NHR-5300 Artificial Intelligence Temperature Controller/Adjuster

User Manual

I. Product Introduction

NHR-5300 artificial intelligence temperature controller/adjuster adopts real artificial intelligence formula. When instrument starts self tuning function, it will automatically find optimal parameters according to the features of objects to realize a good control effect, and need no manual tuning parameters. The precision of temperature control is around ±0.1℃, without overshoot or undershoot. Temperature controller can reach up to international advanced level. It can work with all sorts of sensors and transmitters to realize the measured display of physical quantity like temperature, pressure, liquid level, capacity, power and etc, and possesses PID adjustment and control, alarm control, data collection and other functions on electric heating devices, solenoid valve and electric valves with the assistance of all sorts of actuators. It is suitable for industrial furnace, electric furnace, drying furnace, experiment devices, shoemaking machinery, injection molding machinery, packaging machinery, food machinery, printing machinery and other industries.

With many input types, an instrument can receive and use different input signals which greatly reduce the number of stand-by instruments. Single set PID control or double PID computing control is available for the instrument (for example, heating/cooling control system). PID control output: current, voltage, SSR, single-phase/ three-phase SCR zero-crossing trigger, valve positive inversion control and other methods are available. Position alarm control, analog transmitting output, RS485/232 communication and other functions are available to attach.

II. Technical Parameters

Input				
Input signal	Current	Voltage	Resistance	Couple
Input impedance	≤250Ω	≥500KΩ		
Limit of maximum input current	30mA			
Limit of maximum input voltage		<6V		
Output				
Output signal	Current	Voltage	Relay	24V power distribution or feed
Load allowed upon output	≤500Ω	≥250KΩ (Note: Need to replace the module when a higher load capacity is necessary)	AC220V/0.5A（low） DC24V/0.5A（low） AC220V/2A（high） DC24V/2A（high） See notes	≤30mA
Regulation output				
Control output	Relay	Single phase SCR	Two-phase SCR	Solid state relay
Output load	AC220V/0.5A（low） DC24V/0.5A（low）	AC660V/0.1A	AC600V/5A (In case of direct drive, this shall be indicated)	DC12V/30mA

	AC220V/2A（high） DC24V/2A（high） See notes			
Comprehensive parameters				
Measurement accuracy	0.2%FS±1 byte			
Setting method	Panel touching key number setting; parameter set value locked by password; set value is stored permanently after outage.			
Display mode	Red/green LED double row display or red/green LED double row display + 51 segments LED bar graphic display			
Operating environment	Ambient temperature: 0 to 50℃; relative humidity: ≤85%RH; away from strongly corrosive gases.			
Working power supply	AC 100 to 240 V (switching power supply) (50-60 HZ); DC 20 to 29 V (switching power supply)			
Power consumption	≤5W			
Structure	Standard snap-in			
Communication	Adopt standard MODBUS communication protocol, with RS-485 able to reach up to 1 km and RS-232 up to 15 m in terms of their communication distance. Note: When the instrument is equipped with the communication function, an active communication converter is recommended.			

Note: For Type D and E instruments, the load capacity allowed for relay output is AC 220 V/0.6 A or DC 24 V/0.6 A.

III. Instrument Panel and Display Functions

1) Outline dimensions and hole size of the instrument:

Outline Dimensions/ Code	Hole Size	Outline Dimensions/ Code	Hole Size
160*80mm (horizontal/bar graphic)/A	152*76mm	96*48mm (horizontal)/D	92*45mm
80*160mm (vertical/bar graphic) /B	76*152mm	48*96mm (vertical)/E	45*92mm
96*96mm(squared/bar graphic)/C	92*92mm	72*72mm (squared)/F	68*68mm
48*48mm (squared)/H	45*45mm		

2) Display Window

PV Display Window: display measured values; in case that the parameters are set, display parameter signs

SV Display Window: display PID calculation results in the manual status; display content in the automatic status can be defined via DISP in the secondary menu; in case that the parameters are set, display the parameter values set

3) Panel indicators

A/M：Automatic/manual switch indicator

EV1: Event alarm indicator

AL1: First alarm indicator
AL2: Second alarm indicator
OP1: Output indicator (clockwise)
OP2: Output indicator (anticlockwise)
OP3: Output indicator
OP4: Output indicator

4) Operation Keys

	Enter Key: confirm after number and parameter revision Page Turning Key: page down for parameter setting Setting Exit Key: return to the measurement page by pressing the key for two seconds Use together with can realize switch of automatic/manual control output
	Shift Key: move to the left by one byte upon one press Backspace Key: return to the parameter at a previous level by pressing the key for 2 seconds
	Decrease Key: decrease value Display time when with the print function In jog output, valve jog can be turned down
	Increase Key: increase value Be used for manual printing when with the print function In jog output, valve jog can be turned up

5) Instrument wiring

Attention is to be paid to the following matters upon site wiring of instruments:

PV input (measurement input)

1. Reduce electrical interference by making the wiring between low voltage D.C. current signals and sensor input far away from strong current routing. Otherwise, use shielded conductor and get grounded at the same point.

2. Any device placed between the sensor and the terminal may affect measurement accuracy due to electric resistance or leakage current.

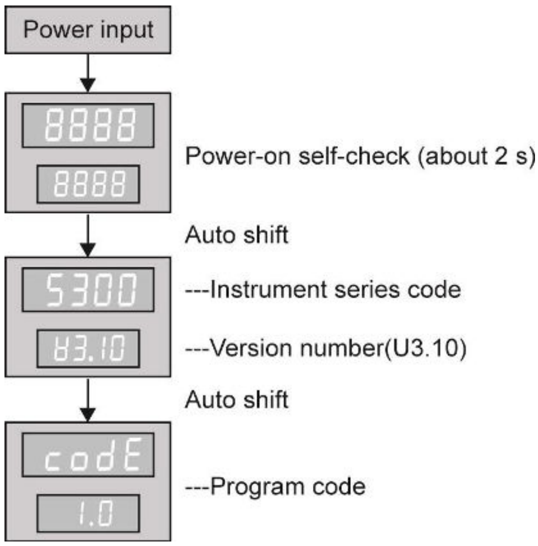
Thermocouple or pyrometer input

Use compensation wire corresponding with thermocouple as the extension line and it is better with shielding.

RTD input

The electric resistance of three conductors shall be the same, with the electric resistance of each conductor no more than 15 Ω; if conductors fail to meet any of the said requirements, it will lead to deviation in thermocouple measurement.

IV. Power-on Settings



When the power is switched on, the instrument enters into the self-checking status (See the right diagram); after that, the instrument is shifted to the working mode, when the power is switched on, the instrument enters into the self-checking status (See the right diagram); after that, the instrument is shifted to the working status, where LOC will appear upon press of with the parameter setting of LOC as follows:

1. 1) Loc= any parameter, enter into the main menu (LOC=00; no lock when LOC=132)

2) Loc=132, enter into the secondary menu by pressing

for four seconds;

3) Loc=130, enter into the time setting menu by pressing for four seconds, for an instrument with the print function;

4) Loc=any other value, press for four seconds to exit and return to the measurement page.

2. When Loc=577, press and under the Loc menu at the same time for four seconds to restore all parameters to factory default settings.

3. Under whatever menu, press for four seconds to exit and return to the measurement page.

4. Time setting

When PV of the instrument displays the measurement value, press to enter into the parameter setting page to set LOC=130. When PV displays LOC and SV displays 130, press for 4 seconds and enter into time parameter setting page. If PV of the instrument shows "d=14" and SV shows "1009", it means that the current date is October 9th, 2014. In this status, the current date can be set by referring to the instrument parameter setting method. When the instrument displays the current date, press and the PV of the instrument will show "T=15" and SV will show "3045", which means the current time is 30’45’’ at 15:00. In this status, the current time can be set by referring to the instrument parameter setting method. When the instrument displays the current time, press again for 4 seconds to exit from the time setting page and return to the PV measurement value display status.

★Returning to Working Mode

1. Manual return: In the instrument parameter setting status, the instrument will automatically return to the real-time measurement status by pressing four seconds.

2. Automatic return: In the instrument parameter setting mode, the instrument will automatically go back to the real-time measurement status after 30 seconds without pressing any key.

V. **Parameter Setting**

5.1 Primary Parameter Setting

In the real-time measurement status, press , and PV will show LOC and SV will show the parameter value: press or to start parameter setting. Press for 2 seconds, to return to the parameter at the previous level. When Loc is equal to any parameter, go to primary parameter setting.

Factory default settings	Parameter	Setting range(byte)	Instructions
LOC 0	Loc Setting parameter lock	0～999	LOC=00: no locking (primary parameters able to be revised) LOC≠00, 132: locking (primary parameters unable to be revised) LOC=132: no locking (primary and secondary parameters able to be revised)
AL1 50	AL 1 First alarm value	-1999～9999	Set alarm value of first alarm
AL2 50	AL2 Second alarm value	-1999～9999	Set alarm value of second alarm
AL3 50	AL3 Third alarm value	-1999～9999	Set alarm value for the third alarm
AL4 50	AL4 Fourth alarm	-1999～9999	Set alarm value for the fourth alarm

Factory default settings	Parameter	Setting range (byte)	Instructions
LBA 100	LbA Control ring wire break/short circuit alarm	1～9999（S）	When the control output of the instrument is equal to PIDL or PIDH, the duration lasts longer than the set LBA time and there is no change to the PV measurement value, the control ring is considered to have problem and output alarm. (Have this parameter when setting LBA alarm)
AH1 10	AH1 Return difference of first alarm	0～9999	Return difference value of first alarm
AH2 10	AH2 Return difference of second alarm	0～9999	Return difference value of second alarm
AH3 10	AH3 Return difference of the third alarm	0～9999	Return difference value of the third alarm/stepping control
AH4 10	AH4 Return difference of the fourth alarm	0～9999	Return difference value of the fourth alarm
P 500	P Proportional band	1～9999	Display the set value of the proportional band (a lower P value indicates a faster system response; and a higher P value indicates a slower system response).
I 100	I Integration time	1～9999 （×0.5S）	Display set value of program integration time, which shall be used in the elimination of residual deviation produced in proportional control. Residual deviation: A lower I value indicates a stronger integral action; a higher I value indicates a relatively weak integral action. Set as (9999), integral action is OFF.
D 25	d Derivation time	0～1999（×0.5S）	Display set value of program derivation time. A lower D value indicates a weaker systematic derivative action; a high D value indicates a stronger systematic derivative action. When set as zero, derivative action is OFF; it is used for predicting the changes of output, preventing disturbance, enhancing the stability of control.
T1 1	T1 Output cycle	1～200（×0.5S） Accuracy：10mS	Control output circle (parameters exit under switching control output)
SF 1.00	SF Output inhabition parameter	0.00～1.00	The larger, the greater the restraining capability: when SF=1.00, the restraining capability is strongest; when SF=0.00, the restraining capability is canceled (see 7.5 for details about the usage notes of SF parameter)
P2 500	P2 Proportional band of auxiliary output	1～9999	Display the set value of auxiliary proportional band (a lower P value indicates a faster system response; and a higher P value indicates a slower system response) (see in Note 1)
I2 100	I2 Auxiliary output Integration time	1～9999 （×0.5S）	Display the set value of auxiliary output integral time, which shall be used in the elimination of residual deviation produced in proportional control. Residual deviation: A lower I value indicates a stronger integral action; a higher I value indicates a relatively weak integral action. Set as (9999), integral action is OFF. (See Note 1)

Factory default settings	Parameter	Setting range (byte)	Instructions
D2 25	d2 Auxiliary output Derivation time	0～1999 （×0.5S）	Display the set value of auxiliary output rate time, and a lower D value indicates a weaker system differential function; a higher D value indicates a stronger system differential function; when the set value is 0, the differentiation action will be OFF; this shall be used to forecast the change of output, prevent perturbation, and enhance the stability of control. (See Note 1)
T2 1	r2 Auxiliary output cycle	1～200（×0.5S） Accuracy：10mS	Cycle of auxiliary output (See Note 1) (parameters exit under switching control output)
SF2 1.00	SF2 Auxiliary output Output inhabition parameter	0.00～1.00	Auxiliary output restrains integral action to reduce overshoots, and the restraining capability is strongest when 1.00, and the restraining capability is canceled when 0.00 (see 7.5 for details about the usage notes of SF parameter) (See Note 1)
AUT 0 Returning to LOC on the original page	Aut Self-tuning	0～1	Aut=0-off: manual setting of PID parameter value Aut=1-on: automatic calculation (self tuning) (See instructions in 7.3)

5. 2 SV setting of control target value

In the measurement state, press , and after 4 seconds, enter the SV setting status of the control target value.

Parameter	Symbol	Name	Setting Range	Instructions	Factory default value
SV	SV	Control target value	Full scale	Display set value of control target value	500 or 50.0

5.3 Secondary parameter setting

In the real-time measurement status, press , and PV will show LOC and SV will show the parameter value: press or to conduct parameter setting. Press for 2 seconds to return to the parameter at the previous level. When Loc=132, press for 4 seconds to enter into secondary parameter setting.

Factory default settings	Parameter	Setting range (byte)	Instructions
Pn 27	Pn Input graduation mark	0～35	Set the input graduation type (See the Instrument Model Selection Table)
dp 0	dP Decimal point	0～3	dP=0: no decimal point dP=1: decimal point in the tenths (displayed as XXX.X) dP=2: decimal point in the percentiles (displayed as XX.XX) dP=3: decimal point in the thousands (displayed as X.XXX)
ALM1 2	ALm1 First alarm mode	0～2	ALM1=0 : no alarm ALM1=1: First alarm as lower limit alarm ALM1=2: First alarm as upper limit alarm ALM1=3: first alarm as alarm beyond limit deviation ALM1=4: first alarm as alarm within limit deviation ALM1=5: first alarm as upper deviation alarm ALM1=6: first alarm as lower deviation alarm ALM1=7: first alarm as LBA alarm (1 to 9,999S) ALM1=8: first alarm as manual and automatic state output

Factory default settings	Parameter	Setting range (byte)	Instructions
ALM2 1	ALM2 Second alarm mode	0～7	ALM2=0: no alarm ALM2=1: Second alarm as lower limit alarm ALM2=2: Second alarm as upper limit alarm ALM2=3: Second alarm as alarm beyond limit deviation ALM2=4: Second alarm as alarm within limit deviation ALM2=5: Second alarm as upper limit deviation alarm ALM2=6: Second alarm as lower limit deviation alarm ALM2=7: Second alarm as LBA alarm (1 to 9,999S) ALM2=8: second alarm as manual and automatic state output
ALM3 0	ALM3 Third alarm mode	0～9	ALM3=0: no alarm ALM3=1: third alarm as lower limit alarm ALM3=2: third alarm as upper limit alarm ALM3=3: third alarm as beyond deviation alarm ALM3=4: third alarm as within deviation alarm ALM3=5: third alarm as upper deviation alarm ALM3=6 : third alarm as lower deviation alarm ALM3=7: third alarm as LBA alarm (1 to 9,999 S) ALM3=8: third alarm as manual and automatic state output ALM3=9: third alarm as clockwise output
ALM4 0	ALM4 Fourth alarm mode	0～9	ALM4=0: no alarm ALM4=1: fourth alarm as lower limit alarm ALM4=2: fourth alarm as upper limit alarm ALM4=3: fourth alarm as beyond deviation alarm ALM4=4: fourth alarm as within deviation alarm ALM4=5: fourth alarm as upper deviation alarm ALM4=6: fourth alarm as lower deviation alarm ALM4=7: fourth alarm as LBA alarm (1 to 9,999 S) ALM4=8: fourth alarm as manual and automatic state output ALM4=9: fourth alarm as anticlockwise output
ALG 0	ALG Flashing alarm	0～1	ALG=0 without flashing alarm ALG=1 with flashing alarm
FK 0	FK Filter coefficient	0 to 19 times	Set the instrument filter coefficient to prevent the display value from jumping (seeNote 1)
Addr 1	Addr Equipment No.	0～250	Set the equipment code of this instrument upon communications
bAud 3	bAUd Communication baud rate	0～3	Baud=0: communication baud rate is 1200bps; Baud=1: communication baud rate is 2400bps Baud=2: communication baud rate is 4800bps; Baud=3: communication baud rate is 9600bps

Factory default settings	Parameter	Setting range (byte)	Instructions
Pr-A 0	Pr-A Print-on-alarm function	0～1	Pt-A=0: without print-on-alarm function Pt-A=1: with print-on-alarm function (no such parameter when there is no print function)
Pr-t 0	Pr-t Interval of timed print	1～2400 min	Set the interval time for timed print (no such parameter when there is no print function)
Pr-U 0	Pr-U Print unit	0～45	See unit setting function code table (no such parameter when there is no print function)
Mode 1	ModE PID mode of action	0～1	Mode=0: direct action Mode=1: reverse action
H-C 0	H-C Heating and cooling mode	0～1	H-C=0: standard mode (unilateral PID adjustment) H-C=1: heating/cooling double output (bilateral PID adjustment) (Note: When H-C=1, position control is not available in formula types)
Out 1	Out PID output type	0～2	Out=0: relay, SSR (solid state relay output), SCR-silicon controlled rectifier zero-crossing trigger Out=1: current and voltage control output Out=2: valve location clockwise and anticlockwise rotation control output (where the third alarm cannot work)
Out2 0	Out2 Cooling output type (Yes, when H-C=1)	0～1	Out2=0: replay, SSR (solid state relay output) SCR-silicon controlled rectifier (where the fourth alarm cannot work) Out2=1: linear current (voltage) output Note: when out=2, main output is valve location positive or reversion control output, out2 can only output analog quantity.
Disp 0	dISP PID output display	0～5	disp=0: SV displays the control target value with bar graph, and the control target value with number disp=1: SV displays the control target value with bar graph, and the PID calculation result with number disp=2: SV displays the control target value with bar graph, and the valve location feedback with number disp=3: SV displays the PID calculation result with bar graph, and the control target value with number disp=4: SV displays the PID calculation result with bar graph, and the PID calculation result with number disp=5: SV displays the PID calculation result with bar graph, and the valve location feedback with number

Factory default settings	Parameter	Setting range (byte)	Instructions
PID 0	PI d Formula type	0～2	PID=0: Artificial intelligence formula is suitable for a control system whose hysteresis is severe and control speed is slow, for example, the heating of electronic furnace PID=1: Artificial intelligence formula is suitable for systems which can swiftly control response speed, for example, the control system of regulating valve for the physical quantity like pressure and flow rate PID=2: Position control
ctrl 0	CtrL Selection of control mode	0～2	ctrl=0: single channel input PID control ctrl=1: Two-channel input valve location control ctrl=2: Two-channel input external preset control
V-T 10	U-T Valve location operation time	0～200	Valve location operation time, the time needed from full cut-off to full open-up. (Parameters exist when Out=2)
Sd 1	Sd Positive or inversion manual control method	0～1	Sd=0: contact output Sd=1: Jog output (Parameters exist when Out=2)
OH 0.5	OH Valve location control output return difference	0.5～10.0%	Positive inversion valve location feedback control: valve control output return difference Positive inversion non-feedback control: valve location control dead zone, when dead zone is 2%, PID will output new value under the status that output changes over 2%; (Parameters exist when Out=2)
PO 1	PO Power-on manual/ automatic status	0～2	PO=0: Power-on initial status is manual status PO=1: Power-on initial status is automatic status PO=2: Power-on initial status is the status before power-down, namely, when it is manual status before power-down, then it will still be manual status when power is on; otherwise, automatic status
PIDL 0.0	PI dL Lower limit of PID control output	-100～100%	PID control output lower limit amplitude (see in Note 2) When 0~100% is set, the heating and cooling mode takes standard mode with unilateral PID adjustment as restraining adjustment output minimum, When 0~100% is set, the instrument works as a bilateral PID control system with the heating/cooling double output function; when main output is used for heating, then auxiliary output is used for cooling
PIDH 100.0	PI dH Upper limit of PID control output	-100～100%	PID control output upper limit amplitude (seeNote 2) When -100%~ to 1% is set, the instrument works as a unilateral output system, main control output is out of work
Pb 0	Pb Input zero shift	Full scale	Shift quantity of input zero (See Note 3)

Factory default settings	Parameter	Setting range (byte)	Instructions
PK 1.000	PK Proportion of input measurement range	0～1.999 times	Magnification of input measurement range (See Note 3)
Cb 0	Cb Zero shift of cold junction compensation	Full scale	Zero shift quantity of cold junction compensation (have such a parameter upon thermocouple input) (See Note 3)
CK 1.000	CK Magnification of cold junction compensation	0～1.999 times	Magnification of cold junction compensation (have such a parameter upon thermocouple input) (See Note 3)
oub 0.000	oub Zero shift of linear output 1	0～1.2	Zero shift quantity of linear output (See Note 4)
ouk 1.000	ouk Magnification of linear output 1	0～1.2	Magnification of linear output 1 (See Note 4)
oub2 0.000	oub2 Zero shift of linear output 2	0～1.2	Zero shift quantity of linear output 2 (See Note 4)
ouk2 1.000	ouk2 Magnification of linear output 2	0～1.2	Magnification of linear output 2 (See Note 4)
ouL 0	ouL Lower limit of the measurement range of transmitting output	Full scale	Lower measurement range of transmitting output
ouH 1000	ouH Upper limit of the measurement range of transmitting output	Full scale	Upper measurement range of transmitting output
GL 0	GL Lower limit of flashing alarm	Full scale	Lower measurement range of flashing alarm (when the measurement value is lower than the set value, display the measurement value and flash, ALG=1, have such function)
GH 1000	GH Upper limit of flashing alarm	Full scale	Upper measurement range of flashing alarm (when the measurement value is higher than the set value, display the measurement value and flash, ALG=1, have such function)

Factory default settings	Parameter	Setting range (byte)	Instructions
ZL 0	ZL PV displays lower limit with bar graph	Full scale	PV displays lower limit measurement range with bar graph (useful for bar graph meter)

ZH 1000	ZH PV displays the upper limit with bar graph	Full scale	PV displays the upper measurement range with bar graph (useful for bar graphic meter)
PL 0	PL Lower limit of measurement range	Full scale	Set the lower measurement range of input signals (See Note 5)
PH 1000	PH Upper limit of measurement range	Full scale	Set the upper measurement range of input signals (See Note 5)
Cut 0	Cut Small signals elimination	0.0～100.0	Small signal resection volumes of set input signal (when input signal is lower than set ratio, it displays 0. This function can only work towards pressure and current signal)
F-n 27	F-n SV inputs graduation mark	0～35	Input graduation type (no such parameter with unilateral input PID controller)
F-dp 0	F-dP SV displays decimal points	0～3	F-dp=0: no decimal point F-dp=1: decimal point in tenths (displayed as XXX.X) F-dp=2: decimal point in percentiles (displayed as XX.XX) F-dp=3: decimal point in thousands (displayed as X.XXX)
F-FK 0	F-FK Filter coefficient	0～19	Set instrument filter coefficient to avoid displayed value hopping
F-b 0	F-b SV displays input zero shift	Full scale	Set the shift quantity of input zero displayed by SV
F-K 1.000	F-K SV displays magnification of input measurement range	0～1.999 times	Set SV to display magnification of input measurement range
F-L 0	F-L Lower limit of SV measurement range	Full scale	Set the lower measurement range of SV input signal (See Note 5)
F-H 1000 Return to the initial page Pn	F-H Upper limit of SV measurement range	Full scale	Set the upper measurement range of SV input signal (See Note 5)

Note 1、Filter coefficient ：the times of sampling, used to prevent the flicking of measured values；

Sampling period – analog signals as input, the interval of each data acquisition is 0.5 seconds. The relation of PV displaying value, filter coefficient and sampling period is listed as followed：

Example：Analog signals as input, supposing the filter coefficient equals 6 (time), then the instrument will automatically average the input signals during(6 × 0.5) 3 seconds, and refresh PV display value. (Namely displaying the average value of the input signals during front 3 seconds)

Note 2、Definitions of PIDL and PIDH: PIDL and PIDH are equal to upper and lower limit amplitude of instrument control output.

e.g. Set PIDL = 10%, the minimum instrument control output value is: 10%. When set PIDH=90%, the maximum instrument control output is: 90%.

Note 3、 formulas of Pb, Pk, Cb and Ck

Pk=predetermined full range ÷ display range × primary Pk；Pb=lower limit of predetermined range - lower limit of display range × Pk + primary Pb;

e.g.: the measuring range of a direct current 4 to 20 mA instrument is -200 to 100KPa. During calibration, it is found that the instrument displays -202 upon input of 4 mA, and then it will display 1008 upon input of 20 mA. (Instrument setting：Pb=0，Pk=1)

According to formula: Pk=predetermined full range ÷ display range × primary Pk

Pk= ［1000-（-200）］ ÷ ［1008-（-202）］ ×1

= 1200÷1210×1≈0.992

Pb= lower limit of predicted measuring range -lower limit of display measuring range ×Pk+ primary Pb

Pb=-200-（-202×0.992）+0=-200-（-200.384）=0.384

Set that: Pb=0.384; Pk=0.992

Note 4、 output quantity Oub, OuK, Oub2, OuK2, Ctb and Ctk set as follow：

Instrument transmitting and control output shall be calibrated by 0~20 mA or 0~5V. Using the formula below can change output range or adjust output deviation.

$$\text{New Oub} = \text{Current Oub} - \frac{\text{Lower limit of current output} - \text{Lower limit of scheduled output}}{\text{Full measurement range}}$$

$$\text{New OuK} = \text{Current OuK} - \frac{\text{Upper limit of current output} - \text{Upper limit of scheduled output}}{\text{Full measurement range}}$$

In formula, when output is current signal, full range =20; when output is voltage signal, full range=5.

e.g. 1: transmitting current 0~20mA output is required to change as 4~20mA. In measurement, output zero point value, output is 0mA; input full range, output is 20mA; currently Oub =0, currently Ouk =1.

$$\text{New Oub} = 0 - \frac{0-4}{20} = 0.2$$

$$\text{New OuK} = 1 - \frac{20-20}{20} = 1$$

Thus, set Oub as 0.2, OuK remains the same, realize the change from 0~20mA output to 4~20mA output.

e.g. 2: Output of the transmitting current ranges from 4 to 20 mA. Upon measurement, an output value of 4.2 mA represents zero point output while an output value of 20.5 mA stands for the output upon full range input. The current Oub=0.2 and current OuK=1.

$$\text{New Oub} = 0.2 - \frac{4.2-4}{20} = 0.19$$

$$\text{New OuK} = 1 - \frac{20.5-20}{20} = 0.975$$

Note5、 measuring range: the settings of PL, PH, F-L and F-H are as follow:

e.g.: change the range of a direct current input instrument from original 0 to 500 Pa to current -100.0 to 500.0 Pa.

Set that: DP=1 (decimal point in the tenths), PL=-100.0, PH=500.0, press Enter and the change of range is completed.

Note 6、 the fixation of different types of valves inside the program shall be operated by limit switches. When the result of PID computation keeps at 0% or 100%, positive or inversion switching value output shall keep outputting after finishing a period of operating time and the relative indicator light will be off; positive or inversion non-feedback valve control will finish valve locating during the start-up of instrument, and inversion switching value will implement a complete shut-down.

Note 7、 when signal is cut off, PID calculation result will become minimum value, self tuning is not available.

Unit setting function code table:

Code	0	1	2	3	4	5	6	7	8	9	10	11
Unit	Kgf	Pa	KPa	MPa	mmHg	mmH_2O	bar	℃	%	Hz	m	t
Code	12	13	14	15	16	17	18	19	20	21	22	23
Unit	l	m^3	Kg	J	MJ	GJ	Nm^3	m/h	t/h	l/h	m^3/h	kg/h
Code	24	25	26	27	28	29	30	31	32	33	34	35
Unit	J/h	MJ/h	GJ/h	Nm^3/h	m/m	t/m	l/m	m^3/m	kg/m	J/m	MJ/m	GJ/m
Code	36	37	38	39	40	41	42	43	44	45		
Unit	Nm^3/m	m/s	t/s	l/s	m^3/s	kg/s	J/s	MJ/s	GJ/s	Nm^3/s		

Ⅵ Instrument Portfolios & Wiring Diagram

6.1 Instrument Portfolios

NHR-5310□-□/☒-□/□/□/□/□（ ）-□（ ）
Single-channel control ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

NHR-5320□-□/□-□/□/□/□/□（ ）-□（ ）
External preset control ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

NHR-5330□-□/□-□/□/□/□/□（ ）-□（ ）
Valve location control ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

①Specification and Dimension		②First channel (measuring) input graduation ③Secondary channel (valve location feedback or external preset) input graduation	
Code	Width*Height*Depth	Code	graduation (Measurement Range)
A	160*80*110mm (horizontal)	X	No input signal
B	80*160*110mm(vertical)	00	Thermocouple B（400～1800℃）
C	96*96*110mm (squared)	01	Thermocouple S（0～1600℃）
D	96*48*110mm (horizontal)	02	Thermocouple K（0～1300℃）
E	48*96*110mm (vertical)	03	Thermocouple of graduation E（0～1000℃）
F	72*72*110mm(squared)	04	Thermocouple of graduation T（-200.0～400.0℃）
H	48*48*110mm(squared)	05	Thermocouple of graduation J（0～1200℃）
K	160*80*110mm(horizontal/bar graphic)	06	Thermocouple of graduation R（0～1600℃）
L	80*160*110mm(vertical/bar graphic)	07	Thermocouple of graduation N（0～1300℃）
M	96*96*110mm(squared/bar graphic)	08	Thermocouple of graduation F2（700～2000℃）
④Master control output (PIDOUT1)(Note 1)		09	Thermocouple of graduation Wre 3-25（0～2300℃）
Code	Output type (resistive load, RL)	10	Thermocouple of graduation Wre 5-26（0～2300℃）
0	4～20mA（RL≤600Ω）	11	RTD Cu50（-50.0～150.0℃）
1	1～5V（RL≥250KΩ）	12	RTD Cu53（-50.0～150.0℃）
2	0～10mA（RL≤1.2KΩ）	13	RTD Cu100（-50.0～150.0℃）
3	0～5V（RL≥250KΩ）	14	RTD Pt100（-200.0～650.0℃）
4	0～20mA（RL≤600Ω）	15	RTD BA1（-200.0～600.0℃）

5	0～10V（RL≥4KΩ）	16	RTD BA2（-200.0～600.0℃）
K1	Relay contact output	17	Linear resistance 0～400Ω（-1999～9999）
K3	SCR zero-crossing trigger pulse output	18	Far transmission resistance 0～350Ω（-1999～9999）
K4	Solid-state relay-driven voltage output	19	Far transmission resistance 30～350Ω（-1999～9999）
K6	Three-phase SCR zero-crossing trigger pulse output	20	0～20mV（-1999～9999）
8	Special specifications	21	0～40mV（-1999～9999）
⑤Auxiliary output (OUT2)(Note 1)		22	0～100mV（-1999～9999）
Code	Output type (resistive load, RL)	23	-20～20mV（-1999～9999）
X	No output	24	-100～100mV（-1999～9999）
0	4～20mA（RL≤600Ω）	25	0～20mA（-1999～9999）
1	1～5V（RL≥250KΩ）	26	0～10mA（-1999～9999）
2	0～10mA（RL≤1.2KΩ）	27	4～20mA（-1999～9999）
3	0～5V（RL≥250KΩ）	28	0～5V（-1999～9999）
4	0～20mA（RL≤600Ω）	29	1～5V（-1999～9999）
5	0～10V（RL≥4KΩ）	30	-5～5V（-1999～9999）
K1	Relay contact output	31	0～10V（-1999～9999）(not to switch)
K3	SCR zero-crossing trigger pulse output	32	0～10mA extraction（-1999～9999）
K4	Solid-state relay-driven voltage output	33	4～20mA extraction（-1999～9999）
K6	Three-phase SCR zero-crossing trigger pulse output	34	0～5V extraction（-1999～9999）
8	Special specifications	35	1～5V extraction（-1999～9999）
⑥Alarm output (relay contact output)		55	Full switch
Code	Limit of alarming times	56	Special specifications
X	No output		
1	1-limit alarm		
2	2-limit alarm		
3	3-limit alarm		
4	4-limit alarm		
⑦Communication output/external incident input		⑧Feed output	
Code	Communication interface/digital quantity input interface	Code	Feed output (output voltage)
X	No output	X	No output
D1	RS-485 communication interface (Modbus)	1P	1 route feed output
D2	RS232 communication interface (Modbus)	2P	2 route feed output
D3	RS232C printing interface (Modbus)		e.g. “2P (12/24)” indicates 12 V and 24 V feed output for the 1st and second route respectively.
Y1	External incident input 1 (forced manual)		
Y2	External event output 2		
Y3	External event output 3		
⑨Power supply source		⑩Notes (no or omitted)	
Code	Voltage Range		
A	AC/DC 100～240V（AC/50～60Hz）		
D	DC 20～29V		

Notes:

1. Auxiliary output can make transmitting output as well as control output. It can be chosen in secondary parameter “H-C”. When H-C=0, it makes transmitting output; when H-C=1, it makes control output. When NHR-5330 valve location control takes switching positive inversion control output, auxiliary output can only take

analog quantity control; when instrument type F control output takes switching positive inversion control output, auxiliary output is not available;

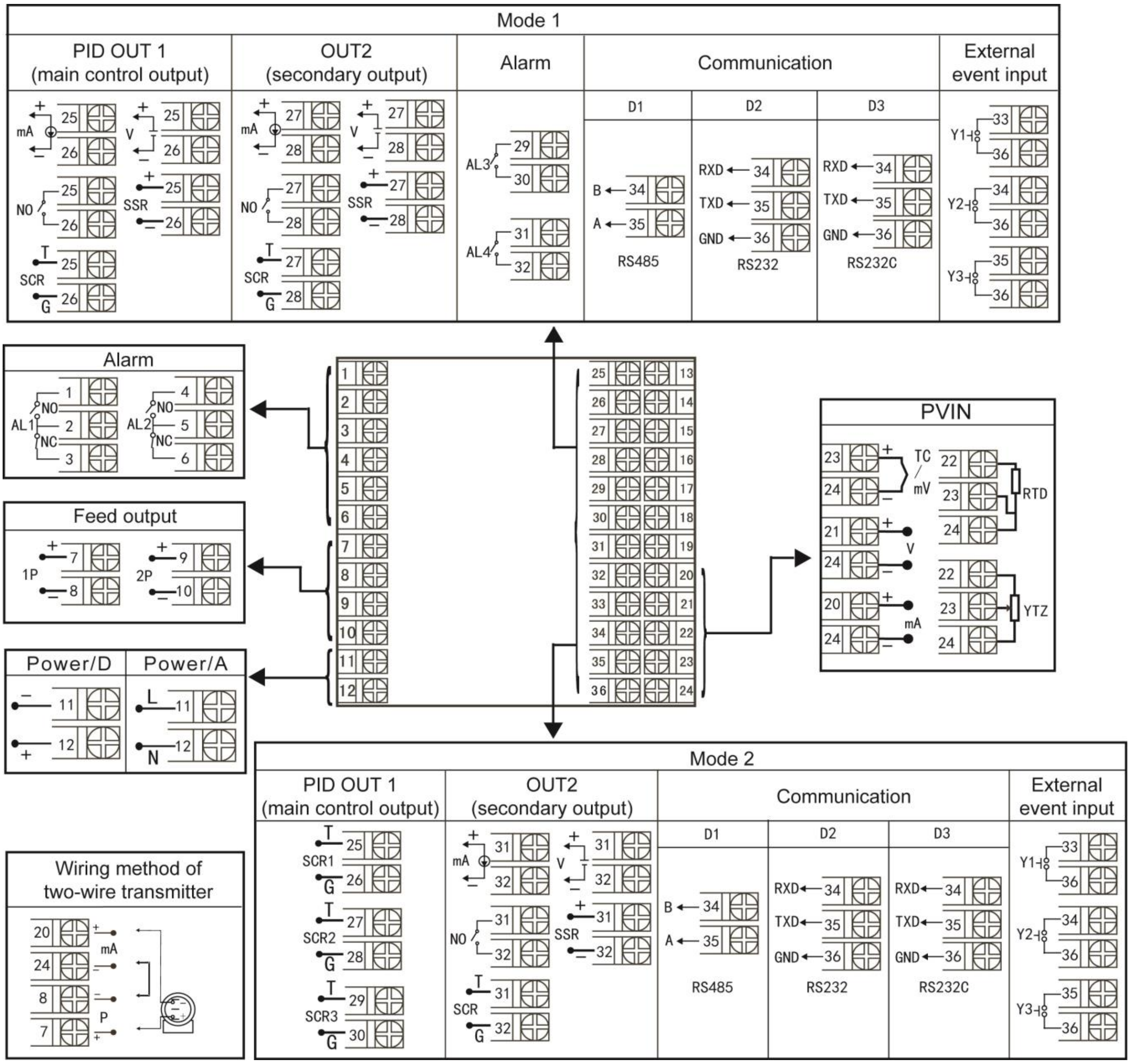
2. Instruments type F and H are not equipped with printing interfaces, instruments type H can only execute single channel control.

3. Instruments type D or E: when there is alarm function in terminal blocks 25 to 36, relay contact capacity is AC 125 V/0.5 A, or DC 24V/0.5A, relay capacities of instrument type H are the same, and relay capacities of instruments of other types are AC 220 V/2 A or DC 24 V/2 A.

4. When control output chooses switching quantity control output, alarm output can only choose 2 limit alarm.

6.2 Wiring diagram

NHR-5310 Single channel PID temperature controller/adjuster wiring diagram



Wiring diagram type A, B, C, D, E, K, L and M

Note: Horizontal and vertical instruments differ in the direction of the wiring terminals at their rear cover, as shown in Diagram 1.

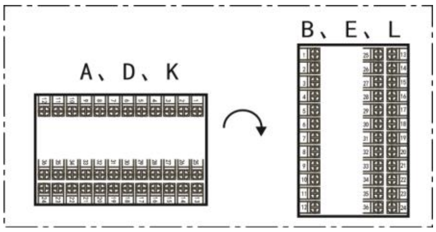
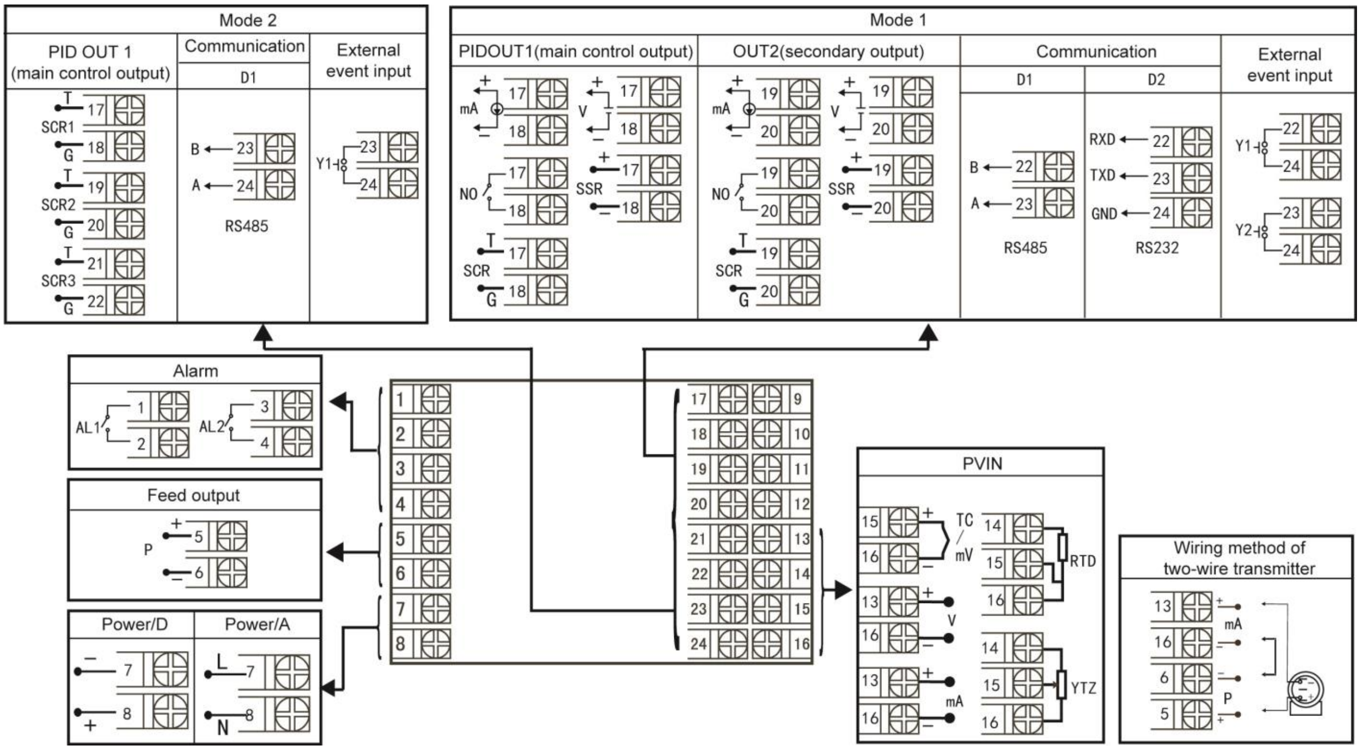
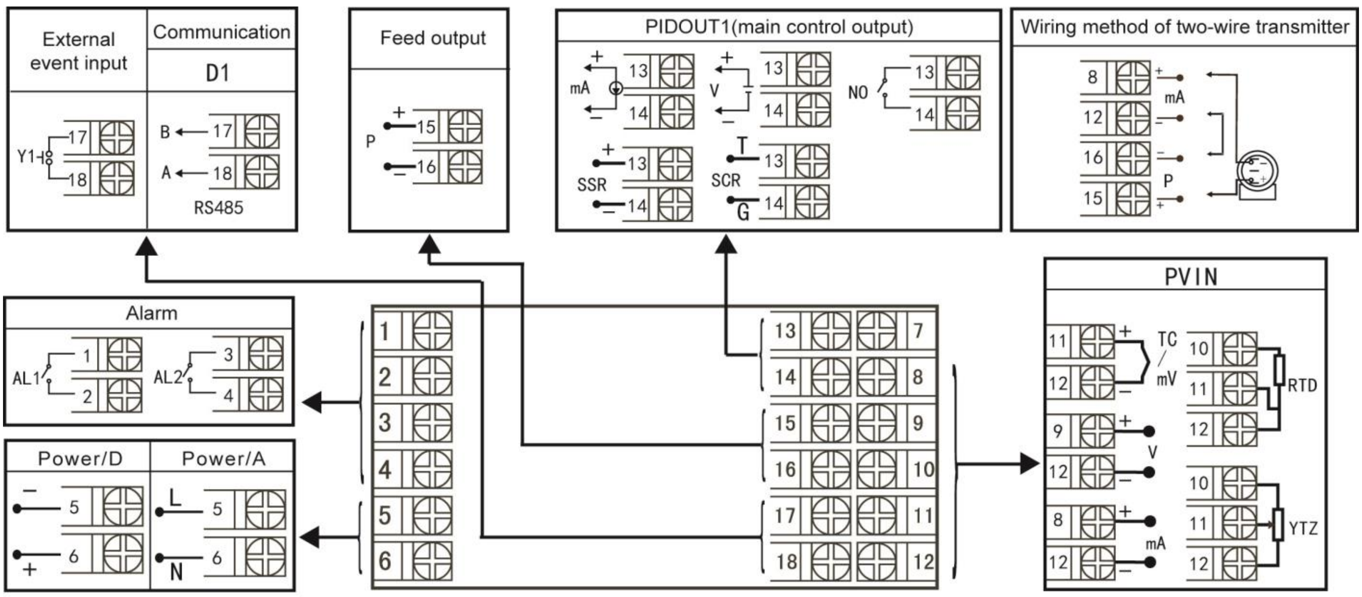


Diagram 1

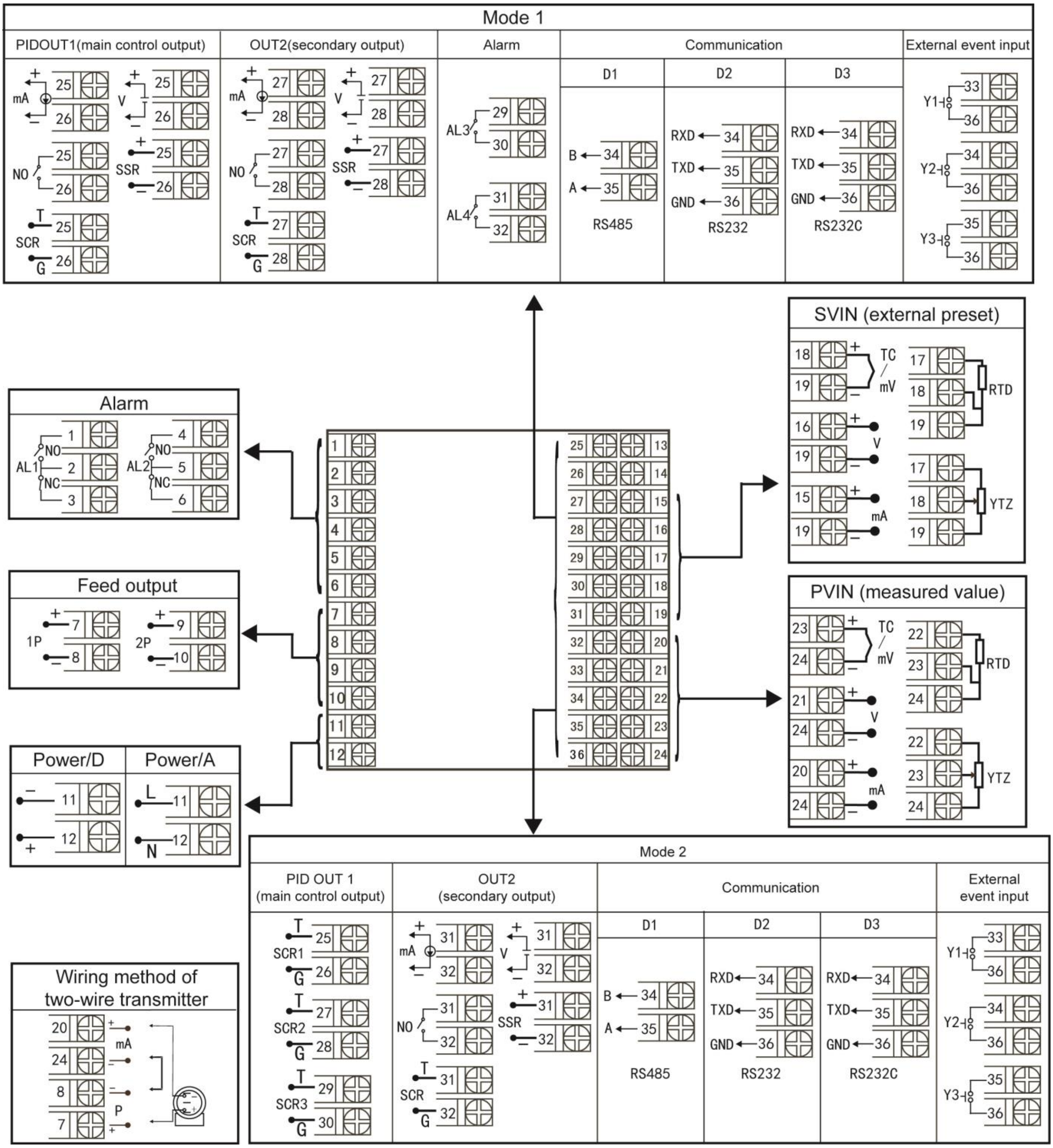


Wiring Diagram of Type F



Wiring Diagram of Type H

NHR-5320 Double channel (external preset) PID temperature controller/adjuster wiring diagram



Wiring diagram type A, B, C, D, E, K, L and M

Note: Horizontal and vertical instruments differ in the direction of the wiring terminals at their rear cover, as shown in Diagram 1.

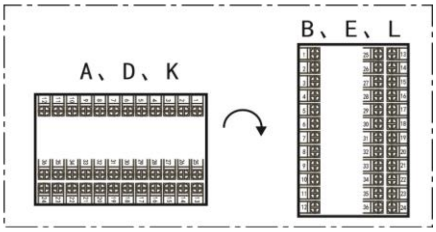
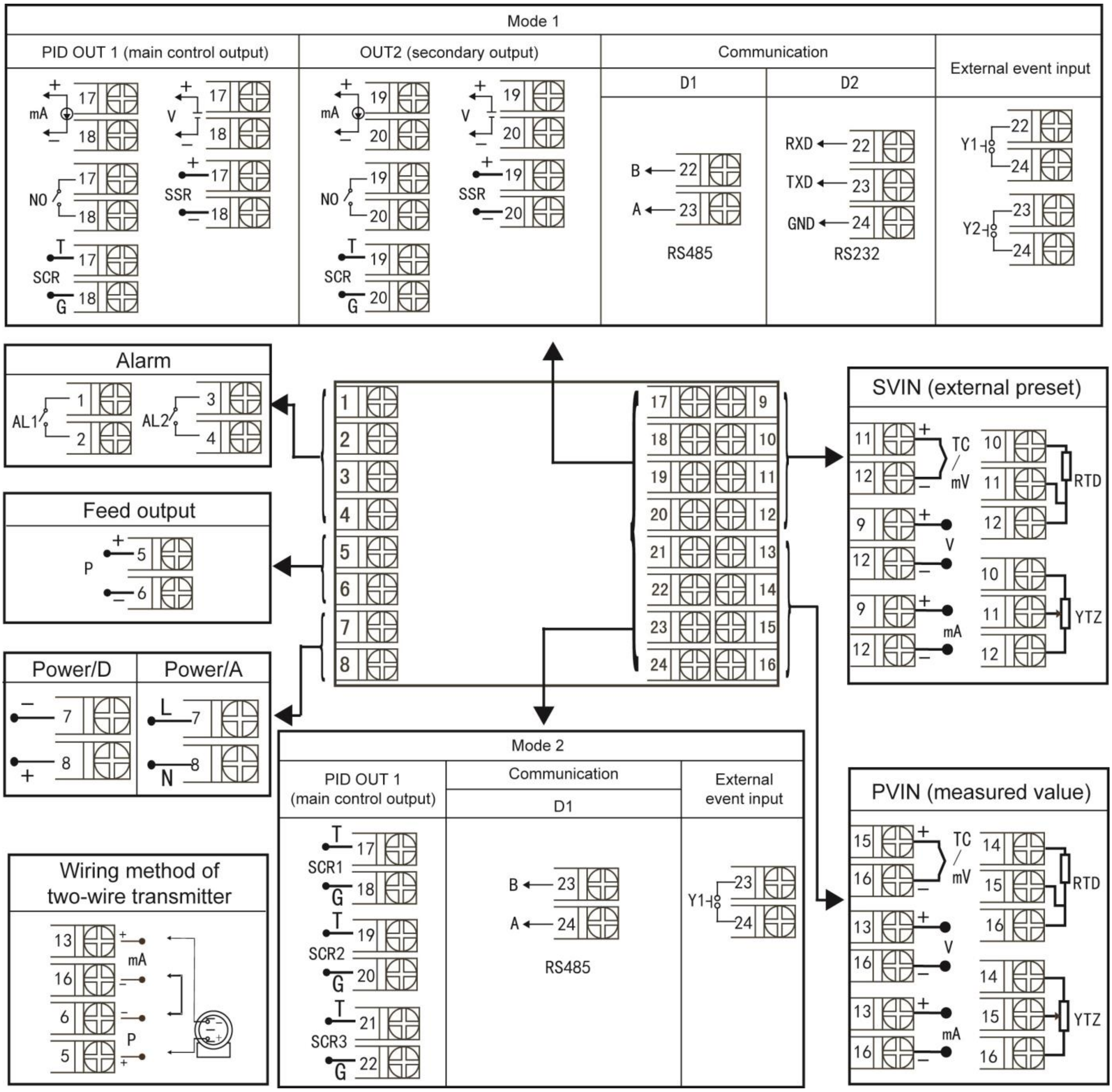
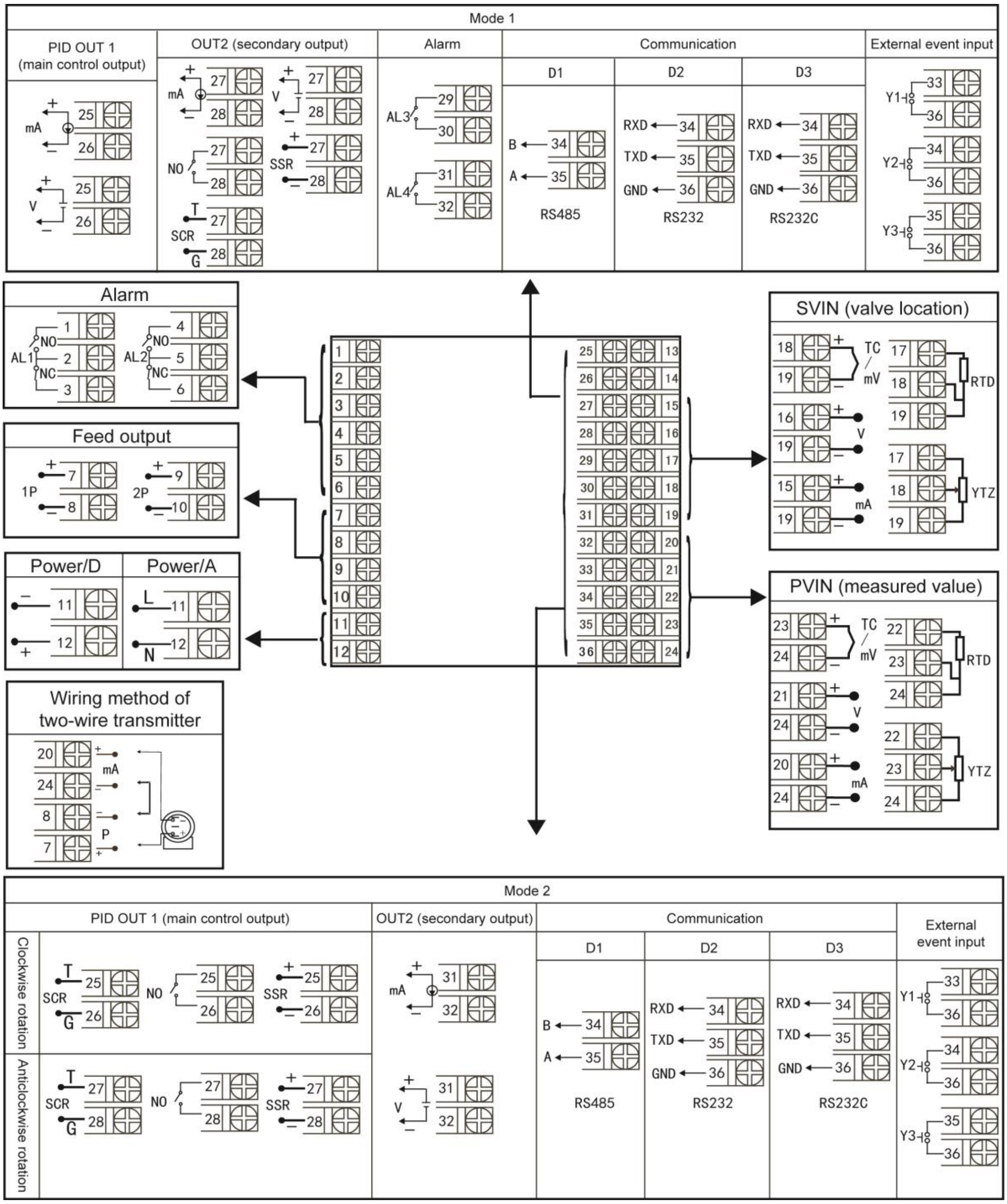


Diagram 1



Wiring Diagram of Type F

NHR-5330 Double channel input (valve location control) PID temperature controller/adjuster wiring diagram



Wiring diagram type A, B, C, D, E, K, L and M

Note: Horizontal and vertical instruments differ in the direction of the wiring terminals at their rear cover, as shown in Diagram 1.

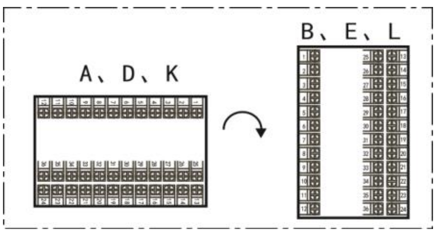
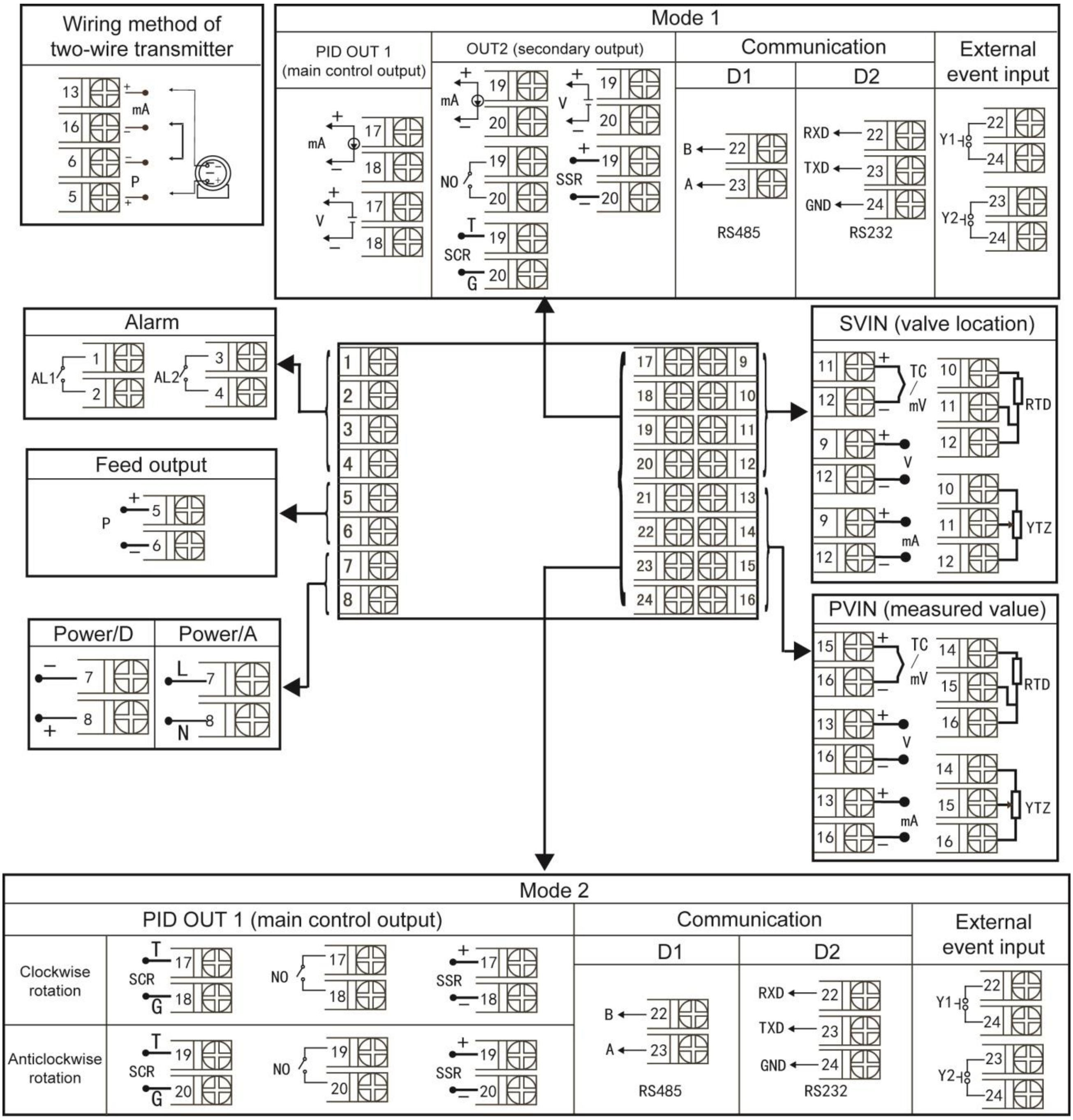


Diagram 1



Wiring Diagram of Type F

Note: Voltage and current input of an instrument with its external dimension code being F must be switched by short circuit ring

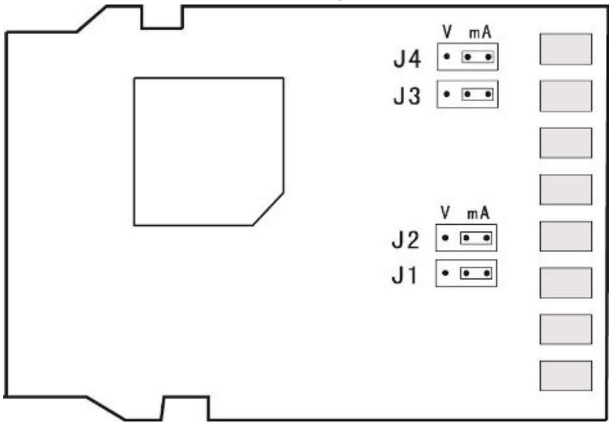
J1 and J2 are the signal switching positions for the first channel (measuring) input graduation

J3 and J4 are the signal switching positions for secondary channel

(valve location feedback or external preset)

	DC voltage input	DC input
Short circuit ring status		

Main board diagram with external dimension code being F is shown as below:



Ⅶ Adjustment settings

7.1 Alarm setting

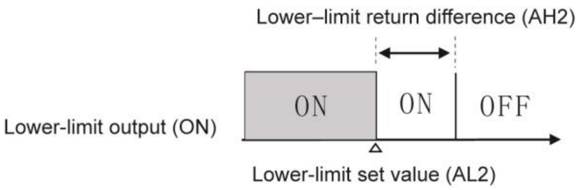
1. Alarm output (AL1, AL2, AH1 and AH2)

★About return difference:

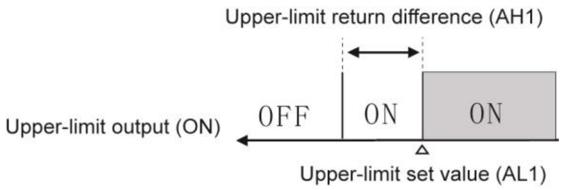
This instrument adopts alarm output to deal with return difference, to prevent frequent movement of output relay around the critical point of alarm output.

The specific output status is as follows:

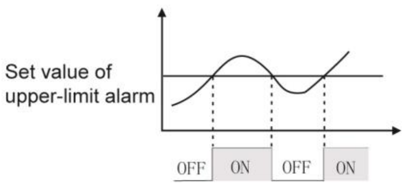
★Measured value rises from a low level:



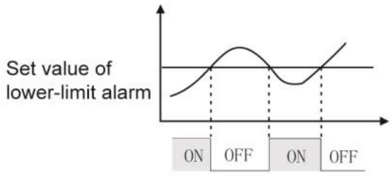
★Measured value descends from a high level:

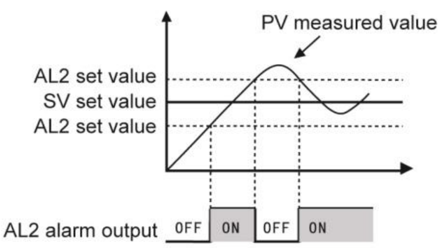


★Position upper limit alarm output:

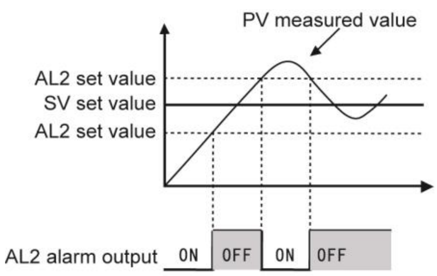


★Position lower limit alarm output:





Deviation internal alarm output



Deviation external alarm output

7.2 Automatic/Manual undisturbed switching method

In instrument automatic control output, press and simultaneously, and the instrument will automatically track output. It is finished when A/M indicator light (red) is on. Upon Automatic/Manual undisturbed switch, pressing or can manually change the ratio of instrument output (range: 0 to 100%).

In manual status, instrument PV displays: real-time measured value; SV displays: the ratio of instrument output.

7.3 Systematic PID parameters and self-tuning automatic status

The temperature controller is equipped with advanced PID control algorithm. When the design and installation of the control system are correct, the quality of control relies on the choosing those three parameters of P, I, D. Regulator has default value of P, I, D parameters. But the default value cannot make perfect effect when applying to the most targets. Self-tuning function can work at this moment. Through self-tuning, regulator can automatically search for optimized parameters according to the features of targets to achieve the best control effect: no overshoot, no oscillation, high precision, rapid response.

Method to start self-tuning: the temperature controller is equipped with PID parameter self-tuning function. During the first time of use, it is required to start self-tuning to determine P, I, D parameters which are most suitable for system control. Set the password of LOC as 0 or 123, and then press ⟲ to go to the next menu. Continue to press ⟲ to find parameter Aut, and change Aut from 0 to 1 to start self-tuning. See figure 1, when tuning gets started, A/M light will flash rapidly indicating instrument has been in self tuning. The temperature controller adopts ON-OFF duel tuning methods, outputs 0% or 100% to make oscillation in system, and then calculates PID parameter according to the system response curve. A larger time constant of object indicates a longer time of self tuning which can range from several seconds to several hours. When abandoning self tuning in advance, it is available to set Aut as 0 to stop self tuning. When self tuning is stopped or over, A/M light will turn from flashing to extinguishing, enter into automatic control. Self tuning can be implemented at any time. Usually it is enough to tune once in the primary debugging stage. When the features of objects change, it is required to do self tuning again.

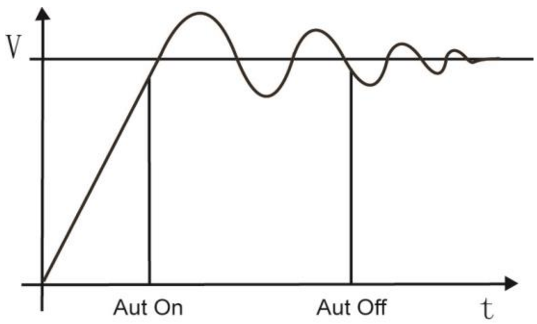


Figure 1

The adjuster adopts real artificial intelligence formula with no need for manual parameter tuning. The precision of temperature control is around ±0.1℃, without overshoot or undershoot. Temperature controller can reach up to the international advanced level.

Working status:

A. Control object: integrated high temperature electronic furnace (type：SXC-1.5)

B. Put full heating materials in to furnace

C. Control target value: 200.0℃

Operation situation:

A. Real intelligence formula without need of manual tuning parameters

B. Maxim overshoot :0.7℃

C. Time to be stabilized: 25min

D. Control precision after stabilization: ±0.1℃

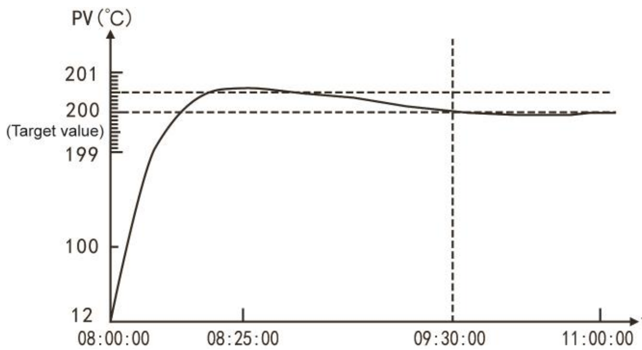


Figure 2

Working curve: See Figure 2

7.4 Manual parameter regulating method

Self tuning precision of this regulator is relatively high and can meet the needs of most objects. When objects are complicated, for example, objects like nonlinear, time varying, severe hysteresis, several times of tuning and manual regulation are needed for a better control effect. In manual adjustment, observe measured curve, when system is in vibration for a long time, vibration can be eliminated by increasing P or reducing D; when system cannot reach target value for a long time, it is available to reduce I to fasten response speed; when there are too many overshoots, it can be solved by increasing I or D. Serial experiment method can be adopted in adjustment, namely increase or reduce any one of P, I, D those three parameters. When control effect gets better, continue to change that parameter in the same direction, or else make reverse adjustment till control effect can meet the commands.

7.5 Overshoot restraining coefficient SF

SF is correspondent to control output, and adjust SF can prevent overshoot (or under shoot) in the transient process. The principle lies in entering into proportional adjustment in advance to put off integral adjustment (overcome integral windup). Influence of SF on transient process is shown in Figure 3; theoretically, too fast an adjustment speed brings about vibration to reach the net set value, while the effect as shown by the picture in the middle is perfect. According to technology time and allowable overshoot value, choose specific overshoot restraining coefficient on site: SF (0.00 to 1.00). SF is common PID when SF=1.00, with high overshoot restraining effect and a slow speed. It is suggested to use default value (SF=1.00).

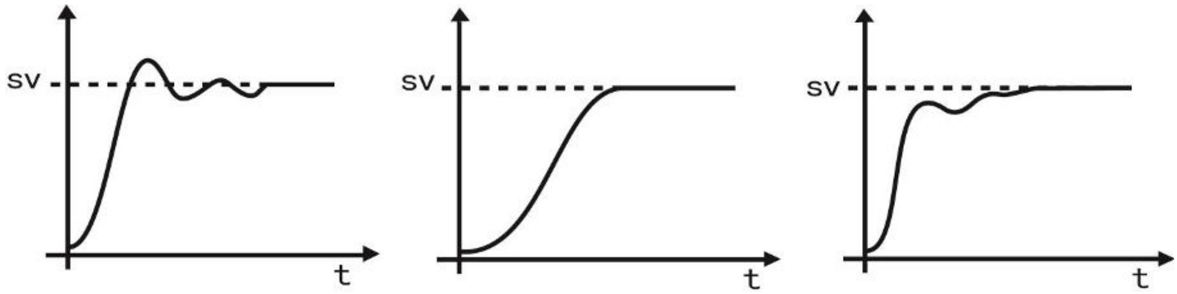


Figure 3: With overshoot, vibration with neither overshoot nor vibration undershoot, long transient time

7.6 Choosing formula types (PID)

The adjuster adopts artificial intelligence formula: when the hysteresis of the control system is severe and the control speed is slow, for example in the heating of electronic furnace when PID=0; when the control response speed is fast, for example in regulating valve’s control of physical quantity like pressure and flow rate when PID=1.

7.7 Operational principles of control output

1. Fuzzy PID self tuning status

(1) Automatic control

When power is on, the instrument is in the tracking status, samples PV input signals, and displays them on PV display window and control target value (or the percentage of output) on SV display window.

(2) Manual operations:

In case certain manual operations, press key and key at the same time, the instrument will automatically switch to manual control output based on current output, and the instrument A/M indicator is on, indicating automatic/manual disturbed switching. In the meantime, SV displays output (0 to 100%), and the valve of output can be regulated by pressing key (increasing output) key (reducing output). Press simultaneously key and key, the instrument will return to automatic control. At this moment, the instrument will set the integration time based on current input according to the controller, and follow the control approximation method to automatically change with PV and return to automatic control

2. Valve location control status:

The instrument can accept bilateral analog input signals, move them to PVin and SVin terminals to be displayed on PV display; PVin input signal shows the measured value and is to be displayed on PV display; SVin input signal shows the valve feedback value and is to be displayed on SV display. According to customers' specific needs, the instrument can output analog quantity (like 0 to 10 mA, 4 to 20 mA, 0 to 5 V, 1 to 5 V etc.) or other control signals (like positive inversion of valve location control).

(1) Automatic operation status:

During automatic control output, according to the fuzzy PID control algorithm, when the control output percentage is lower than SV valve location feedback, the instrument outputs inversion till control output=SV valve location feedback. When the control output percentage is higher than SV valve location feedback, the instrument outputs co-rotation till control output=SV valve location feedback.

★ The size of current control output can be seen by switching to manual status.

(2) Manual operation status

When the instrument is in key, and key, the instrument will automatically switch to manual control output based on current output; the instrument A/M indicator is on, indicating automatic/manual disturbed switching. SV displays percentage output (0 to 100%), and:

1) Press key, and the instrument will increase output (output co-rotation), till control output=SV valve location feedback, and then let go of the key to stop output.

2) Press key, and instrument will reduce output (output co-rotation), till control output=SV valve location feedback, and then let go of the key to stop output.

3) Press simultaneously key and key, and the instrument will return to automatic control output status, and control the opening of valve location according to the real-time measured value.

3. External preset control status:

The instrument can accept bilateral analog input signals and move them to PVin and SVin terminals. PVin input signal shows the measured value and is to be displayed on PV display; SVin input signal shows the external preset value and is to be displayed by the SV display. According to customers' specific needs, the instrument can output analog quantity (like 0 to 10 mA, 4 to 20 mA, 0 to 5 V, 1 to 5 V, etc) or other control signals (like positive inversion of valve location control).

(1) Automatic control status (analog quantity output)

The instrument is in automatic control status after automatic power-on. The instrument samples PVin input signal, controls the output of analog quantity according to PID control algorithm, and displays the measured value on PV display.

(2) Manual operation status

In case certain manual operations, press key and key, the instrument will automatically switch to manual control output based on current output; and the instrument A/M indicator is on, indicating automatic/manual disturbed switching.

In the meantime, SV displays output (0 to 100%), and the valve of output can be regulated by pressing key (increasing output) key (reducing output). Press simultaneously key and key, and the instrument will return to automatic control.

7.8 Print function

1. Manual print

In the instrument measurement value display status, press , and print the current real-time measurement value.

2. Timed print

When the measured time is equal to the interval time, the instrument will control the printer to perform timed print where the current real-time measurement value will be printed in a timed manner. The print format is:

TIME PRINT
2009－04－14 ----------------------Date
21：06：15 ----------------------Time
PV= －250℃ -----------------------First channel measurement value
SV= 500 -----------------------Control target value
Out= 0.0% ------------------------Percentage output value
Alm：○ ● ------------------------Alarm state
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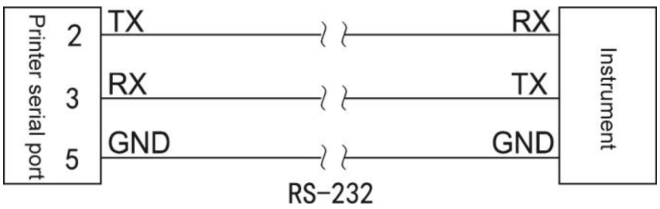
3. Wiring mode



VIII. Instrument communication

This instrument has communication function, and it can realize data collection, parameter setting and remote monitoring and control at an upper computer.

Technical index and communication mode: Serial communication RS-485, RS-232;

Baud rate: 1,200 to 9,600 bps

Data format: 1 start bit, 8 data bits and 1 stop bit

★For specific parameters, please consult the Manual for Instrument Communication.