Explosion-proof Digital Temperature Controller

DTC1-LS
Digital Temperature Controller
OPERATING TEMPERATURE -40°C to 55°C (-40°F to +131°F)

Vmax 277V
Amax 32A
Type 4X, IP66
Ta= -40°C to 55°C (-40°F to 131°F)

⚠ **Explosion and Shock Hazard**
For use with SHTL, EHTM, EHTX and EHTR Heat Trace Cables

Measurement Range
Model 1: -40°C to 200°C (-40°F to 392°F)
Model 2: -40°C to 600°C (-40°F to 1,112°F)
Sensor Type: RTD-100, 3-wire

POWER TRACE
Commercial & Industrial
Heat Trace Products

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**User Manual of Industrial Temperature Controller
USER MANUAL**

**DTC-*-1
POWER TRACE LLC Version No.:
20250310**

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Technical data may change iteratively in the future without prior notice. Alteration, error and tying error shall not constitute grounds for any damage compensation. The product shall be installed and used in accordance with relevant standards and regulations of safety components and systems, as well as the corresponding user manuals and installation instructions.

Contents

Overview

Explosion-proof Digital Temperature Controller is an intelligent controller delivering accurate and reliable temperature control for electric tracing. It supports field installation, display and control, as well as remote monitoring.

According to:

IEC 60079-0-2017 Explosive atmospheres -- Part 0: Equipment -- General requirements,
IEC 60079-7-2017 Explosive atmospheres - Part 7: Equipment protection by increased safety "e",
IEC 60079-18-2017 Explosive atmospheres -- Part 18: Equipment protection by encapsulation "m",
IEC 60079-11-2011 Explosive atmospheres -- Part 11: Equipment protection by intrinsic safety "i",
IEC 60079-31-2022 Explosive atmospheres -- Part 31: Equipment dust ignition protection by enclosure 't,

Increased safety, Encapsulation and "Intrinsically safe" type compound explosion-proof controllers are manufactured.

　　The product is provided with corrosion-resistant increased safety type polyester shell, its display keys and sensors are matched with Intrinsically safe circuit, and the relay part is encapsulated by casting. After passing the review, inspection and certification from a third party, the controller is issued with the corresponding explosion-proof certificate, suitable for Zone 1 and 2 in Class II areas with explosive gas atmosphere, Class III areas with explosive dust atmosphere. It can be used in zone 1 or zone 2 (gas), zone 21 or zone 22 (dust) of hazardous area and also non-hazardous area.

　　In case of repair, replacement or alteration of parts and structures that may affect explosion-proof performance is not allowed without authorization.

　　When Explosion-proof Digital Temperature Controller is installed in explosive atmosphere, cable gland and blanking element with an additional seal, complying with IEC 60079-0:2017 or IEC 60079-31:2022 with type of protection Ex tb IIIC Db and degree of protection IP66, shall be adopted.

Product model and classification

t model designation and classification definition are described below:

DTC ★-1

★: Window and communication, with A.B.C
　 as optional code
A: with window and communication
B: with window but without communication
C: without window and communication

Basic parameters

1、 **The controller can work reliably in the following environmental conditions:**
   A) Atmospheric pressure: 0.086 ~ 0.108(Mpa)
   B) Ambient air temperature range: -40°F ~ 113°F (-40 ~ 45°C)
   C) Ambient air humidity range ≤95%(2S°C)
   D) Used both outdoors and indoors.

2、 **Electrical parameters**
   Rated voltage: AC220V/50Hz
   Rated current for heating cable: 32A
   Prospective short circuit current:0.85A
   Measuring temperature range: -76°~ 392°F (-60°C ~ 200°C)
   Measurement accuracy: ±3 (-76°F ~ 392°F / -60°C ~ 200°C)
   Operating temperature return difference: defaulted as 37°F (3°C),
   adjustable Alarm relay contact: 5A 250Vac/5A 30Vdc (dry contact)
   RS485 contact: 4-6V
   Communication protocol: Modbus RTU (Physical layer RS485)
   Protection level: IP66
   Explosion-proof mark: Ex eb ib mb IIC T4 Gb , Ex tb IIIC T135℃ Db
   IEC60079-0:2017,IEC60079-7:2017,
   IEC60079-11:2011, IEC60079-18:2017,IEC60079-31:2022

Note: The relationship between the operating temperature range, rated input current, measuring process temperature of the product and the temperature group thereof is shown in Table 1 below.

Table 1

Rated voltage	Scope of the applicable ambient temperature range	Rated current	Measuring process temperature	Product temperature group
AC220V	-40~45℃	32A	≤75℃	T4, T135℃

Precautions for installation, wiring and use

1、 **This product is installed vertically for use. The overall and installation dimensions are shown in Figure 1 and Figure 2.**
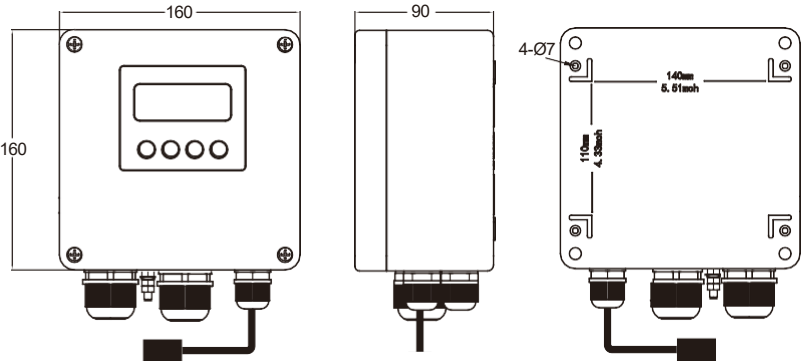

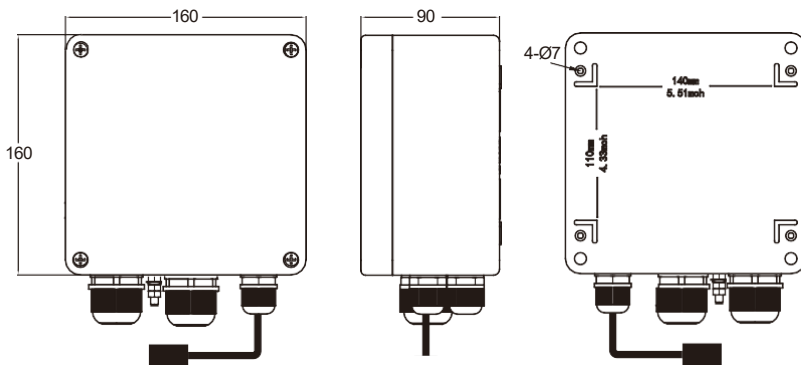Figure 1: Overall installation dimensions with window

Figure 2: Overall installation dimensions without window

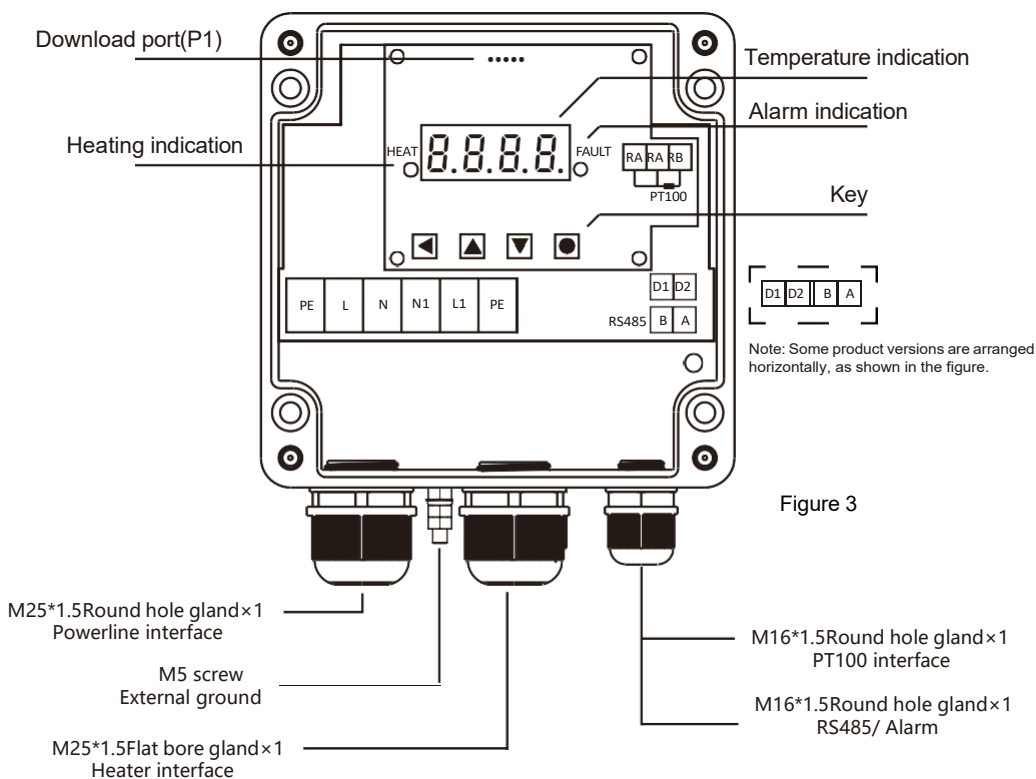**2. Display keys and terminal layout are shown in Figure 3.**

Download port(P1)

Temperature indication

Alarm indication

Heating indication

HEAT   8.8.8.8.   FAULT   RA RA RB   PT100

Key

D1 D2
RS485 B A

D1 D2 B A

Note: Some product versions are arranged horizontally, as shown in the figure.

PE | L | N | N1 | L1 | PE

Figure 3

M25*1.5Round hole gland×1
Powerline interface

M5 screw
External ground

M25*1.5Flat bore gland×1
Heater interface

M16*1.5Round hole gland×1
PT100 interface

M16*1.5Round hole gland×1
RS485/ Alarm

Note: Customers are not allowed to use this download port to download, when the equipment failure needs to be repaired, you need to contact the professional staff of Power Trace LLC for download and maintenance.

3. Wire connection.

1) Wires are connected according to Figure 3 and the function codes in Table 2.
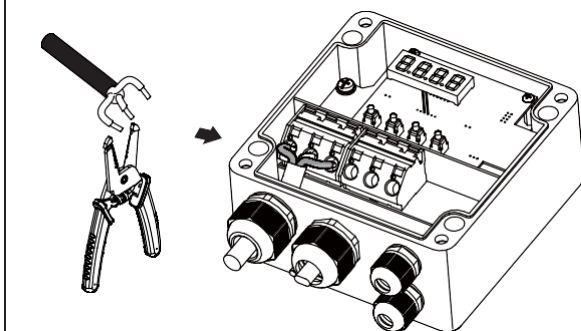2) The wiring terminals are tightened to a torque of 1.2Nm.

Table 2

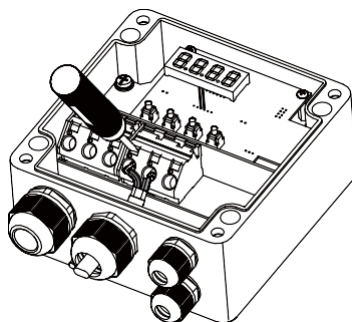| Number (left-right)	Identifier	Description	Cable requirements	Remark
1	PE	Ground wire	≤32A：6mm² cable	-Strictly according to the load power Select cable diameter
2	L	Live wire	≤25A：4mm² cable	
3	N	Neutral wire	≤16A：2.5mm² cable	
4	N1	Neutral wire of electric tracing band		
5	L1	Live wire of electric tracing band		
6	PE	Ground wire of electric tracing band		
1	D1	Alarm	≤5A：1-2.5mm² cable	
2	D2	Alarm		
3	B	RS485-B	≤5A：1-2.5mm² cable	Shielded twisted pair
4	A	RS485-A		
1	RA	PT100	Please use the PT100 accompanying the product	
2	RA			
3	RB			
Grounding bolt	⏚	External ground	2.5-6mm² cable	Steel terminal connections must be used

4. Precautions for installation and use

1) The installation shall be carried out at a position with vibration or with little vibration if possible.
2) The user shall not replace any parts of the product at will, and shall work with the manufacturer to resolve faults arising from the operation, in order to prevent any damage.
3) The installation site shall comply with the requirements in this Manual.
4) The intrinsic safety terminals are used as the sensor terminals. Note to arrange the sensor wires and non-intrinsic safety wires separately.
5) The internal programming interface is only used for supplier's programming maintenance.
6) During on-site use and maintenance, the principles of "Power off before opening the lid" and "No lid opening in dust explosion hazardous area " must be strictly observed.
7) When the product is used at the site, it is necessary to clean the surface regularly, and keep the thickness of accumulated dust not exceeding 5mm.
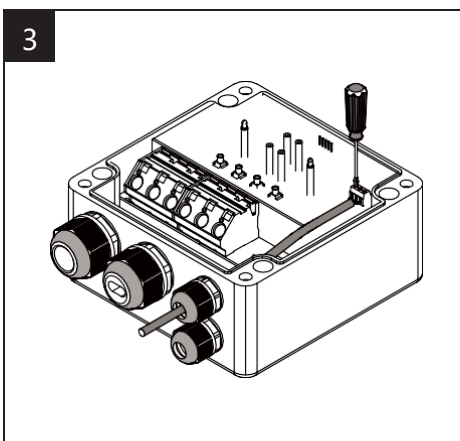
Installation instructions

1) Strip off the cable skin to expose the 10-12mm long cable core. Connect the cable to the PE/L/N from left to right.
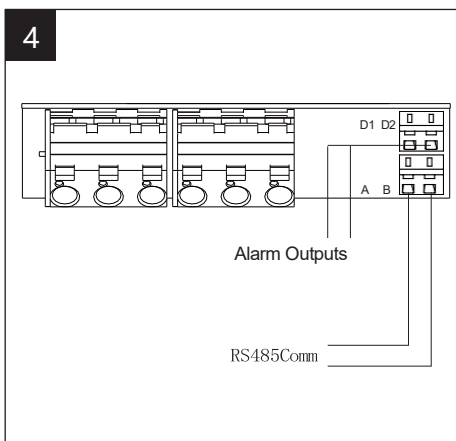Note: The PE port on the leftmost side has been connected to the ground terminal of the product before delivery. The power cable ground cable can be connected at the same time.

2) Refer to the above method and connect the load cable to L1/N1.
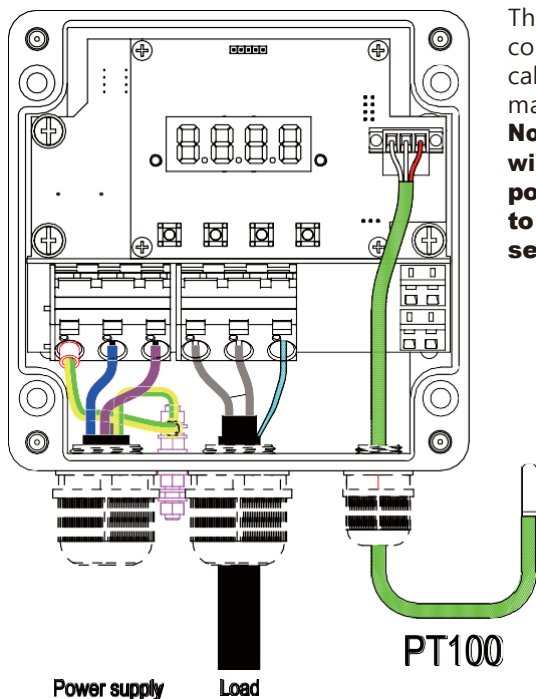

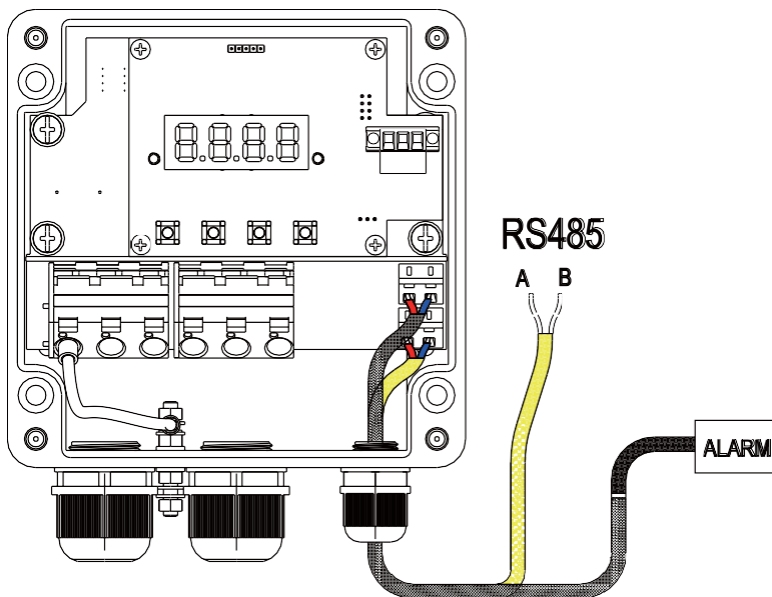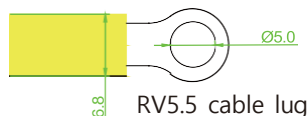6) The PT100 sensor has been connected and tested at the factory, If there are no special circumstances, do not disassemble and reconnect.

7) The right terminal can be connected to an external alarm according to customer requirements. Show equipment and communication. When an alarm signal occurs on the thermostat, turn on D1/D2 to synchronize with the external alarm device.

The ground cable of supply must be connected to the ground pole with the RV5.5 cable lug. The yellow and green lines are marked in the figure.
Note: When connecting the grounding wire, the two M5 nuts of the grounding pole near the shell are not allowed to be disassembled to ensure the sealing performance.

RV5.5 cable lug

Ø5.0

6.8

PT100

Power supply   Load

RS485

A   B

ALARM

Display operation instructions

1. As shown in Figure 3, the controller display and buttons are described as follows:

1) 4 - digit 8 - segment digital tube displays the real-time temperature when working normally.

2) Left LED indicator light, used for heating indication, indicating that the trace heating is enabled if on.

3) Right LED indicator, used for fault indication, indicating that the dry contact output is closed if on.

4) From left to right, there are"SHIFT◁ "、 "UP△、 "DOWN▽"、 "SET○ "keys.

2. Operation instructions

1) Upon power-on self-test, the instrument automatically enters the working state. In the working state, press "DOWN▽ "to display the instrument parameters, and press "SET○ "to exit from the parameter display.

2) In the working state, press "SET○ "to enter the corresponding parameter settings.

3) Under the display of the parameter setting mode EoT, press "SET○ "to return to the measurement state.

How to return to the working state

1) Manual return: in the instrument parameter setting mode, press and hold "SET○" for 5 seconds, the instrument will automatically return to the real-time measurement state.

2) Automatic return: in the instrument parameter setting mode, if no key is pressed, 60 seconds later the instrument will automatically return to the real-time measurement state.

3. Parameter setting mode

In the working state, press "SET○"twice to enter the ALOC setting. After setting LOC to 0 (default-ed as 0) by pressing the "UP△" and "DOWN▽"keys, press and hold "SET○"for 5 seconds to enter the parameter setting. The setting parameters are given in Table 3.

Table 3

Parameter	Symbol	Name	Set range (byte)	Description	Factory default
LOC	L o C	Menu password	0 ~ 9999	Enter menu password	0
EOT	E o T	Exit indication	Null	Exit indication	0
S.T	5 .T	Temperature setting value	-199.9 ~ 999.9	Set the temperature	40.0
H.T	H .T	Temperature control return difference	0 ~ 999.9	Set the temperature control return difference	3.0

ALM	ALm	Relay alarm mode 1: Alarm 0: No alarm	Bit3-Bit0 Note: bit0 and bit1 cannot be set to 1 simultaneously	Bit3: Sensor failure Bit2: Communication failure Bit1: Upper limit of temperature Bit0: Lower limit of temperature	0101
ALA	ALA	Relay output alarm value	-199.9 ~ 999.9	Set the relay temperature alarm value	200.0
ADDR	Addr	Instrument address	1 ~ 200	Set the device code during communication	1
BAUD	bAUd	Communication baud rate	BAUD=0 BAUD=1 BAUD=2 BAUD=3	The communication baud rate 2400bps 4800bps 9600bps 19200bps	2

Indicator and fault description

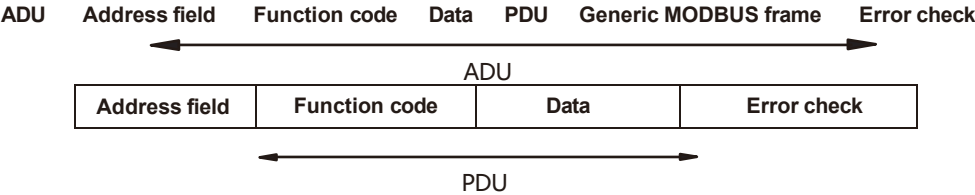| Fault and status	Indicator	Possible cause	Solution
Heating	Green light	/	/
Sensor fault	Blinking red lamp -OH-/-OL-	OL: Sensor short circuit/ OH: Sensor disconnection	Checking sensor connections
Temperature limit alarm	Red light	The temperature exceeds the limit	
Nixie tube failure	/	Non-voltage output/ Product failure	Check the power supply circuit/ Return to factory for repair
Communication failure	Blinking red lamp	Line connection error/ Signal interference	Check the connection to the host / Remove interference sources

Digital communication

The following R applies to PTDC-A-1 models:

This product (digital communication version) can communicate with computer network systems. The communication protocol is MODBUS RTU. Data communication adopts master/slave mode, the host computer is the main, the device is the slave. The device will send data to the host computer only after receiving valid commands from the host computer. Details of the agreement can be found at www.modbus.org.

When connecting cables, the interface board with isolation shall be used. Otherwise, the communication may be affected due to interference or different ground potential. The shielded twisted pair shall be selected as the wire.

1、Protocol description

The MODBUS protocol defines a simple protocol data unit (PDU) that is independent of the underling communication layer. MODBUS protocol mapping on a particular bus or network can introduce additional domains on the application data Unit (ADU).

ADU   Address field   Function code   Data PDU   Generic MODBUS frame   Error check

ADU

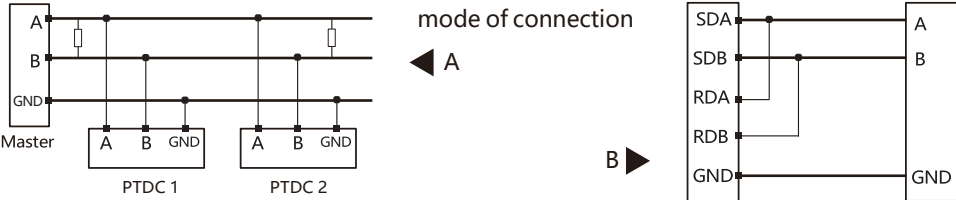| Address field	Function code	Data	Error check

PDU

The entire packet frame must be sent in a continuous stream of characters. If the idle interval between two characters is greater than 1.5 characters, the packet frame is considered incomplete and should be discarded by the receiving node. The default baud rate of serial port communication is 9600,8,n,1

Note: Changes in the serial port address and communication baud rate take effect after the device is powered off and restarted.

2、Wiring

This product adopts a twisted pair two-way connection. It is worth noting that in the low-speed non-interference short-distance environment, the use of ordinary twisted pair can be, in the high-speed long-term transmission, it is recommended to use impedance matching RS485 special cable or armored shielded cable.

The A/B port represents the communication port of the RS485 port and is responsible for connecting to the A/B port on the host. The wiring sequence follows A-A, B-B.

mode of connection

3、Read register data

In a remote device, the function code is used to read the contents of a continuous block of the hold register. The request PDU specifies the start register address and number of registers. The register data in the response message is divided into two bytes per register, and the binary content is adjusted directly in each byte. For each register, the first byte includes the high bit, and the second byte includes the low bit.

Demand

Address	1byte	0×01
Function code	1byte	0×03
Initial address	2bytes	0×0000~0×FFFF
Number of registers	2bytes	0×0000~0×FFFF
CRC check	2bytes	check code

Response

Address	1byte	0×01
Function code	1byte	0×03
Number of bytes	1byte	2N*
Register value	N*×2bytes	
CRC check	2byte	check code

Example: Host send: 0103000000044409

Request		Response		
Domain name	Base 16	Domain name	Base 10	Explain
Address	01	Address	01	Device address
Function	03	Function	03	Read command
High origin address	00	Number of bytes	08	
Low origin address	00	Register value Hi (1)	56	For"V"
High Register value	00	Register value Lo (1)	31	For"1"
Low Register value	04	Register value Hi (2)	2E	For"."
CRC check High	44	Register value Lo (2)	30	For"0"
CRC check Low	09	Register value Hi (3)	01	Temp. measurement (HEX): 0106, The corresponding decimal (HEX) value is 262; A multiple of 10, real the temp. is 26.2℃.
		Register value Lo (3)	06	

Request		Response		
		Register value Hi (4)	00	Retain
		Register value Lo (4)	00	
		CRC check High	76	check code
		CRC check Low	48	

Denote the contents of register 1 as two hexadecimal byte values 56 31 and the contents of register 2 as two hexadecimal byte values 2E 30.

4、Write register data

    In a remote device, the function code is used to write contiguous register blocks (0 to 19 registers). In the request data field, the value written by the request is stated. Each register splits the data into two bytes. A normal response returns the function code, the start address, and the number of registers that were written.

Address	1byte	0×01
Function code	1byte	0×10
Initial address	2bytes	0×0000~0×FFFF
Number of registers	2bytes	0×0000~0×FFFF
Number of bytes	1byte	
Register value	N*×2bytes	value

Example：

Request		Response		
Domain name	Base 16	Domain name	Base 16	Explain
Address	01	Address	01	Device address
Function code	10	Function code	10	Write command
High origin address	00	High origin address	00	Start address start of the tenth register (sequence number 11 parameter function)
Low origin address	0A	Low origin address	0A	
High Register value	00	High Register value	00	From the tenth register contains the tenth register
Low Register value	04	Low Register value	04	Starts modifying four register parameters later
Number of bytes	08	/	/	8bytes
Register value Hi	01	/	/	50 ° C (modify the parameter of item 11) 01F4 corresponds to 500, the multiple is 10, and the actual value is 50 ° C.
Register value Lo	F4	/	/	
Register value Hi	00	/	/	5 ° C (modify the parameter of item 12) 0032 corresponds to 50, the multiple is 10, the actual value is 5 ° C
Register value Lo	32	/	/	
Register value Hi	00	/	/	0101 Modify the parameter of item 13
Register value Lo	05	/	/	
Register value Hi	03	/	/	100 ° C (modify the parameter of item 14) 03E8 corresponds to 1000, the multiple is 10, the actual value is 100 ° C
Register value Lo	E8	/	/	
check code Lo	71	High origin address	E0	check code
check code Hi	1B	Low origin address	2A	

5、The register address is defined in the following table

Serial NO.	Register name	Address	Read Write	Description	Default	Data format
1	Software version H	0	R	Two high digits Represents software version	V1	Hexadecimal convert ASCII code
2	Software version L	1	R	Two low digits Represents software version	0	
3	Measured value	2	R	Measurements of input channel	Tenfold relation	Hexadecimal
4	Reserved	3				
5	PT100 status indication	4	R	0000: Normal 0001: PT100 short-circuited 0002: PT100 open-circuited		Hexadecimal
6	Upper and lower temperature limit alarm indication	5	R	0000: Normal 0001: Upper limit alarm 0002: Lower limit alarm		Hexadecimal
7	Reserved	6				
8	Reserved	7				
9	Tracing band control output status / Relay control output status	8	R	0000: Normal 0001: Tracing band output, D1/D2 has no output 0002: Tracing band has no output, D1/D2 output 0003:Tracing band output, D1/D2 output		Hexadecimal
10	Reserved	9				
11	Temperature setting value	10	W/R	-199.9 ~ 999.9	40.0	Hexadecimal
12	Temperature control return difference	11	W/R	0 ~ 999.9	3.0	Hexadecimal
13	D1,D2 alarm relay output Settings 0-Not started 1-Started	12	W/R	Default setting：0101 Corresponding to the sensor, communication, temperature upper limit, temperature lower limit;	0005	Hexadecimal
14	Hi/lo temp. limit alarm value	13	W/R	-199.9 ~ 999.9	200	Hexadecimal
15	Reserved	14				
16	Instrument communication address	15	W/R	1 - 247	1	Hexadecimal
17	Meter communication baud rate	16	W/R	0：2400,8,n,1 1：4800,8,n,1 2：9600,8,n,1 3：19200,8,n,1	2	Hexadecimal
18	Reserved	17				
19	Reserved	18				
20	Reserved	19				

Storage

The controller shall be stored in a dry and ventilated warehouse without corrosive substances.

Enclosed accessories

1. Controller   1 each
2. Product user manual   1 copy
3. Product certificate   1 copy
4. PT100 sensor   1 each