**Yudian (H.K.) Automation Technology Co. Ltd.**
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# ARTIFICIAL INTELLIGENCE

# PROGRAMMABLE

# TEMPERATURE CONTROLLER

~ One Timer ~

~ Ramp Rate Control ~

## **AI-216P** (V8.22)


# User Manual

[Beta version, 2014]

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## I. Model Code Symbol

**The type of AI-216P is made up of 4 parts**:

| **AI-216P** | ☐ | ☐ | ☐ |
|---|---|---|---|
| **Part 1 (Series)** | **Part 2 (Size)** | **Part 3 (Oupt)** | **Part 4 (AUX)** |

1. **(Part 1) Model Series**
   AI-216P standard temperature controller provides 0.3%FS±0.1℃ accuracy.
   Sensor inputs accepts thermocouples and RTDs.
   Select thermocouples or RTD by pressing buttons.
   Suitable for -999~3200℃ application. Maximum support two alarms contact output
   Universal voltage input (100~240VAC)

2. **(Part 2) Front panel dimension**

| **Size** | **Front Panel** (width×height) | **Cut Out** (width×height) | **Depth Behind Mounting** |
|---|---|---|---|
| A | 96×96mm | 92×92mm | 100mm |
| B | 160×80mm | 152×76mm | 100mm |
| D | 72×72mm | 68×68mm | 95mm |
| D2 | 48×48mm | 45×45mm | 95mm |
| E | 48×96mm | 45×92mm | 100mm |
| F | 96×48mm | 92×45mm | 100mm |

3. **(Part 3 and 4) indicate the module installed in OUTP and AUX sockets.**

   Allowed modules in each socket are as below:

| Allowed Type / Module Socket | N | L | L1 | L5 | G |
|---|---|---|---|---|---|
| **3. OUTP (main output)** | | √ | | | √ |
| **4. AUX (Auxiliary output)** | √ | | √ | √ | |

**N** (or none) no module installed

**L** Relay contact output module (Capacity: 5A/250VAC, normal open)

**L1** Relay contact output module (Capacity: 2A/250VAC, normal open/ normal close)

**L5** Dual relay output module Output module (Capacity: 2A/250VAC, normal open, support AU1 and AU2 alarm output)

**G** SSR voltage output module (30mA/5VDC)

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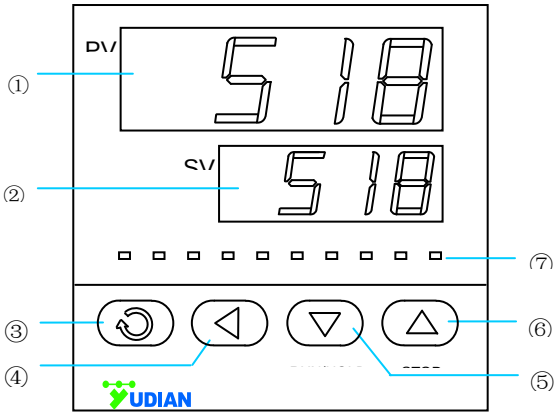
## II. TECHNICAL SPECIFICATION

1. **Input type :**
   Thermocouple: K, E, J, N
   Resistance temperature detector: Pt100
2. **Instrument Input range :**
   K, E, J, N : (0~+999)℃ ; Pt100: (0~+800)℃
3. **Measurement accuracy :** 0.3%FS±1℃
4. **Temperature display resolution :** 0 or 0.0 (0.0 just for 0~99.9 display)
5. **Control mode:**
   On-off control mode, Standard PID with auto tuning (nPid), or AI PID with auto tuning, adopting artificial intelligence algorithm. (APid)
6. **Alarm function:** High limit alarm, Lower limit alarm, Deviation High Alarm; providing the function of alarm blocking at the beginning of power on.
7. **Power supply voltage rating**: 100-240VAC, -15%, +10% / 50-60Hz.
8. **Power consumption:** ≤2W
9. **Ambient temperature:** -10~+60℃, Humidity: 0~90RH%

## III. FRONT PANEL AND OPERATION




① Process Value(PV), or parameter code
② Set Value(SV), alarming code, or value of a parameter
③ Setup key, for accessing parameter table, and confirming change.
④ Data shift key, also for activating auto turning
⑤ Data decrease key
⑥ Data increase key
⑦ Status display LED,
OP1, AU1, AU2, and RUN indicate I/O operation of the corresponding module.

**Basal display status:**

When power on, will shows the process value (PV) and the set point (SV). If the input signal is out of the measurable range (for example, the thermocouple or RTD circuit is break, or input specification sets wrong). Instrument will alternately display “orA”, and limit alarm of PV, moreover, instrument will automatically stop the output.

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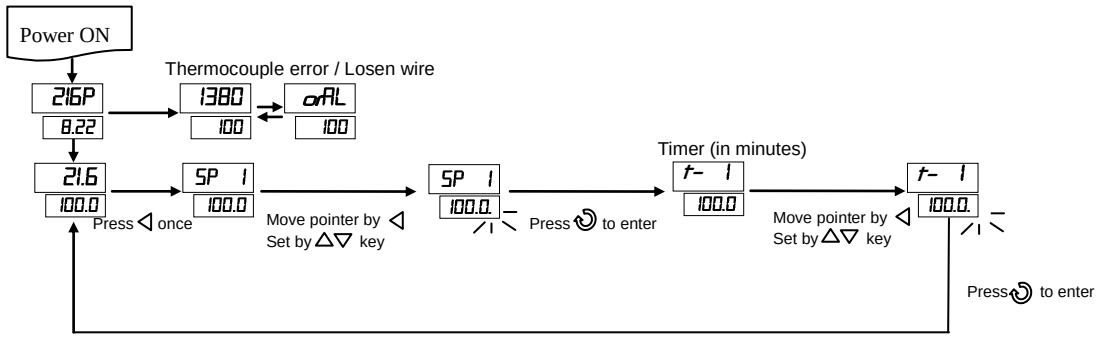
# IV. OPERATION DESCRIPTION

- **Set and Change a SV:**

  if the parameter lock “Loc” isn't locked, we can set setpoint (SV) by pressing 、 or . Press key to decrease the value, key to increase the value, and key to move to the digit expected to modify. Keep pressing or , the speed of decreasing or inscreasing value get quick. The range of setpoint is between the parameter SPH. The default range is 0 to 400.

  After power on, it will show the instrument model number and version number for 3 seconds. Then PV will display the measured temperature while SV will display the set value.




- **Parameter Setting:**

  In basal display status, press and hold for about 2 seconds can access Field Parameter Table. Pressing can go to the next parameter; if parameter have not locked, pressing 、 or can modify a parameter. Press and hold can return to the preceding parameter. Press (don't release) and then press key simultaneously can escape from the parameter table. The instrument will escape auomatically from the parameter table if no key is pressed within 30 seconds. Setting Loc=808 and then press can access System Parameter Table.

- **AI artificial intelligence control and auto tuning**

  When AI artificial intelligence control method is chosen (CrL=AI), the PID parameters can be obtained by running auto-tuning. In basal display status, press for 2 seconds, the “At” parameter will appear. Press to change the value of “At” from “oFF” to “on”, then press to active the auto-tuning process. During auto tuning, the instrument executes on-off control. After 2-3 times of on-off action, the instrument will obtain the optimal control parameter value. If you want to escape from auto tuning status, 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.

**Note 1:** If the setpoint is different, the parameters obtained from auto-tuning are possible different. So you’d better set setpoint to an often-used value or middle value first, and then start auto-tuning. For the ovens with good heat preservation, the setpoint can be set at the highest applicable temperature. Depending on the system, the auto-tuning time can be from several seconds to several hours.

**Note 2:** Parameter Ctl (on-off differential, control hysteresis) has influence on the accuracy of auto-tuning. Generally, the smaller the value of Ctl, the higher the precision of auto tuning. But Ctl parameter value should be large enough to prevent the instrument from error action around setpoint due to the oscillation of input. Ctl is recommended to be 2.0.

**Note 3:** AI series instrument has the function of self-learning. It is able to learn the process while working. The control effect at the first run after auto tuning is probably not perfect, but excellent control result will be obtained after a period of time because of self-learning.

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## V. PARAMETER AND SETTING

**Field parameter table (Press and hold for 2 seconds to access)**

<table>
<tr><th>Code</th><th>Name</th><th>Description</th><th>Setting Range</th><th>Default</th></tr>
<tr><td>HiAL</td><td>High limit alarm</td><td>Alarm on when PV (Process Value) >HiAL;<br>alarm off when PV<HIA-AHY</td><td>-999～<br>+3200</td><td>3200</td></tr>
<tr><td>LoAL</td><td>Lower limit alarm</td><td>Alarm on when PV (Process Value) < LoAL;<br>alarm off when PV > LoA+AHY</td><td>-999～<br>+3200</td><td>-999</td></tr>
<tr><td>HdAL</td><td>Deviation high alarm</td><td>Alarm on when PV-SV>HdA;<br>alarm off when PV-SV<HdA-AHY</td><td>-999～<br>+3200</td><td>3200</td></tr>
<tr><td>LdAL</td><td>Deviation Low alarm</td><td>LdAL = -2 Ready Function activation.</td><td>-999～<br>+3200</td><td>-999</td></tr>
<tr><td>Loc</td><td>Parameter lock</td><td>Loc=0~1: Allowed to modify parameters HIA, LoA, HdA and SV.<br>Loc=2~3: Allowed to modify parameters HIA, LoA, HdA. But cannot change SV.<br>Loc=4~255: NOT allowed to modify any parameters and SV.<br>Loc=808, Set to 808 and press , allowed modify all parameters.</td><td>0～255</td><td></td></tr>
<tr><td>AHYS</td><td>Hysteresis</td><td>Avoid frequent alarm on-off action because of the fluctuation of PV, usually sets to AHY=2</td><td>0~200.0</td><td>2.0</td></tr>
<tr><td>AOP</td><td>Alarm output assignment</td><td>
<table>
<tr><th>Alarm / Output to</th><th>HdA (x100)</th><th>LoA (x10)</th><th>HIA (x1)</th></tr>
<tr><td>None</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>AU1</td><td>1</td><td>1</td><td>1</td></tr>
<tr><td>AU2</td><td>2</td><td>2</td><td>2</td></tr>
</table>
eg: AOP=201 means HdA have alarm action from AU2, LoA, no alarm action , HIA alarm action output from AU1.</td><td>0~444</td><td>3333</td></tr>
<tr><td>CtrL</td><td>Control mode</td><td>● onF : On-off control, When PV=SV, Output stop. When PV<SV-CHY, start output.<br>● AI : AI PID control, high precision and the output time proportion can set by parameter Ctl</td><td>OnoF, APid, nPid</td><td>APId</td></tr>
<tr><td>Srun</td><td>Run Status</td><td>run: Control or program was running, “RUN” led light on<br>StoP : No output and program was stopped. Lower display keeps flashing “StoP” and “RUN” LED goes off.<br>HoLd: Lower display keeps flashing “HoLd”. It holds the temperature at set point. The timer will not have effect.</td><td>StoP, run, Hold</td><td>run</td></tr>
<tr><td>Act</td><td>Acting method</td><td>rE: Reverse acting. Increase in measured variable causes a decrease in the output, such as heating control.<br>dr: Direct acting. Increase in measured variable causes an increase in the output, such as refrigerating control.<br>rEb: Reverse acting with low limit alarm and deviation low alarm blocking at the beginning of power on.<br>drb: Direct acting with high limit alarm and deviation high alarm blocking at the beginning of power on.</td><td>rE , dr , rEb, drb</td><td>rE</td></tr>
<tr><td>At</td><td>Auto-tuning</td><td>oFF: Auto tuning function was off.<br>on: Active auto turning function to calculate the values<br>FoFF : Auto tuning function was off, cannot activate again by pressing key from panel .</td><td>On, OFF</td><td>off</td></tr>
</table>

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<table>
<tr><td>P</td><td>Proportion band</td><td>Proportion band in PID with unit ℃or ℉</td><td>1~3200.0</td><td>25.0</td></tr>
<tr><td>I</td><td>Time of integral</td><td>Time of integral in PID. No integral effect when I=0</td><td>0~9999 sec</td><td>100</td></tr>
<tr><td>d</td><td>Time of derivative</td><td>Time of derivative in PID. No derivative effect when d=0</td><td>0~999.9 sec</td><td>50.0</td></tr>
<tr><td>Ctl</td><td>Control period</td><td>Small value can improve control accuracy.<br>For SSR output, generally 0.5 to 3 seconds.<br>For Relay output, generally 15 to 40 seconds, because small value will cause the frequent On-Off of mechanical switch and shorten its service life. Ctl is recommended to be 1/4 – 1/10 of derivative time. When control under on-off control, Ctl use as restart delay time after off, for protect compressor application.</td><td>0.2-300.0 sec</td><td>15.0</td></tr>
<tr><td>CHYS</td><td>Control hysteresis</td><td>CHY is used for ON-OFF Control.<br>PV > SV, Output turns OFF;<br>PV<SV-CHY, Output turns ON.</td><td>0~2000</td><td>2.0</td></tr>
<tr><td>InP</td><td>Input specification</td><td><table><tr><td>Sn</td><td>Input spec.</td><td>Sn</td><td>Input spec.</td></tr><tr><td>0</td><td>K</td><td>1-3</td><td>Spare</td></tr><tr><td>4</td><td>E</td><td>5</td><td>J</td></tr><tr><td>6</td><td>Spare</td><td>7</td><td>N</td></tr><tr><td>8-20</td><td>Spare</td><td>21</td><td>Pt100</td></tr></table></td><td>0～42</td><td>0</td></tr>
<tr><td>dPt</td><td>Resolution</td><td>0 or 0.0 selectable, 0.0 just for 0~99.9 ℃ / ℉ display</td><td>0.0<br>0.00<br>0.000</td><td>0.0</td></tr>
<tr><td>Scb</td><td>Input shift</td><td>Scb is used to make input shift to compensate the error produced by sensor or input signal.<br>PV after compensation= PV before compensation + Scb.</td><td>-999～ +400.0℃</td><td>0.0</td></tr>
<tr><td>FILt</td><td>PV input filter</td><td>The value of FIL will determine the ability of filtering noise.<br>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.<br>If great interference exists, then you can increase parameter “FIL” gradually to make momentary fluctuation of measured value less than 2 to 5.<br>When the instrument is being metrological verified, “FIL” s can be set to 0 or 1 to shorten the response time.</td><td>0～40</td><td>1</td></tr>
<tr><td>Fru</td><td>Selection of power frequency and temperature unit</td><td>50C: 50Hz,display ℃. , 50F: 50Hz, display ℉<br>60C: 60Hz,display ℃. , 60F: 60Hz, display ℉.<br>Input has max. anti-interference ability to 50Hz or 60Hz frequency when parameter set.</td><td>50C, 50F, 60C, 60F</td><td>50C</td></tr>
<tr><td>OPH</td><td>Output upper limit</td><td>OPL limits the maximum of OUTP (main output) when PV<OEF. OPH should be greater than OPL.</td><td>0～110%</td><td>100</td></tr>
<tr><td>OEF</td><td>Work range of OPH</td><td>When PV<OEF, the upper limit of OUTP is OPH; when PV>OEF, the upper limit of OUTP is 100%.<br>For example, to avoid that the temperature raises too quickly, under 150℃, a heater can work only under 30% of power, then we can set OEF=150.0 (℃), OPH=30 (%)</td><td>-999～ +3200</td><td>3200</td></tr>
<tr><td>AF</td><td>Advanced function</td><td>No function.</td><td>0</td><td>0</td></tr>
</table>

| | | | | |
|---|---|---|---|---|
| SPL | Low limit of SV | Minimum value that SV is allowed to be. | | -999 |
| SPH | Upper limit of SV | Maximum value that SV allowed to be. When SPH=400, the SV range will 0~400℃ | 0～999℃ | 3200 |
| SPr | Ramp Slope limit / Rate of temperate change | Once SPr was set, if PV<SV when program start, the ramp slope will limited by SPr value until the temperature reach the first SV , under this limitation, the RUN lamp will keep flashing.<br>SPr > 0.0 activates Ramp Mode.<br>SPr = 0.0 remains in Soak Mode. | 0.0 ~ 3200.0℃ /Min | 0.0 |
| PonP | Program run mode after power restart | **Cont :** Continue to run the program from the original break point. If STOP Status is activated before power cut, then it (the program) will keep stop status after power restart.<br>**StoP** : Stop the program after power restart<br>**run1** : Start to run the program from Step 1 unless the instrument was in “StoP” state before power cut.<br>**dASt** : If these have deviation alarm after power resume, then stop the program, otherwise, continue run the program from the original break point.<br>**HoLd** : Go into HOLD state after power on. If it is in StoP state before power cut, then keep in StoP State after power on. | Cont / StoP / run1 / dASt / HoLd | Cont |
| EP1 | Field parameter definition | Field Parameter #1, acting a shortcut to specific parameter without password | | HiAL |
| EP2 | | Field Parameter #2, acting a shortcut to specific parameter without password | | LoAL |
| EP3 | | Field Parameter #3, acting a shortcut to specific parameter without password | | hdAL |
| EP4 | | Field Parameter #4, acting a shortcut to specific parameter without password | | LdAL |
| EP5 | | Field Parameter #5, acting a shortcut to specific parameter without password | | nonE |
| EP6 | | Field Parameter #6, acting a shortcut to specific parameter without password | | nonE |
| EP7 | | Field Parameter #7, acting a shortcut to specific parameter without password | | nonE |
| EP8 | | Field Parameter #8, acting a shortcut to specific parameter without password | | nonE |

## VI. PARAMETER AND SETTING

**Program parameter table (Press ◁ to access)**

| Code | Name | Description | Setting Range | Default |
|---|---|---|---|---|
| SP1 | Setpoint 1 | | -999～3200℃ | 100 |
| t- 1 | Time 1 | Timer in minutes.<br>(-1) with Srun = Hold to go back to non-program mode | 0～999 | 100 |

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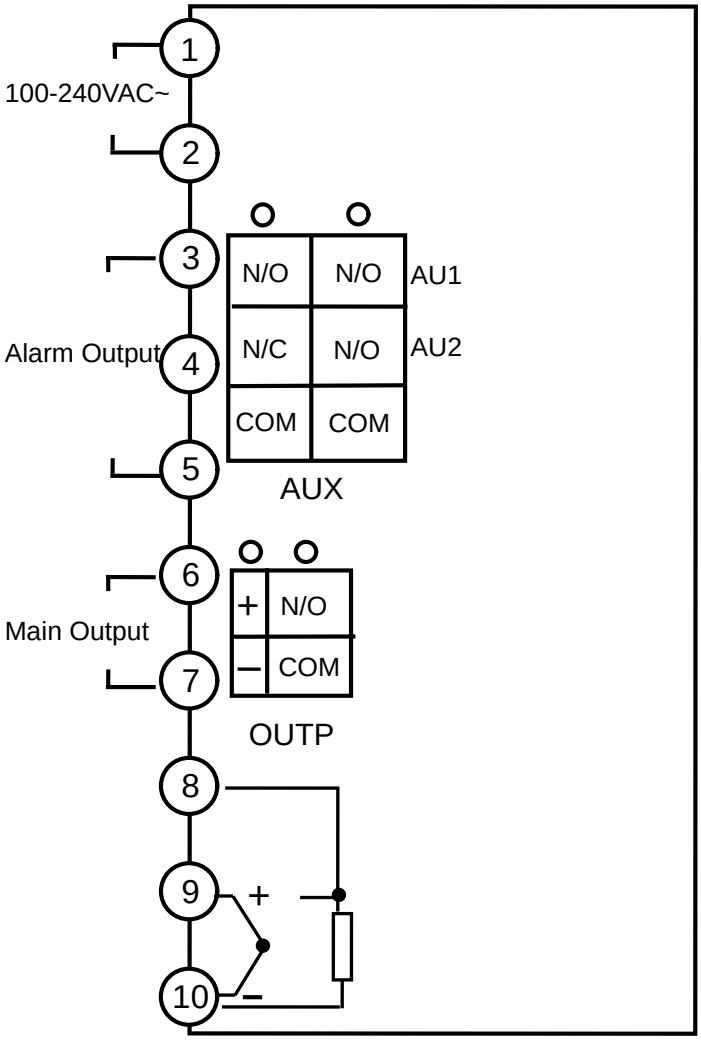
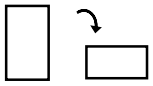
## VII. INSTRUMENT INSTALLATION AND WIRING

**Wiring graph for instruments with dimension A, B, E or F**



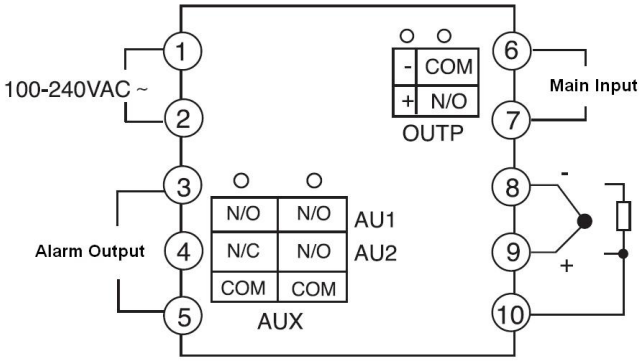

Note: The graph suits for upright instruments with dimension A or E



For instruments with dimension B or F size, just clockwise rotate the graph 90 degree.

**Wiring graph for D2 dimension**

**（48X48mm）instruments：**




**Wiring graph for D dimension**

**(72mm X 72mm) instruments**