TS-800 Series Slim Multi-Loop Independent Self-Tuning PID Temperature Control Module Operation Manual



⚠ WARNING

1. Wiring warning

If the controller fails or malfunctions, it may cause a system failure. Install an external protection circuit to prevent such accidents. To prevent the controller from being damaged or failing, appropriate fuses should be selected to protect the power lines and input/output lines from current surges.

2. Power supply for the controller

To prevent damage or failure of the controller, when powered by a DC power supply, the voltage must not be lower than 21.6VDC and must not be higher than 26.4VDC. When powered by an AC supply, the voltage must not be lower than 85VAC and must not exceed 264VAC. To prevent electric shock or controller failure, please check the wiring after all wiring work is completed. Only after confirming that there are no errors can the power be connected.

3. Do not use near flammable gases

For fire prevention, explosion prevention or to prevent damage to the controller, it is prohibited to use in places with flammable and explosive gases or where steam is discharged.

4. Do not touch the interior of the controller

To prevent electric shock or combustion, it is strictly forbidden to touch the interior of the controller. There are high-voltage and high-temperature parts inside the controller. Touching them without authorization is extremely dangerous!

5. It is strictly prohibited to modify the instrument

To prevent accidents or controller failure, it is strictly prohibited to modify the controller.

6. Maintenance

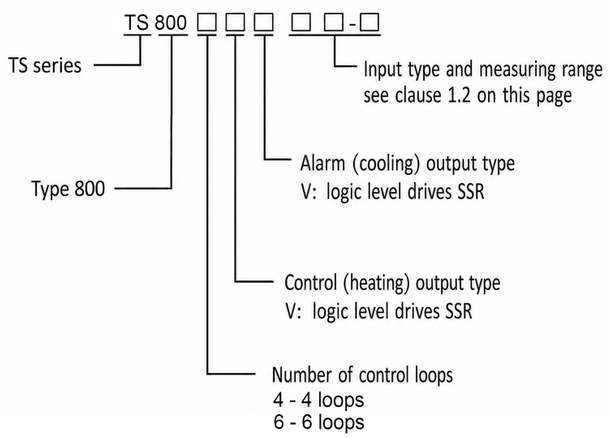
To ensure the long-term safe use of the controller, regular maintenance is necessary. Some components inside the controller may be damaged as the usage time increases.

7. Cleaning

The controller can be wiped only after the power is cut off. Please use a soft cloth or cotton paper to remove stains from the monitor. The monitor is prone to scratches. Do not wipe or touch it with hard objects. Do not operate the panel keys with hard objects such as screwdrivers or writing pens, otherwise the keys may be damaged or scratched.

1. Product confirmation

1.1. Please refer to the following selection code to confirm whether the delivered product is exactly the same as the model you have chosen.



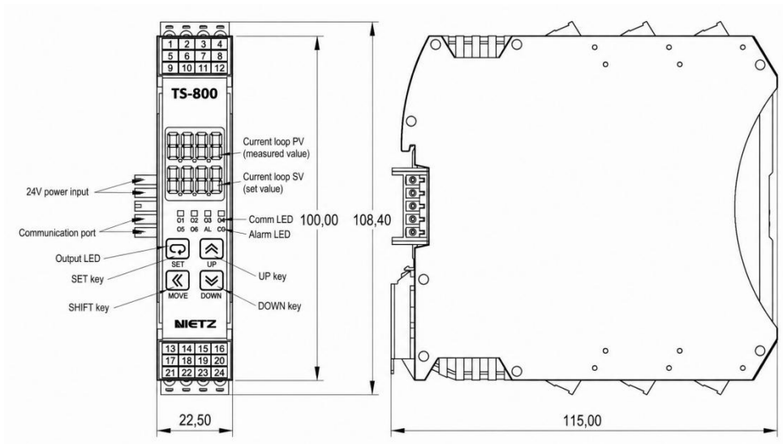
1.2. List of Common Input Types and Measurement Ranges

Serial number	Input type	SN	Graduation number	Maximum measurement range	
				Celsius（℃）	Fahrenheit（℉）
1	Thermocouple	1	E	-270～1000	-454～1832
2	Thermocouple	2	J	-210～1200	-346～2192
3	Thermocouple	3	K	-270～1372	-454～2501
4	Thermocouple	4	N	-270～1300	-454～2372
5	Thermal resistance	15	Pt100	-200～0850	-328～1562
6	Other sensors	Customizable		-500～4000	

1.3. Main technical indicators

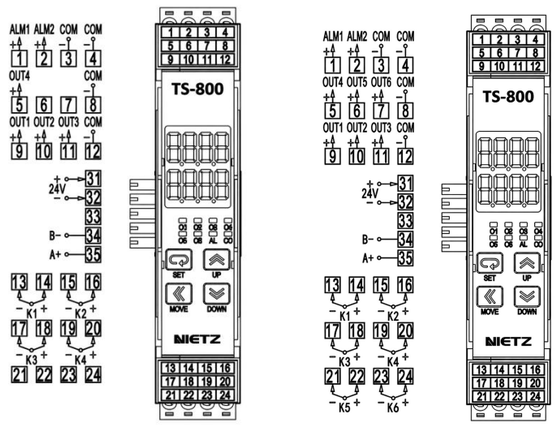
1) Measurement accuracy: ±0.5%FS±1db;
2) Cycle control period: 0.2 seconds for 6 loops;
3) Operating environment: Atmospheric pressure: 86~106kPa; Ambient temperature: -10~50℃; Relative humidity: 45~85%RH;
4) Power supply: 24VDC±10%, power consumption: ≤5VA; a 100~240VAC power supply version is also customizable;
5) Pay attention to avoiding:
   Condensation may be caused by sudden changes in ambient temperature;
   Directly vibrate or impact the main structure;
   Pollution from water, oil, chemicals, smoke or steam. Corrosive and flammable gases;
   Excessive dust, salt or metal powder.

2. Appearance and Installation



3. Terminal wiring

3.1. Wiring diagram of the thermocouple (or standard signal) input controller



TS-804 Wiring Diagram

TS-806 Wiring Diagram

4. Control parameter Settings

4.1. Control Parameter Settings

Press and hold the key for 4 seconds to enter the control parameter setting state. At this time, the upper row displays the parameter prompt “SV”, and the lower row displays the control parameters. At this time, the units digit flashes. Briefly press the key to move the number of flashing digits. After selecting the number of digits to be modified, briefly press the or key to modify the control parameter. Continue to briefly press the key. The upper row will display the prompt symbols of each parameter in sequence. After finding the parameter that needs to be modified, continue to briefly press the key to move the number of flashing digits. After selecting the number of digits that need to be modified, briefly press the or key again to modify the control parameter.

Press and hold the key for more than 4 seconds, and the controller will automatically return to the normal control state (if there is no key operation within 60 seconds, the controller will automatically return to the normal control state).

Tap the function key to confirm the current parameter and jump to the next one. If you press the shift key first and then tap the function key, you will confirm the current parameter and jump to the previous one.

4.2. List of Control Parameter Settings

Serial number	Parameter name	Symbol	Data range	Unit	Explanation	Initial value
1	Set value	SV	SVL~SVH	℃	Set the target value of the controller for this loop.	100
2	Lower limit alarm 1	AL1	-500～4000	℃	For details, please refer to 4.5 Alarm Output Description.	10
3	Lower limit alarm 2	AL2	-500～4000	℃	It has the same function as AL1, but can only be output through communication.	50
4	Upper limit alarm 1	AH1	-500～4000	℃	For details, please refer to 4.5 Alarm Output Description.	50
5	Upper limit alarm 2	AH2	-500～4000	℃	It has the same function as AH1, but can only be output through communication.	50
6	Alarm type	SA	00～66	—	The units digit of XX represents the selection of alarm type 1, and the tens digit represents the selection of alarm type 2: X= 0: No alarm; 1: Upper limit deviation value alarm; 2: Lower limit deviation value alarm; 3: Alarm when the upper and lower limit deviation values are exceeded; 4: Alarm within the upper and lower limit deviation values; 5: Upper limit absolute value alarm; 6: Lower limit absolute value alarm.	11
7	Forward and reverse action control and the first power-on alarm enable	EA	000~111	—	The hundreds digit of XXX is selected for both forward and reverse action control: X=0: Reaction control (heating type); 1: Positive action control (cooling type). The tens digit of XXX represents the first alarm enable selection of alarm 2, and the units digit of XXX represents the first alarm enable selection of alarm 1: X=0: After power-on, if the alarm conditions are met, no alarm will be triggered; thereafter, if the alarm conditions are met, an alarm will be triggered; 1: All conditions that meet the alarm requirements will trigger an alarm.	011
8	Proportional band	P	0~9999	℃	Proportional effect regulation: The larger the P, the smaller the proportional effect, and the lower the system gain. 0: Switch to on-off control mode. At this point, the integral time I becomes 0.1 times the upper limit of the insensitive region, and the differential time D becomes 0.1 times the lower limit of the insensitive region.	30

Continue from the above table

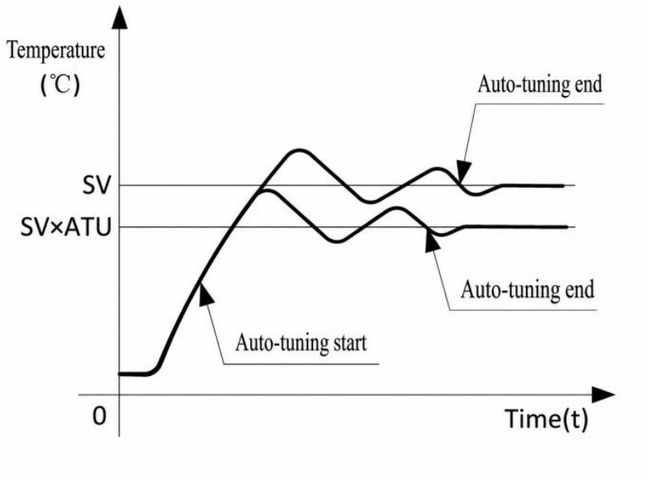
Serial number	Parameter name	Symbol	Data range	Unit	Explanation	Initial value
9	Integral time	I	0~9999	S	The integral action time constant: The larger I, the weaker the integral action. It is mainly used to eliminate static aberration. 0: Switch to PD control mode. At this point, the integral suppression Ar is RESET, and Ar is set to zero, with the unit being ℃, to eliminate static error. When the proportional band P=0, see the explanation of the proportional band P.	240
10	Differential time	d	0~9999	S	Differential action time constant: The larger the D, the stronger the differential action, mainly used to suppress overshoot of the measured value. When the proportional band P=0, see the explanation of the proportional band P.	60
11	Integral suppression	Ar	0~100	%	Integral suppression ratio: The larger the Ar, the greater the possible overshoot; if the Ar is too small, static tolerance may occur. When the integration time I=0, see the description of the integration time I.	100
12	Positional hysteresis	HY	Full range	Degree	It is effective when P=0 bit control is applied	20
13	Sensor correction	Pb	-500~4000	℃	It is used to correct the measurement errors caused by sensors and thermocouple compensating wires.	0
14	Self-tuning	At	nO or YES	—	YES: Start self-tuning. After self-tuning is completed, resume nO. If self-tuning is not completed within 4 hours, it is considered a failure and the original P, I, and D	nO

					values are still used for control.	
15	Self-tuning limit	AtU	0~100	%	To overcome the overshoot phenomenon during self-tuning, the self-tuning control point can be lowered to SV×ATU.	100
16	Filtering coefficient	FIL	0~250	—	The smaller this value is, the faster the response speed of the measurement value will be, but there may be fluctuations. The larger this value is, the slower the response speed of the measured value will be, and the more stable the display will be.	125
17	Alarm 1 Switching difference	FH1	-500~4000	℃	The switching difference is 0.1 times that of FH1.	10
18	Alarm 2 Switching difference	FH2	-500~4000	℃	The switching difference is 0.1 times that of FH2.	10
19	Upper limit of the sensor range	RH	Full range	Degree	Measure the upper limit of the range according to the type of goods or sensor	500
20	Lower limit of the sensor range	RL	Full range	Degree	The lower limit of the measurement range is determined by the type of goods or sensor	0
21	Upper limit of temperature control value	SꓯH	RL—RH	℃	Set the maximum temperature control value according to the heating load	300
22	Lower limit of temperature control value	SꓯL	RL--RH	℃	Set the minimum temperature control value according to the heating load	0
23	Control output Switch	SSt	On~Off	—	Off: The control output is turned off (SV displays 0FF under normal conditions), and only the output is turned off. Other functions such as alarms operate normally. On: Output enabled.	On
24	Lower output limit	PL	0—30%	%	Generally, when heating at 4-20mA, set and adjust the maximum heating percentage. For example, if set to 50, then the maximum heating percentage of 50 means the maximum output is 12mA,	0
25	Output upper limit	PH	50—100%	%	Generally, when heating from 4 to 20mA, set and adjust the minimum heating percentage. For example, if set to 5, the minimum heating will be 5%, that is, the minimum output will be 4.8mA,	100
26	Slope heating	SPR	0~9999	0	Reserved. Not in use yet	0

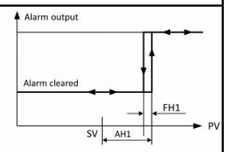
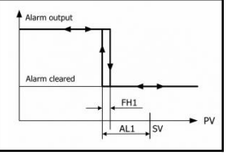
4.2. Self-tuning PID parameter function

Following the control parameter setting operation, find the self-tuning start parameter AT. The upper row shows the AT prompt, and the lower row shows the nO prompt, indicating that the limit tuning or self-tuning function has not been enabled yet. Press the key to make the lower row display the YES prompt, indicating that the user is ready to start the self-tuning function of this loop. If the loop system does not allow the temperature to exceed the set value SV by too much, the next parameter, the self-tuning limit ATU, can be set. Generally, the ATU can be set between 70% and 80% (i.e., self-tuning is performed within 70% to 80% of the set value). Then, press the key for more than 1 second to exit the parameter setting. At this point, the AT indicator will flash, indicating that the controller is in the process of tuning. After two to three fluctuations in temperature, the self-tuning process is completed. The AT indicator light goes out, and a set of P, I, and D parameter values suitable for the control of this loop is obtained. Control is then carried out according to the new P, I, and D parameters, which will be permanently saved in the controller.

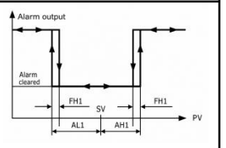
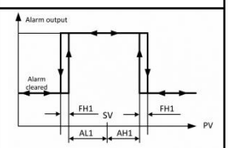
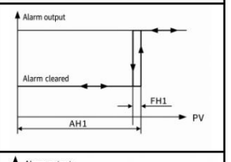
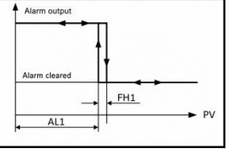
If it is necessary to interrupt the self-tuning process during the tuning process, you need to re-enter the control parameter menu, set the self-tuning start parameter AT to nO, and then exit the control parameter menu. At this time, the AT indication goes out, and the controller will control according to the original P, I, and D parameters.



4.3. Alarm Output Description

Serial number	Type	Action conditions		Schematic diagram (Taking Alarm 1 as an example only)
		Alarm 1	Alarm 2	
1	No alarm	The units digit of SA =0.	The tens digit of SA =0.	——
2	Upper limit deviation alarm	The units digit of SA =1; An alarm is triggered when PV exceeds SV+AH1. The alarm is cleared when PV≤SV+AH1-FH1.	The tens digit of SA =1; An alarm is triggered when PV exceeds SV+AH2. The alarm is cleared when PV≤SV+AH2-FH2.	
3	Lower limit deviation alarm	The units digit of SA =2; An alarm is triggered when PV<SV-AL1. The alarm is cleared when PV≥SV-AL1+FH1.	The tens digit of SA =2; An alarm is triggered when PV<SV-AL2. The alarm is cleared when PV≥SV-AL2+FH2.	

Continue from the above table

Serial number	Type	Action conditions		Schematic diagram (Taking Alarm 1 as an example only)
		Alarm 1	Alarm 2	
4	Alarm for deviation outside the upper and lower limits	The units digit of SA =3; An alarm is triggered when PV exceeds SV+AH1. When PV≤SV+AH1-FH1, the alarm is cleared; An alarm is triggered when PV<SV-AL1. The alarm is cleared when PV≥SV-AL1+FH1.	The tens digit of SA =3; An alarm is triggered when PV exceeds SV+AH2. When PV≤SV+AH2-FH2, the alarm is cleared; An alarm is triggered when PV<SV-AL2. The alarm is cleared when PV≥SV-AL2+FH2.	
5	Alarm within the deviation of the upper and lower limits	The units digit of SA =4; SV-AL1<PV<SV+AH1 alarm; Or when PV≥SV+AH1+FH1 or PV≤SV-AL1-FH1, the alarm is lifted.	The tens digit of SA =4; SV-AL2<PV<SV+AH2 alarm; Or when PV≥SV+AH2+FH2 or PV≤SV-AL2-FH2, the alarm is lifted.	
6	Upper limit absolute value alarm	The units digit of SA =5; An alarm is triggered when PV exceeds AH1. The alarm is cleared when PV≤AH1-FH1.	The tens digit of SA =5; An alarm is triggered when PV exceeds AH2. The alarm is cleared when PV≤AH2-FH2.	
7	Lower limit absolute value alarm	The units digit of SA =6; An alarm is triggered when PV<AL1. The alarm is cleared when PV≥AL1+FH1.	The tens digit of SA =6; An alarm is triggered when PV<AL2. The alarm is cleared when PV≥AL2+FH2.	

4.4. Error message

When the measured value PV is lower than the lower limit of the range RL, it will be displayed as ooo (communication output -16666), indicating that the thermocouple is connected in reverse, the thermal resistance is short-circuited, the three-wire system is connected incorrectly, or the ambient temperature (cold end temperature) is too low, etc. Please check whether the sensor wiring is correct or if the sensor is damaged. When the ambient temperature is too low, you can try lowering the lower limit of the range RL.

When the measured value PV is higher than the upper limit of the range RH, it is displayed as ooo (communication output is 18888), indicating that the thermocouple is open-circuited, the thermal resistor is open-circuited, the actual measured temperature is higher than the upper limit of the range (the sensor and the heating unit do not form the same circuit, resulting in long-term heating), etc.

4.5. Enter the internal copy menu (Press the plus and minus keys simultaneously to modify LoCK=1120) The parameters are the same as those in Table 4.4

As long as the modified value is different from the original value, the new number will be copied by default. For example, if AL1 was originally 100 and is modified to 110, then the alarm 1s from 1 to 16 will all be changed to 110. If there are no changes, all will remain the original values.

4.6. Restore factory Settings (simultaneously press the plus and minus keys to modify LoCK=2324)

5. Internal parameter Settings

5.1. Communication parameter Settings (under normal conditions, press the key for more than 3 seconds to enter the communication parameter Settings.)

Serial number	Parameter name	Parameter symbol	Data range	Explanation	Initial value
1	Correspondence Address	Addr	1~250	The address number of the lower server of the module	1
2	Communication rate (bps)	bAUd	1.2K—38.4K	19.2k indicates a baud rate of 19,200	19.2K
3	Communication stop bit	UAEP	1-2	Select 1 as one stop position and 2 as two stop positions	1
4	Communication check bit	PEPS	---	Select the communication parity bit, NONE for no parity bit, ODD for odd parity bit, and EUEN for even parity bit	NONE
5	Passage inspection time	CHLS	0~100	Check the waiting key between 0 conduction. The unit is seconds	4

5.2. Internal public parameter Settings (Simultaneously press the plus and minus keys to modify LOCK=88)

Serial number	Parameter name	Parameter symbol	Data range	Explanation	Initial value
1	Selection of graduation number	SN	--	Select the sensor input type	K
2	Decimal point	DP	0-3	When using thermocouples or thermal resistors, set 0 to 1. When setting the standard signal, set 0-3. When the tens digit of OABY equals 5, the setting is invalid. At this time, PV has one decimal point and SP has no decimal point	0
3	Temperature unit	UINT	C/F	Select the temperature unit of Celsius (Fahrenheit)	℃
4	Heating cycle	T	---	The heating cycle is set to 20 seconds when the relay is heating	3 s
5	Room temperature correction	TXXX	-10.0—100.0	The upper row of thousands shows the temperature of the current room, and the lower row modifies the room temperature error	0.0
6	Heating direction	DIR	---	-------	HEAT
7	Output type	OUT	--	The output type selection cannot be switched by software at present. It can only be specified as solid-state, relay or thyristor heating when placing an order	0
8	Control parameter 1	OABY	00--9999	Dividing it into units, tens, hundreds and thousands represents independent meanings. When the units digit is 1, the button will sound a buzzer as a prompt. When the tens digit equals 5, limit the decimal point of DP. The setting sequence is as follows: if DP=1, restore the factory settings first, or set DP=0 and then set it to 5	0001
9	Control parameter 2	A3PY	00---9999	Dividing it into units, tens, hundreds and thousands represents independent meanings	0000
10	Overshoot coefficient	STPU	0.0—25.0	Power-on overshoot percentage coefficient	0.7
11	Display coefficient	STDT	0.0--100.0	Display stability coefficient	1.5
12	Closure deviation	PHOF	0-Full range	Force off the heating deviation. This function is not available when set to 0 When PV>SV+PHOF, the heating is forcibly turned off	4
13	Lower display control	RLTO	0—30 min	When measuring the overflow within the RLTO time after power-on, display RL-50	10 min
14	Channel selection	SCH	1--8	It can be set to 1---- (number of ordered channels)	6
15	Parameter password lock	LCK	0--9999	=0 can modify any parameter, = others cannot be modified and can only be viewed	0

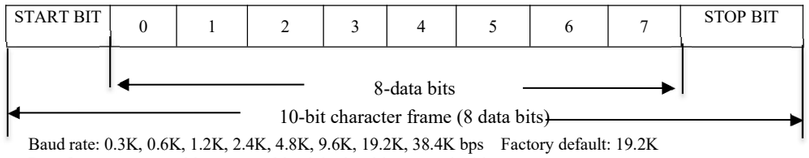
TS-800 series Slim Temperature Module RTU Communication Protocol

Operation Manual (Software Edition)



1. Character structure (10-bit character frame) and baud rate

Data format 8.N.1



Baud rate: 0.3K, 0.6K, 1.2K, 2.4K, 4.8K, 9.6K, 19.2K, 38.4K bps Factory default: 19.2K

Data format: one start bit, one stop bit, eight data bits, no parity bit

Data type: one parameter address is represented by two bytes in two's complement; the measured value PV carries one decimal place.

2. Communication data structure

2.1. Data format frame

START	No input signal, hold ≥ 20 ms
Address	Communication address: 8-bit binary address
Function	Function code: 8-bit binary
DATA(n-1) …… DATA 0	Data content: n (8-bit data). Read: n ≤ all data; Write: n ≤ 60
CRC CHK Low	CRC check code: 16-bit CRC check code composed of two 8-bit binary bytes
CRC CHK High	
END	No input signal, hold ≥ 20 ms

2.2. Communication address (Address), slave device address

00H: broadcast to all controllers, only for function codes 06H and 10H

01H: to the controller at address 01

0FH: to the controller at address 15

10H: to the controller at address 16

and so on …… up to a maximum of 254 (FEH).

2.3. Function code (Function) and data content (Data Characters)

03H: read the contents of the controller registers

06H: write a single register of the controller

10H: write multiple registers of the controller; currently up to 16 consecutive register addresses are supported

08H: loopback detection

2.3.1. Function code 03H: read register contents

Example: for controller address 01H, read 12 consecutive register contents; the starting register address is 0000H.

The host asks the slave machine for the format:

Address	01H
Function	03H
Starting data address	00H 00H
Number of data (count by word)	00H 0CH
CRC CHK Low	45H
CRC CHK High	CFH

The format of the slave madhine respondina to the host:

Address	01H	Content of data address 0006h SLED1	20H 51H
Function	03H		
Number of data (count by byte)	18H	Content of data address 0007h SLED2	21H 53H
Content of data	03H	Content of data	22H
address 0000h PV1	E8H	address 0008h SLED3	51H
Content of data address 0001h PV2	03H E8H	Content of data address 0009h SLED4	23H 51H
Content of data address 0002h PV3	03H E8H	address 000Ah SLED5	2451H
Content of data address 0003h PV4	03H E8H	address 000Bh SLED6	3251H
address 0004h PV5	03E8H	CRC CHK Low	4AH
address 0004h PV5	03E8H	CRC CHK High	8BH

Note:

The first measured value read out is PV1 = 100.0; it is currently heating, heating percentage 32%.

The second measured value read out is PV2 = 100.0; it is currently heating and alarm 1 is active, heating percentage 33%.

The third measured value read out is PV3 = 100.0; it is currently heating, heating percentage 34%.

The fourth measured value read out is PV4 = 100.0; it is currently heating, heating percentage 35%.

The fifth measured value read out is PV5 = 100.0; it is currently heating, heating percentage 36%.

The sixth measured value read out is PV6 = 100.0; it is currently heating, heating percentage 50%.

2.3.3. Function code 06H: write one WORD to a register

Example: for controller address 01H, write 100 (0064H) to controller register address 000CH (SP1 set value).

The host asks the slave machine for the format	
Address	01H
Function	06H
Data address	00H 0CH
Data content	00H 64H
CRC CHK Low	48H
CRC CHK High	22H

The format of the slave madhine respondina to the host:	
Address	01H
Function	06H
Data address	00H 0CH
Data content	00H 64H
CRC CHK Low	48H
CRC CHK High	22H

2.3.4. Function code 10H: write multiple WORDs to registers

Example: for controller address 01H, consecutively write SP1–SP6.

The host asks the slave machine for the format:

Slave address	Address	01H
Function code	Function	10H
Starting register address of the slave	Data Addr High	00H
	Data Addr Low	0CH
Total number of addresses to write (one word = two bytes)	Number of data (count by word)	00H 06H
Total number of bytes written	Count By Byte	0CH
Consecutively write SP1–SP6 data	SP1 high byte	00H
	SP1 low byte	1EH
	SP2 high byte	00H
	SP2 low byte	2EH
	SP3 high byte	00H
	SP3 low byte	3EH
	SP4 high byte	00H
	SP4 low byte	4EH
	SP5	005EH
	SP6	010EH
CRC low byte	CRC Check Low	ECH
CRC high byte	CRC Check High	10H

The format of the slave madhine respondina to the host:

Slave address	Address	01H
Function code	Function	10H
Return the slave register address that was written	Data Addr High	00H
	Data Addr Low	08H
Return the total number of addresses written (one word = two bytes)	Number of data (count by word)	00H 04H
CRC low byte	CRC Check Low	40H
CRC high byte	CRC Check High	08H

2.3.5. Function code 08H: loopback detection

Example: for controller address 01H, perform loopback detection; the query message string is identical to the response message string. The format is as follows:

The host asks the slave machine for the format	
Address	01H
Function	08H
Sub-function Hi	00H
Sub-function Lo	00H
Data content	12H ABH
CRC CHK Low	ADH
CRC CHK High	14H

The format of the slave madhine respondina to the host:	
Address	01H
Function	08H
Sub-function Hi	00H
Sub-function Lo	00H
Data content	12H ABH
CRC CHK Low	ADH
CRC CHK High	14H

3. Controller parameter address definition

Name	Register address	Data range	Factory value	Attribute
Measured value (PV1)	0000H	Measured value of channel 1, Note 1	—	R
Measured value (PV2)	0001H	Measured value of channel 2, Note 1	—	R
Measured value (PV3)	0002H	Measured value of channel 3, Note 1	—	R
Measured value (PV4)	0003H	Measured value of channel 4, Note 1	—	R
Measured value (PV5)	0004H	Measured value of channel 5, Note 1	—	R
Measured value (PV6)	0005H	Measured value of channel 6, Note 1	—	R
Status indication (SLED1)	0006H	Current status indication of channel 1, Note 2	—	R
Status indication (SLED2)	0007H	Current status indication of channel 2, Note 2	—	R
Status indication (SLED3)	0008H	Current status indication of channel 3, Note 2	—	R
Status indication (SLED4)	0009H	Current status indication of channel 4, Note 2	—	R
Status indication (SLED5)	000AH	Current status indication of channel 5, Note 2	—	R
Status indication (SLED6)	000BH	Current status indication of channel 6, Note 2	—	R
Control temperature (SP1)	000CH	Target control temperature of channel 1, setting range 0–SPH1	100 degrees	R/W
Control temperature (SP2)	000DH	Target control temperature of channel 2, setting range 0–SPH2	100 degrees	R/W
Control temperature (SP3)	000EH	Target control temperature of channel 3, setting range 0–SPH3	100 degrees	R/W
Control temperature (SP4)	000FH	Target control temperature of channel 4, setting range 0–SPH4	100 degrees	R/W
Control temperature (SP5)	0010H	Target control temperature of channel 5, setting range 0–SPH5	100 degrees	R/W
Control temperature (SP6)	0011H	Target control temperature of channel 6, setting range 0–SPH6	100 degrees	R/W
Alarm 1 of channel 1 (1AL1)	0012H	Alarm temperature 1 of channel 1, setting range: full scale	10 degrees	R/W
Alarm 1 of channel 2 (2AL1)	0013H	Alarm temperature 1 of channel 2, setting range: full scale	10 degrees	R/W
Alarm 1 of channel 3 (3AL1)	0014H	Alarm temperature 1 of channel 3, setting range: full scale	10 degrees	R/W
Alarm 1 of channel 4 (4AL1)	0015H	Alarm temperature 1 of channel 4, setting range: full scale	10 degrees	R/W
Alarm 1 of channel 5 (5AL1)	0016H	Alarm temperature 1 of channel 5, setting range: full scale	10 degrees	R/W
Alarm 1 of channel 6 (6AL1)	0017H	Alarm temperature 1 of channel 6, setting range: full scale	10 degrees	R/W
Alarm 2 of channel 1 (1AL2)	0018H	Alarm temperature 2 of channel 1, setting range: full scale	20 degrees	R/W
Alarm 2 of channel 2 (2AL2)	0019H	Alarm temperature 2 of channel 2, setting range: full scale	20 degrees	R/W
Alarm 2 of channel 3 (3AL2)	001AH	Alarm temperature 2 of channel 3, setting range: full scale	20 degrees	R/W
Alarm 2 of channel 4 (4AL2)	001BH	Alarm temperature 2 of channel 4, setting range: full scale	20 degrees	R/W
Alarm 2 of channel 5 (5AL2)	001CH	Alarm temperature 2 of channel 5, setting range: full scale	20 degrees	R/W
Alarm 2 of channel 6 (6AL2)	001DH	Alarm temperature 2 of channel 6, setting range: full scale	20 degrees	R/W
Function switch of channel 1 (ATU1)	001EH	Units digit: 1 = start auto-tuning, 2 = stop auto-tuning, other values are meaningless. Tens digit: 1 = heating switch on (normal temperature control), 2 = heating off and lower display shows OFF, other values are meaningless.	10	R/W
Function switch of channel 2 (ATU2)	001FH	Units digit: 1 = start auto-tuning, 2 = stop auto-tuning, other values are meaningless. Tens digit: 1 = heating switch on (normal temperature control), 2 = heating off and lower display shows OFF, other values are meaningless.	10	R/W
Function switch of channel 3 (ATU3)	0020H	Units digit: 1 = start auto-tuning, 2 = stop auto-tuning, other values are meaningless. Tens digit: 1 = heating switch on (normal temperature control), 2 = heating off and lower display shows OFF, other values are meaningless.	10	R/W
Function switch of channel 4 (ATU4)	0021H	Units digit: 1 = start auto-tuning, 2 = stop auto-tuning, other values are meaningless. Tens digit: 1 = heating switch on (normal temperature control), 2 = heating off and lower display shows OFF, other values are meaningless.	10	R/W
Function switch of channel 5 (ATU5)	0022H	Units digit: 1 = start auto-tuning, 2 = stop auto-tuning, other values are meaningless. Tens digit: 1 = heating switch on (normal temperature control), 2 = heating off and lower display shows OFF, other values are meaningless.	10	R/W
Function switch of channel 6 (ATU6)	0023H	Units digit: 1 = start auto-tuning, 2 = stop auto-tuning, other values are meaningless. Tens digit: 1 = heating switch on (normal temperature control), 2 = heating off and lower display shows OFF, other values are meaningless.	10	R/W
Proportional band (P1)	0024H	Proportional band heating of channel 1, 0–full scale; =0 means ON-OFF (two-position) control	30 degrees	R/W
Proportional band	0025H	Proportional band heating of channel 2, 0–full scale; =0 means	30	R/W

(P2)		ON-OFF (two-position) control	degrees	
Proportional band (P3)	0026H	Proportional band heating of channel 3, 0–full scale; =0 means ON-OFF (two-position) control	30 degrees	R/W
Proportional band (P4)	0027H	Proportional band heating of channel 4, 0–full scale; =0 means ON-OFF (two-position) control	30 degrees	R/W
Proportional band (P5)	0028H	Proportional band heating of channel 5, 0–full scale; =0 means ON-OFF (two-position) control	30 degrees	R/W
Proportional band (P6)	0029H	Proportional band heating of channel 6, 0–full scale; =0 means ON-OFF (two-position) control	30 degrees	R/W
Integral time (I1)	002AH	Integral time of channel 1, 0–full scale	100 s	R/W
Integral time (I2)	002BH	Integral time of channel 2, 0–full scale	100 s	R/W
Integral time (I3)	002CH	Integral time of channel 3, 0–full scale	100 s	R/W
Integral time (I4)	002DH	Integral time of channel 4, 0–full scale	100 s	R/W
Integral time (I5)	002EH	Integral time of channel 5, 0–full scale	100 s	R/W
Integral time (I6)	002FH	Integral time of channel 6, 0–full scale	100 s	R/W
Derivative time (D1)	0030H	Derivative time of channel 1, 0–full scale	25 s	R/W
Derivative time (D2)	0031H	Derivative time of channel 2, 0–full scale	25 s	R/W
Derivative time (D3)	0032H	Derivative time of channel 3, 0–full scale	25 s	R/W
Derivative time (D4)	0033H	Derivative time of channel 4, 0–full scale	25 s	R/W
Derivative time (D5)	0034H	Derivative time of channel 5, 0–full scale	25 s	R/W
Derivative time (D6)	0035H	Derivative time of channel 6, 0–full scale	25 s	R/W
Correction value (PB1)	0036H	PV1 = measured value 1 + PB1	0	R/W
Correction value (PB2)	0037H	PV2 = measured value 2 + PB2	0	R/W
Correction value (PB3)	0038H	PV3 = measured value 3 + PB3	0	R/W
Correction value (PB4)	0039H	PV4 = measured value 4 + PB4	0	R/W
Correction value (PB5)	003AH	PV5 = measured value 5 + PB5	0	R/W
Correction value (PB6)	003BH	PV6 = measured value 6 + PB6	0	R/W
Alarm hysteresis (AH1)	003CH	Hysteresis of alarm 1 and alarm 2 of channel 1	2	R/W
Alarm hysteresis (AH2)	003DH	Hysteresis of alarm 1 and alarm 2 of channel 2	2	R/W
Alarm hysteresis (AH3)	003EH	Hysteresis of alarm 1 and alarm 2 of channel 3	2	R/W
Alarm hysteresis (AH4)	003FH	Hysteresis of alarm 1 and alarm 2 of channel 4	2	R/W
Alarm hysteresis (AH5)	0040H	Hysteresis of alarm 1 and alarm 2 of channel 5	2	R/W
Alarm hysteresis (AH6)	0041H	Hysteresis of alarm 1 and alarm 2 of channel 6	2	R/W
Manual output (MO1)	0042H	Manual output percentage of channel 1, 0–100%	0	R/W
Manual output (MO2)	0043H	Manual output percentage of channel 2, 0–100%	0	R/W
Manual output (MO3)	0044H	Manual output percentage of channel 3, 0–100%	0	R/W
Manual output (MO4)	0045H	Manual output percentage of channel 4, 0–100%	0	R/W
Manual output (MO5)	0046H	Manual output percentage of channel 5, 0–100%	0	R/W
Manual output (MO6)	0047H	Manual output percentage of channel 6, 0–100%	0	R/W
Minimum output (OPL1)	0048H	Minimum heating output percentage of channel 1, 0–30%	0	R/W
Minimum output (OPL2)	0049H	Minimum heating output percentage of channel 2, 0–30%	0	R/W
Minimum output (OPL3)	004AH	Minimum heating output percentage of channel 3, 0–30%	0	R/W
Minimum output (OPL4)	004BH	Minimum heating output percentage of channel 4, 0–30%	0	R/W
Minimum output (OPL5)	004CH	Minimum heating output percentage of channel 5, 0–30%	0	R/W
Minimum output (OPL6)	004DH	Minimum heating output percentage of channel 6, 0–30%	0	R/W
Maximum output (OPH1)	004EH	Maximum heating output percentage of channel 1, OPL1–100%	100	R/W
Maximum output (OPH2)	004FH	Maximum heating output percentage of channel 2, OPL2–100%	100	R/W
Maximum output (OPH3)	0050H	Maximum heating output percentage of channel 3, OPL3–100%	100	R/W
Maximum output (OPH4)	0051H	Maximum heating output percentage of channel 4, OPL4–100%	100	R/W
Maximum output (OPH5)	0052H	Maximum heating output percentage of channel 5, OPL5–100%	100	R/W
Maximum output (OPH6)	0053H	Maximum heating output percentage of channel 6, OPL6–100%	100	R/W
Ramp rate (SPR1)	0054H	Ramp rate of channel 1, generally used at start-up; set to 0 for full-speed ramp; unit: degree/minute	0	R/W
Ramp rate (SPR2)	0055H	Ramp rate of channel 2, generally used at start-up; set to 0 for full-speed ramp; unit: degree/minute	0	R/W
Ramp rate (SPR3)	0056H	Ramp rate of channel 3, generally used at start-up; set to 0 for full-speed ramp; unit: degree/minute	0	R/W
Ramp rate (SPR4)	0057H	Ramp rate of channel 4, generally used at start-up; set to 0 for full-speed ramp; unit: degree/minute	0	R/W
Ramp rate (SPR5)	0058H	Ramp rate of channel 5, generally used at start-up; set to 0 for full-speed ramp; unit: degree/minute	0	R/W
Ramp rate (SPR6)	0059H	Ramp rate of channel 6, generally used at start-up; set to 0 for full-speed ramp; unit: degree/minute	0	R/W
Set value upper limit (SPH1)	005AH	Maximum value of the target control setting of channel 1, 0–RH1	400	R/W
Set value upper limit (SPH2)	005BH	Maximum value of the target control setting of channel 2, 0–RH2	400	R/W
Set value upper limit (SPH3)	005CH	Maximum value of the target control setting of channel 3, 0–RH3	400	R/W
Set value upper limit (SPH4)	005DH	Maximum value of the target control setting of channel 4, 0–RH4	400	R/W
Set value upper limit (SPH5)	005EH	Maximum value of the target control setting of channel 5, 0–RH5	400	R/W
Set value upper limit (SPH6)	005FH	Maximum value of the target control setting of channel 6, 0–RH6	400	R/W
Measured value upper limit (RH1)	0060H	Sensor measurement upper limit of channel 1, 0–full scale	500	R/W
Measured value upper limit (RH2)	0061H	Sensor measurement upper limit of channel 2, 0–full scale	500	R/W
Measured value upper limit (RH3)	0062H	Sensor measurement upper limit of channel 3, 0–full scale	500	R/W
Measured value upper limit (RH4)	0063H	Sensor measurement upper limit of channel 4, 0–full scale	500	R/W
Measured value upper limit (RH5)	0064H	Sensor measurement upper limit of channel 5, 0–full scale	500	R/W
Measured value upper limit (RH6)	0065H	Sensor measurement upper limit of channel 6, 0–full scale	500	R/W
Alarm mode 1 (1SA1)	0066H	Alarm mode of alarm 1 of channel 1 (1AL1)	3	R/W
Alarm mode 1 (2SA1)	0067H	Alarm mode of alarm 1 of channel 2 (2AL1)	3	R/W
Alarm mode 1 (3SA1)	0068H	Alarm mode of alarm 1 of channel 3 (3AL1)	3	R/W
Alarm mode 1 (4SA1)	0069H	Alarm mode of alarm 1 of channel 4 (4AL1)	3	R/W
Alarm mode 1 (5SA1)	006AH	Alarm mode of alarm 1 of channel 5 (5AL1)	3	R/W
Alarm mode 1 (6SA1)	006BH	Alarm mode of alarm 1 of channel 6 (6AL1)	3	R/W
Alarm mode 2 (1SA2)	006CH	Alarm mode of alarm 2 of channel 1 (1AL2)	3	R/W
Alarm mode 2 (2SA2)	006DH	Alarm mode of alarm 2 of channel 2 (2AL2)	3	R/W
Alarm mode 2 (3SA2)	006EH	Alarm mode of alarm 2 of channel 3 (3AL2)	3	R/W
Alarm mode 2 (4SA2)	006FH	Alarm mode of alarm 2 of channel 4 (4AL2)	3	R/W
Alarm mode 2 (5SA2)	0070H	Alarm mode of alarm 2 of channel 5 (5AL2)	3	R/W
Alarm mode 2 (6SA2)	0071H	Alarm mode of alarm 2 of channel 6 (6AL2)	3	R/W
Filter coefficient (FIL1)	0072H	Filter coefficient of channel 1, 0–250	200	R/W
Filter coefficient (FIL2)	0073H	Filter coefficient of channel 2, 0–250	200	R/W
Filter coefficient (FIL3)	0074H	Filter coefficient of channel 3, 0–250	200	R/W
Filter coefficient (FIL4)	0075H	Filter coefficient of channel 4, 0–250	200	R/W
Filter coefficient (FIL5)	0076H	Filter coefficient of channel 5, 0–250	200	R/W
Filter coefficient (FIL6)	0077H	Filter coefficient of channel 6, 0–250	200	R/W
Heating cycle (T)	0078H	One heating cycle shared by four channels, 0.1–10.0 s	2.0 s	R/W
Temperature unit (UINT)	0079H	Unit selection shared by four channels, =1 means Fahrenheit	0	R/W
Inspection display time (TDIS)	007AH	Interval display time of the four channels, 0–17 s	4 s	R/W
Reset password (PASS)	007BH	Writing 2324 restores the factory parameter settings; other written values and read values are meaningless; this register	0	R/W
		does not support the 10H multiple-write function, only 06H single write		

Note 1*: 7FFFH: overflow — the measured temperature is infinite, or the sensor is disconnected;
8001H: underflow — the measured temperature is infinitesimal, or the sensor is reverse-connected.
All data are represented in two-byte two's complement; the measurement carries one decimal place by default, e.g. reading 03E8H = 100.0 degrees.

Note 2*:

bit0 Heating: current output status indication, =1 currently heating, =0 not heating.
bit1 Alarm AL1 status, =1 alarm 1 (AL1) is active, =0 no alarm.
bit2 Alarm AL2 status, =1 alarm 2 (AL2) is active, =0 no alarm.
bit3 Auto-tuning indication, =1 auto-tuning in progress, =0 normal control; same as the units digit of ATUx.
bit4 Heating switch indication, =1 the heating controller is on normally, =0 heating off and lower display shows OFF.
bit5 Temperature unit indication, =0 Celsius, =1 Fahrenheit.
bit6 Decimal point indication, =0 no decimal point, =1 one decimal point.
The high byte, i.e. bit8–bit15, indicates the current heating percentage, = 0–100.

4. Additional response in case of communication error

When the controller is in a communication connection and an error occurs, the controller replies with an error code and returns the Function code AND 80H to the master system, so that the master system knows that an error has occurred. Refer to the meaning of the error codes for communication errors.

RTU mode:

Address	01H
Function	86H
Exception code	02H
CRC CHK Low	C3H
CRC CHK High	A1H

Meaning of the error codes:

Error code	Explanation
01	Function code error; the function codes that the controller can recognize are 03H, 06H, 08H
02	Data address error; the data address cannot be recognized by the controller
03	Data content value error; the data content value is too large or too small, and is not a value that the controller can recognize
04	The controller cannot process it; the controller cannot execute this command
06	The controller is busy; the controller is processing data, please widen the interval between command strings
09	Check code error; the check code in the command string is wrong
11	Frame error: character frame error
12	The message bytes in the command string are too short
13	The message bytes in the command string are too long

5. CRC check code (CRC Check) in RTU mode

The check code runs from Address to the end of Data content. Its calculation rules are as follows:

Step 1: Set the 16-bit register (CRC register) = FFFFH.
Step 2: Exclusive OR the first 8-bit byte of the message instruction with the low-order 16-bit CRC register, and store the result in the CRC register.
Step 3: Right-shift the CRC register, filling 0 into the high-order bit.
Step 4: Check the right-shifted value; if it is 0, store the new value from Step 3 in the CRC register, otherwise Exclusive OR A001H with the CRC register and store the result in the CRC register.
Step 5: Repeat Steps 3–4 until all 8 bits have been processed.
Step 6: Repeat Steps 2–5 with the next 8-bit message instruction until all message instructions have been processed. Finally, the value obtained in the CRC register is the CRC check code. Note that the CRC check code must be swapped when it is placed into the message instruction.

The following is an example of the CRC check code calculation written in C language:

```
unsigned char *data;
unsigned char length;
  unsigned int crc_chk(unsigned char *data,unsigned char length)
{
  int j;unsigned int reg_crc=0xffff;
  while(length--){
    reg_crc^=*data++;
    for(j=0;j<8;j++){
      if(reg_crc&0x01){
        reg_crc=(reg_crc>>1)^0xa001;}
      else{
        reg_crc=reg_crc>>1;
      }
    }
  }
  return reg_crc;
}
```