic signal isolation among channels. It is suitable for application of grounded thermocouples of which the negative pole of thermocouple is connected to the probe shell.

- AI-7048 is fully compatible to AI-7028. AI-7028 is a 2 channel individual controller. The wire connection method is taken reference to the first 2 channel of AI-7048.

2. Technical Specification

- **Input type:**

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

Linear voltage: 0~20mV, 0~60mV, 0~100mV, 0~1V, etc.

- **Instrument Input range**

K(-50~+1300°C), S(-50~+1700 °C), R(-50~+1700°C), T(-200~+350°C), E(0~+800°C),

J(0~+1000°C), B(+200~+1800°C), N(0~+1300°C), WRe3-WRe25(0~+2300°C),

WRe5-WRe26(0~+2300°C), Pt100(-200~+800°C)

Linear mV Input: Range defined by SCH and SCL parameters.

- **Measurement accuracy** : $\pm 0.2\%FS \pm 0.1^\circ C$

Note 1: For thermocouple input with internal compensation, cold junction compensation error up to 1°C should be considered.

Note 2: Type-B thermocouple can reach the stated measurement accuracy only at the range of 600~1800°C.

- **Temperature shift** : $\leq 0.01\%FS / ^\circ C$ (typical value is 60ppm/°C)

- **Electromagnetic compatibility (EMC)** : $\pm 4KV/5KHz$ according to IEC61000-4-4;

4KV according to IEC61000-4-5.

- **Isolation withstanding voltage** : Between power, relay contact or signal terminal $\geq 2300VDC$;
Between SSR voltage output and thermocouple input $\geq 600VDC$

- **Control period** : 0.48 sec / 4 channels

- **Output** : SSR driving voltage, 12VDC/20mA each channel with short-circuit protection

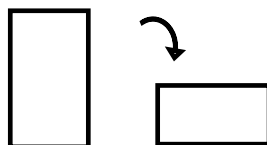
- **Power Supply**: 100~240VAC/ 50Hz or 24VAC/DC +10%, -15%; 5VA.

- **Operating Ambient**: Temperature -10~60°C; humidity $\leq 90\%RH$

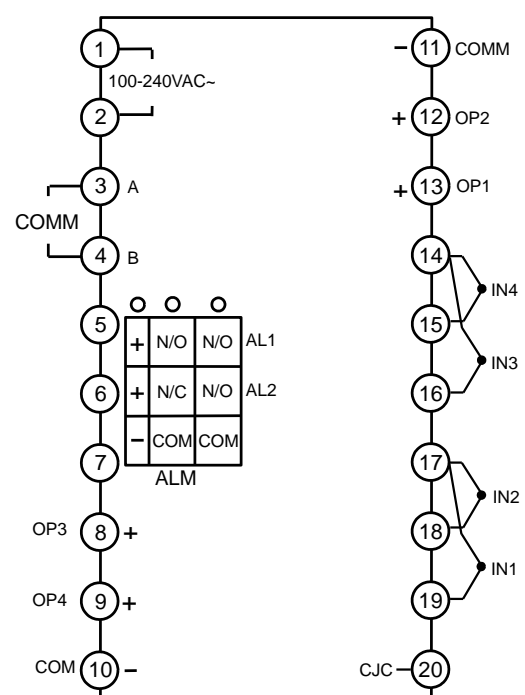
3. Rear Terminal Layout and Wiring

Wiring diagram of AI-7028/7048 multi-channel temperature controller

This wiring diagram is valid for panel size code A, C, E, E5 or etc.

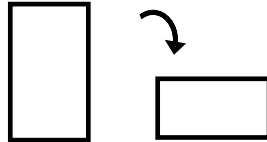


For instruments with dimension B and F, the diagram is clock-wisely rotated by 90°. The terminal numbers keep unchanged.

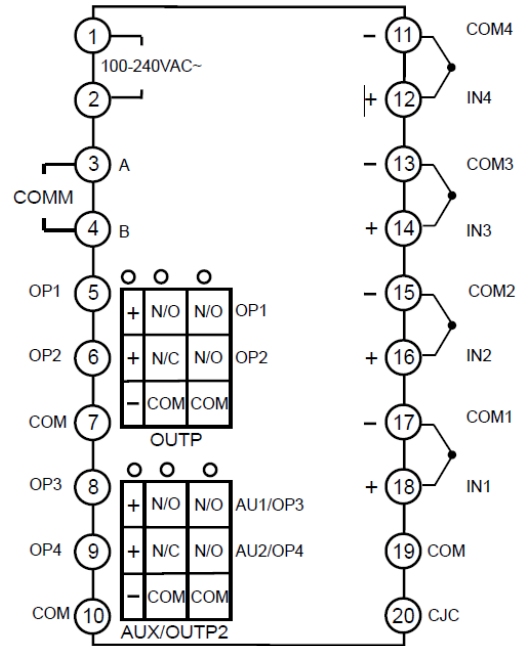


Wiring diagram of AI-70482 multi-channel temperature controller

This wiring diagram is valid for panel size code A, C, E, E5 or etc.



For instruments with dimension B and F, the diagram is clock-wisely rotated by 90°. The terminal numbers keep unchanged.



Wiring diagram and explanation of indicating lights of D5 panel

MODE: Status of communication and alarm

OP1~OP4: Output of channel 1~4.

Terminal 1~2: Power 100~240VAC or 24VAC/DC

Terminal 9~12: Positive poles of 4 thermocouple inputs

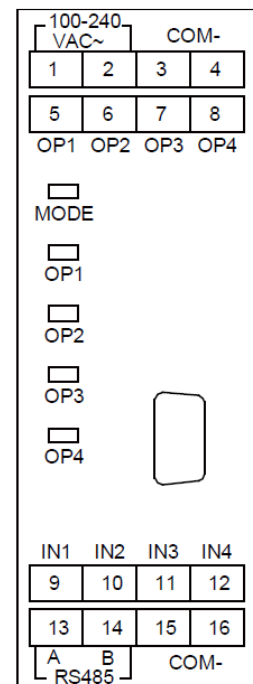
Terminal 15~16: Negative poles of 4 thermocouple inputs in common.

Terminal 5~8: Positive poles of 4 SSR voltage outputs

Terminal 3~4: Negative poles of 4 SSR voltage outputs in common. The specification of SSR outputs is 12~16VDC/20mA with short-circuit protection.

Terminal 13~14: RS485 communication.

No alarm output is available in this D5 panel.



D7 multi-channel temperature controller

Wiring diagram

Power Base Terminals

Terminal 1~2: Power 100~240VAC or 24VAC/DC

Terminal 4~5: RS485 communication.

Instrument Terminals

Terminal 5~8: Positive poles of 4 SSR voltage outputs

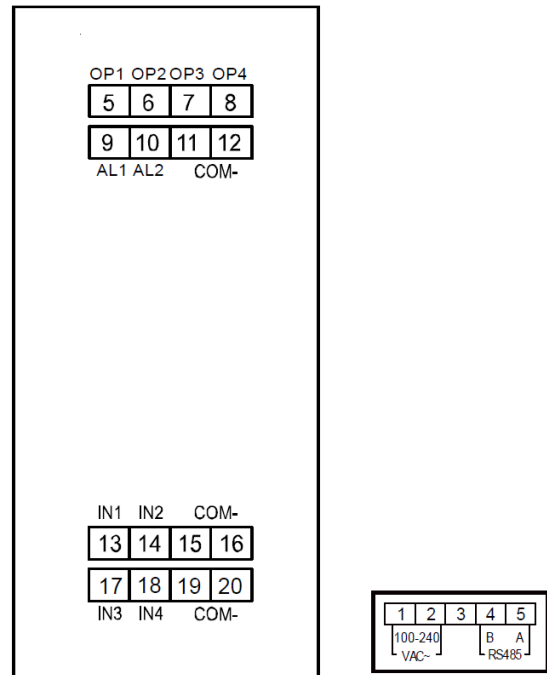
Terminal 9~10: Positive poles of AL1 and AL2 SSR alarm outputs.

Terminal 11~12: Negative poles of AL1 and AL2 SSR alarm outputs.

The specification of SSR outputs is 12~16VDC/20mA with short-circuit protection.

Terminal 13,14,17,18: Positive poles of 4 thermocouple inputs

Terminal 15,16,19,20: Negative poles of 4 thermocouple inputs



E7 multi-channel temperature controller

Wiring diagram

Terminal 3~4: Power 100~240VAC or 24VAC/DC

Terminal 5~8: Positive poles of 4 SSR voltage outputs

Terminal 9~10: Positive poles of AL1 and AL2 SSR alarm outputs.

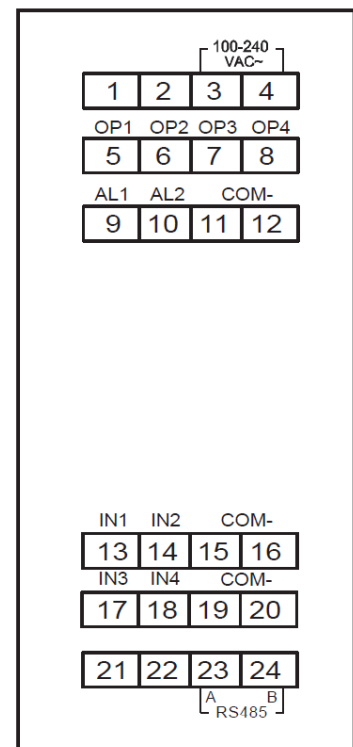
Terminal 11~12: Negative poles of AL1 and AL2 SSR alarm outputs.

The specification of SSR outputs is 12~16VDC/20mA with short-circuit protection.

Terminal 13,14,17,18: Positive poles of 4 thermocouple inputs

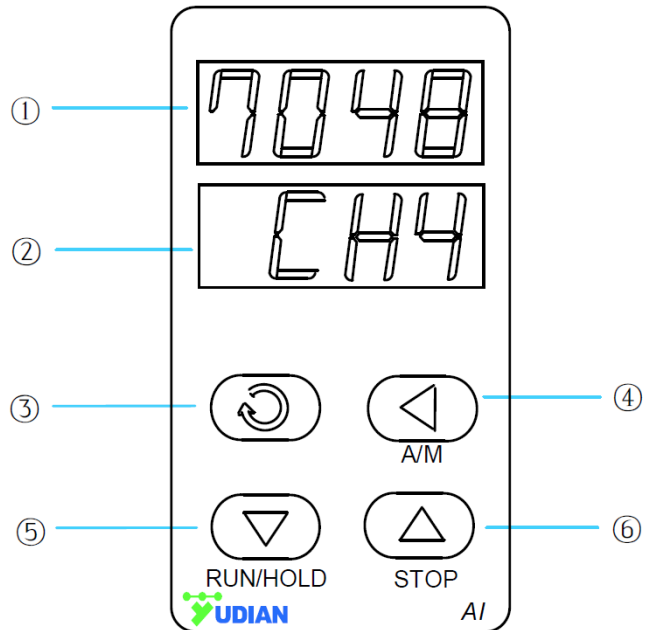
Terminal 15,16,19,20: Negative poles of 4 thermocouple inputs

Terminal 23~24: RS485 communication.



4. DISPLAYS AND OPERATIONS

- ① Upper display window, displays PV, parameter code, etc.
- ② Lower display window, displays SV, parameter value, channel no. or alarm code.
- ③ Setup key, for accessing parameter table and conforming parameter modification.
- ④ Data shift key, or for switching the channel display in manual/auto.
- ⑤ Data decrease key, and also for displaying the previous channel.
- ⑥ Data increase key, and also for displaying the next channel.



Operation Instructions:

1. Switch between channels:

Press to display to the previous channel

Press to display the next channel.

Press can switch between auto multi-channel circulating display status and normal display.

2. Set parameters:

Keep pressing about 2 seconds can access Full Parameter Table (When the parameter lock "Loc" isn't locked. Loc=808.)

Pressing can go to the next parameter, and pressing , or can modify a parameter.

Setpoints (SV) can be set by pressing , or

Press key to decrease the value.

Press key to increase the value.

Press key to move to the digit expected to modify.

Keep pressing or , the speed of decreasing or increasing value gets quick. The range of setpoint is between the parameter SPL and SPH.

Pressing and holding can return to the preceding parameter. Pressing (don't release) and then press key simultaneously can escape from the parameter table.

When the parameter is locked, pressing can display Field Parameter Table which includes up to 12 parameters selected by user.

The instrument will escape automatically from the parameter table if no key is pressed within 25 seconds, and the change of the last parameter will not be saved.

3. Alarm display:

The channel number is displayed in the lower display window.

When high or low limit alarm occurs, the first digital on the left side flickeringly displays H or L. When an input signal is out of range, for example, the thermocouple circuit is break, the upper window will display the upper limit or lower limit, and the lower window will flicker.

4. MODE indication light:

When the instrument is communicating with the host computer, the light will keep flashing in random speed.

When the instrument hasn't received signal from the host computer more than 6 seconds, the indication light should flicker with the same light on time and light off time.

It means:

The on-off period is as long as 1.6 second means no communication and no alarm (it can be treated as normal);

The light flashing with period 0.6 second means no communication and some general error occurs.

The light quickly flashing with period 0.3 second means no communication and severe error such as input over range occurs.

The light keeping off means the instrument power off or damaged; the light keep on (longer than 8 seconds) means the instrument power on but damaged.

5. Setting Parameters:

(Note: x means channel number. It can be 1~4.)

Parameter	Name	Remarks	Setting range																																												
bAud	Baud rate	When COMM module interface is used for communication, bAud defines the baud rate range is 300~19200bit/s.	0 ~ 19.2K bit/S																																												
Addr	Communication address	Every instrument in the same communication line should be assigned to different communication address. The communication applies AIBUS protocol. Every input channel takes one address. For example, if channel number Cn=3 and Addr=10, then the communication address 10~12 are assigned to the instrument.	0 ~ 80																																												
SPx	Setpoint	Setpoints of channel 1~4.	-999~+ 3200°C																																												
Atx	Auto tuning	0: Auto tuning function is disable 1: Active auto turning function to calculate the values of parameters P, I, d and Ctl. After auto tuning is accomplished, "At" will be automatically changed to 0.	0~1																																												
INPx	Input specification	Define the input specification of channel 1~ 4. <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th>INP</th> <th>Input spec.</th> <th>INP</th> <th>Input spec.</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>K</td> <td>1</td> <td>S</td> </tr> <tr> <td>2</td> <td>R</td> <td>3</td> <td>T</td> </tr> <tr> <td>4</td> <td>E</td> <td>5</td> <td>J</td> </tr> <tr> <td>6</td> <td>B</td> <td>7</td> <td>N</td> </tr> <tr> <td>8</td> <td>WRe3-WRe25</td> <td>9</td> <td>WRe5-WRe26</td> </tr> <tr> <td>10</td> <td>Extended input spec.</td> <td>11~24</td> <td>Spare</td> </tr> <tr> <td>25</td> <td>0~75mV</td> <td>26~27</td> <td>Spare</td> </tr> <tr> <td>28</td> <td>0~20mV</td> <td>29</td> <td>0~100mV</td> </tr> <tr> <td>30</td> <td>0~60mV</td> <td>31</td> <td>0~1V</td> </tr> <tr> <td>32</td> <td>0.2~1V</td> <td></td> <td></td> </tr> </tbody> </table>	INP	Input spec.	INP	Input spec.	0	K	1	S	2	R	3	T	4	E	5	J	6	B	7	N	8	WRe3-WRe25	9	WRe5-WRe26	10	Extended input spec.	11~24	Spare	25	0~75mV	26~27	Spare	28	0~20mV	29	0~100mV	30	0~60mV	31	0~1V	32	0.2~1V			0 ~ 39
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dPtx	Decimal point	dPtx is set to select display resolution for channel x for linear inputs, the corresponding display resolution of dPt=0,1,2,3 are 0, 0.0, 0.00 and 0.000 For thermocouple inputs, when dPt=0, the display resolution is 1°C; when dPt=1, the resolution is 0.1°C Note: dPt only affects the display, and has no effect on internal data.	0~3																																												
SCLx	Scale low limit	SCL and SCH define the corresponding scale range of linear inputs as mV.	-9999~+30000 units																																												
SCHx	Scale high limit																																														
Scbx	Input offset	For thermocouple, the units of Scb is 0.1°C. For example, when Scb=-100, the actual offset=-10°C, then the measured temperature will be 10°C lower than that when Sc=0.	-1999~+4000 units or 0.1°C																																												
FILx	Digital filter	The value of FIL will determine the ability of filtering noise. FIL=0, no filtering; FIL=1, filtering with mean; FIL=2~40, filtering with mean and integral. 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 strong interference exists, then you can increase parameter FIL gradually to make momentary fluctuation of measured value less than 2 to 5. When the instrument is being metrological verified, FIL can be set to 0 or 1 to shorten the response time.	0~40																																												
Px	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 Ctl can be obtained by auto tuning. They can also be manually inputted if you already know the correct values.	10~9999 units																																												
Ix	Time of Integral	Time of Integral in PID. No integral effect when I=0	0~9999 seconds																																												
Dx	Time of derivative	Time of derivative in PID. No derivative effect when d=0	0~999.9 seconds																																												

H.ALx	Alarm high limit	x channel high alarm is triggered when PVx (the present value of x channel)>H.ALx; alarm releases when PVx<H.ALx - HYSx.	-999~+3200 °C															
L.ALx	Alarm low limit	x channel low alarm is triggered when PVx<L.ALx; alarm releases when PVx>L.ALx+HYSx.																
HYSx	Hysteresis	HYS is set to avoid high frequent alarm on/off actions caused by process input fluctuation. It also works at auto-tuning.	0~999.9°C															
AOPx	Alarm output allocation (Valid only for E5 size)	<table border="1"> <thead> <tr> <th>Alarm</th> <th>Low limit alarm</th> <th>High limit alarm</th> </tr> </thead> <tbody> <tr> <td>Output to</td> <td></td> <td></td> </tr> <tr> <td>None</td> <td>0</td> <td>0</td> </tr> <tr> <td>AL1</td> <td>3</td> <td>3</td> </tr> <tr> <td>AL2</td> <td>4</td> <td>4</td> </tr> </tbody> </table>	Alarm	Low limit alarm	High limit alarm	Output to			None	0	0	AL1	3	3	AL2	4	4	0~44
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For example, AOP1=43 that the low limit alarm of channel 1 is sent to AL2, and high limit alarms sent to AL1																		
Cn	Number of input channels	Define actual number of input channels. Setting range is 1~4. When Cn=2, the lower window display the present value of channel 2 instead of the channel number.	1~ 4															
Cno	First display channel setting	If several of AI-7048 has used, this parameter can define the AI-7048 to display assigned channel number on display. For example, when Cno=6, the controller will display channel number from 6~9. (6, 7, 8, 9)																
AF	Addition function setting 1	Parameter "AF" was defined as below: AF=A x 1 + B x 2 + C x 3 + D x 4 A=0; Normal speed in channel cycle display; A=1; Faster speed in channel cycle display; B=0; C=0; D=0; Normal application; D=1; Change all of the low alarm to be high alarm;																
AF2	Addition function setting 2	Parameter "AF2" was defined as below: AF=A x 1 + B x 2 A=0; Normal application; A=1; Change all of the high alarm to be high deviation alarm; when deviation value (PV - SV) > H.ALx, it will trigger the alarm. When (PV - SV) < H.ALx - HYSx, alarm off, set the H.ALx value to maximum will disable the alarm function. B=0; Normal application; B=1; Change all of the low alarm to be low deviation alarm; when deviation value (PV - SV) < L.ALx, it will trigger the alarm. When (PV - SV) > L.ALx - HYSx, alarm off, set the L.ALx value to minimum will disable the alarm function.																
nonc	NO/NC selection	Single channel relay module provides both normal open and normal close output, while dual relay output module L5 only provides normal open output. However, by parameter "nonc", the NO output can be changed to NC output. nonc = 0, AL1, AL2 (L5 is installed in ALM socket) are normal open output. nonc = 127, AL1 and AL2 are normal close output	0, 127															
Loc	Parameter lock	Loc=0, Allow to display and modify parameter "Loc" and the field parameters which is defined in EP1~EP12 . Loc=1, Allow to display and modify parameter "Loc", and only display field parameters, can't modify them. Loc=808, allow to display and set all parameters. Note: This setting just effect on external display. Modify parameter by communication was always allowed.	0 ~9999															
EP1-12	Field parameter	When configuration of the instrument is completed, most parameters will not need to be set by field operators. Furthermore, field operators may not understand many parameters, and may probably set parameters incorrectly by mistake and make the instrument unable to work. EP1~EP12 define 0~12 field parameters for operators' use in parameter table. Their parameter values are parameters except parameter EP itself, for example, H.AL1, L.AL1, .etc, Parameters from EP1 to EP12 can define 12 field parameters at most, if the number of field parameters is less than 12(sometimes even none), it is necessary to define field parameters from EP1 to EP12 in order, the first unused EP should be set to none. For example, four parameters of SP1 to SP4 (all channels' setpoints) are	NonE~bAud															

		need to be modified by field operators, the parameter EP can be set as : EP1=SP1, EP2=SP2, EP3=SP3, EP4=SP4, EP5=none, Loc=0 Then only parameter SP1~4 can be displayed and modified, but via communication, on the host computer, all parameters can be displayed and modified.	
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