ARTM-4 温度巡检仪
ARTM-4 temperature measuring instrument

安装使用说明书 V1.1
Installation & Operation Manual V1.1

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申 明

DECLARATION

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1.1 概述

1.1 Overview

ARTM-4 温度巡检测控仪适用于多路温度的测量和控制，主要应用于低压配电系统电气接点、电机/变压器等设备绕组测温及其他设备或变配电场景的温度监测与控制。

The ARTM-4 temperature inspection and control instrument is suitable for measuring and controlling multiple temperatures, mainly used for temperature monitoring and control of electrical contacts, motor/transformer windings, and other equipment or distribution scenarios in low-voltage distribution systems.

1.2 型号及功能

1.2 Model and Feature

型号 Model	特点 Feature	附加功能 Additional features
ARTM-4	测量 4 通道 Pt100 温度，也可以屏蔽其中任意通道。 Measure the temperature of PT100 in 4 channels, and any channel can also be shielded.	每一通道温度测量对应 2 段报警，继电器输出可以任意设置报警方向及报警值； Each channel temperature measurement corresponds to 2 alarm segments, and the relay output can be set to any alarm direction and value; 带有 RS485 通讯接口(MODBUS-RTU 协议)，可实现数据远传。 Equipped with RS485 communication interface (MODBUS-RTU protocol), it can achieve remote data transmission.

注：**ARTM-4 的测温通道可由用户指定，具体见订货范例。**

Note: The temperature measurement channel of ARTM-4 can be specified by the user, please refer to the ordering example for details.

1.3 技术参数

1.3 Technical Parameters

功能 Function　＼　技术指标 Technical indicators		指　标 Indicator
		ARTM-4
测量通道数 Number of measurement channels		4
输入信号 Input signal		Pt100； Pt1000
精度等级 Accuracy level		0.5 级 Level 0.5
辅 助 电 源 Power supply	电压范围 Voltage range	AC85~265V/DC 100~350V
	功　耗 Power waste	≤2W
报 警 输 出 Alarm output	路　数 Number of routes	4 组常开 4 sets of normally open
	容　量 Capacity	AC250V/5A，DC30V/5A
变 送 输 出 Transmission output	路　数 Number of routes	1
	范　围 Range	4~20mA
通 讯 Communication	协　议 Agreement	MODBUS-RTU
	接　口 Interface	RS485
	波 特 率 Baud rate	可选 1200，2400，4800，9600，19200 Optional　1200，2400，4800，9600，19200
工频耐压 Power frequency withstand voltage		2kV/1min 交流有效值 2kV/1min AC effective value
环 境 Environment	温　度 Temperature	工作：-10～+55℃，存贮：-25～+70℃ Work: -10~+55 ℃, Storage: -25~+70 ℃
	湿　度 Humidity	≤95%，不结露，无腐蚀性气体场所 ≤ 95%, non condensing, non corrosive gas environment
	海　拔 Altitude	≤2000m

1.4 包装

1.4 Packaging

包装内含下列项目：

The packaging contains the following items:

主机（含插拔式端子排，铭牌，安装支架等）；

Host (including plug-in terminal block, nameplate, installation bracket, etc.);

产品安装使用手册。

Product installation and usage manual.

在打开产品包装时，请仔细检查是否有损坏，如有任何损坏，请及时通知 ACREL 公司或代理商，并请保留损坏的外包装。如系 ACREL 公司或代理商责任，将及时予以更换。

When opening the product packaging, please carefully check for any damage. If there is any damage, please notify ACREL company or agent in a timely manner and keep the damaged outer packaging. If it is the responsibility of ACREL company or agent, it will be replaced in a timely manner.

1.5 安装和接线方法

1.5 Installation and wiring methods

1.5.1 安装尺寸
1.5.1 Installation dimensions

■ ARTM-4：

正视图	侧视图	盘面开孔
Front view	**Side view**	**Disk opening size**
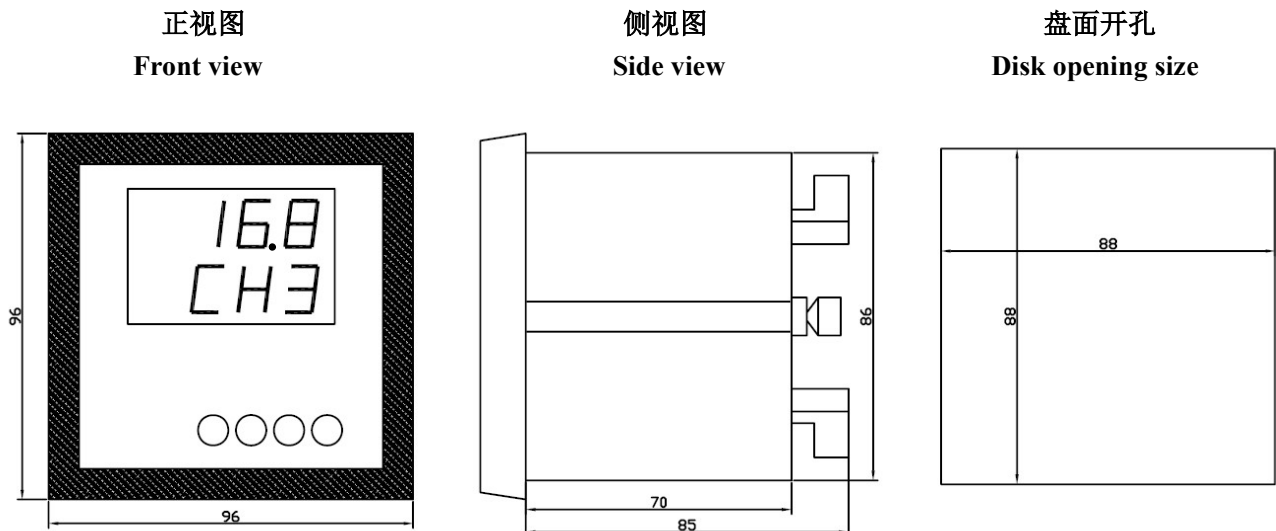
1.5.2 安装方法

1.5.2 Installation Method

在您的配电盘上，选择合适的地方开一个与所安装温度巡检仪开孔尺寸相同的安装孔。

On your distribution panel, choose a suitable location to open an installation hole with the same size as the opening of the installed temperature monitoring device.

取出温度巡检仪，松开定位螺钉（逆时针），取下安装支架。

Take out the temperature monitoring device, loosen the positioning screw (counterclockwise), and remove the installation bracket.
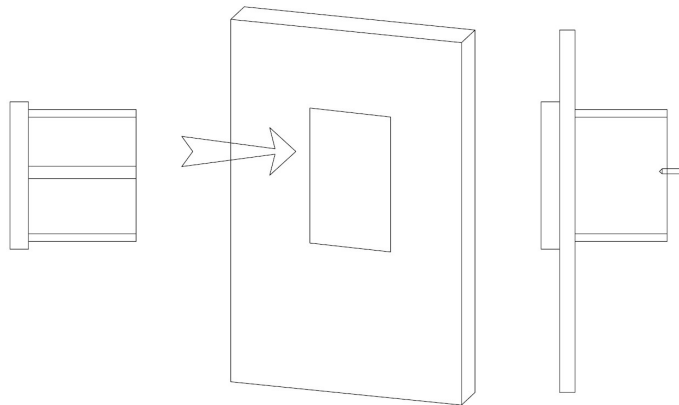
把仪表插入配电盘仪表孔中。

Insert the instrument into the instrument hole of the distribution panel.

插入仪表后装上安装支架、定位螺钉（顺时针）。

Insert the instrument and install the mounting bracket and positioning screw (clockwise).

1.5.3 接线方法（请以仪表上的接线图为准）

1.5.3 Wiring method (please refer to the wiring diagram on the instrument)

■   ARTM-4：
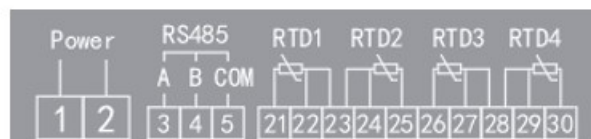
注意：二线制接线时必须按照图示，将热电阻传感器的其中一根引线接到 2 个端子上。

Attention: When wiring in a two-wire system, one of the leads of the thermistor sensor must be connected to two terminals according to the diagram.

Pt100 接线方式：21~23 号为 Pt100 的第 1 路接线端子，23~25 号为 Pt100 的第 2 路接线端子，以此类推。

Pt100 wiring method: Terminals 21-23 are the first wiring terminals of Pt100, terminals 23-25 are the second wiring terminals of Pt100, and so on.

两线制：第一路 Pt100 的 A、B 线分别接入 21 号和 22 号端子，22 号端子引一根短接线到 23 号端子，第二路 Pt100 的 A、B 线分别接入 25 号和 24 号端子，24 号端子引一根短接线到 23 号端子，以此类推。

Two wire system: The A and B wires of the first Pt100 are connected to terminals 21 and 22, respectively. Terminal 22 leads a short wire to terminal 23. The A and B wires of the second Pt100 are connected to terminals 25 and 24, respectively. Terminal 24 leads a short wire to terminal 23, and so on.

三线制：第一路 Pt100 的 A 线接入 21 号端子，B、C 两线分别接入 22 号和 23 号端子，第二路 Pt100 的 A 线接入 25 号端子，B、C 两线分别接入 24 号和 23 号端子，以此类推。

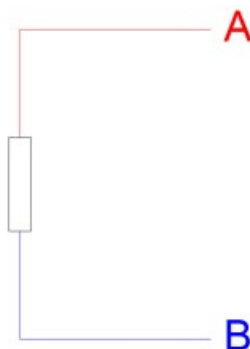Three wire system: The A wire of the first Pt100 is connected to terminal 21, and the B and C wires are connected to terminals 22 and 23 respectively. The A wire of the second Pt100 is connected to terminal 25, and the B and C wires are connected to terminals 24 and 23 respectively, and so on.
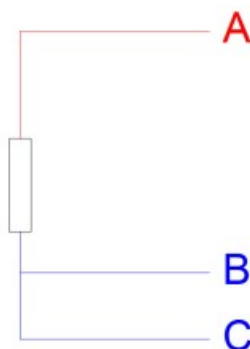
四线制第一种接线方法：第一路 Pt100 的 A 和 B 线接入 21 号端子，C 和 D 线接入 22 号端子，22 号端子引一根短接线到 23 号端子，第二路 Pt100 的 A 和 B 线接入 25 号端子，C 和 D 线接入 24 号端子，24 号端子引一根短接线到 23 号端子，以此类推。

The first wiring method of the four wire system: Connect the A and B wires of the first Pt100 to terminal 21, connect the C and D wires to terminal 22, and connect a short wire from terminal 22 to terminal 23. Connect the A and B wires of the second Pt100 to terminal 25, connect the C and D wires to terminal 24, and connect a short wire from terminal 24 to terminal 23, and so on.

四线制第一种接线方法：第一路 Pt100 的 A 线接入 21 号端子，C、D 两线接入 22 号和 23 号端子，第二路 Pt100 的 A 接入 25 号端子，C、D 两线接入 24 号和 23 号端子，以此类推。

The first wiring method of the four wire system: Connect the A wire of the first Pt100 to terminal 21, connect the C and D wires to terminals 22 and 23, connect the A wire of the second Pt100 to terminal 25, connect the C and D wires to terminals 24 and 23, and so on.

注意：四线制 Pt100 接线时推荐第一种接线方法。

Attention: The first wiring method is recommended for the four wire Pt100 system.
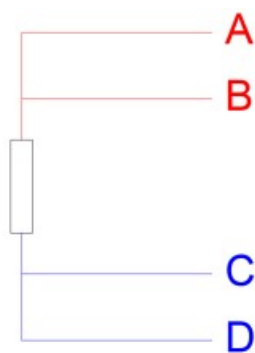
注：考虑本装置采集温度数据的准确性与装置接线端子的匹配，本装置推荐使用三线制的 **Pt100** 传感器。

Note: Considering the accuracy of temperature data collected by this device and the matching of device wiring terminals, it is recommended to use a three wire Pt100 sensor for this device.

2 操作指南

2 Operation Guide

2.1 显示介绍

2.1 Display Introduction

■ ARTM-4 的面板图示

■ Panel diagram of ARTM-4
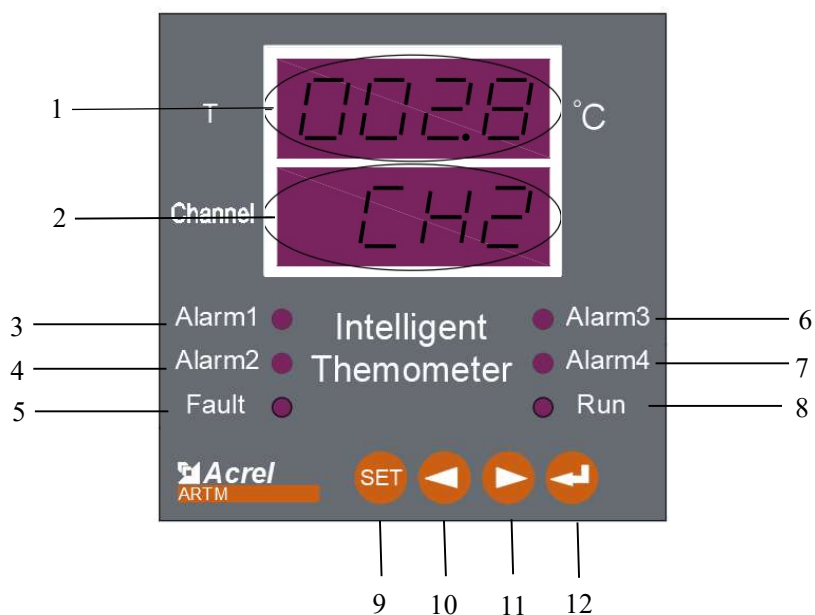
编号 Number	名称 Name	状态示例 Example of Status	说明 Explain
1	LEDA	002.8	显示当前通道测得的温度值，单位℃，4 位数码管，分辨率 0.1 Display the temperature value measured in the current channel, unit: ℃, 4-digit digital display, resolution: 0.1

2	LEDB	CH2	当前显示的测量通道 The currently displayed measurement channel
3	Alarm1	指示灯点亮 The indicator light is on	DO 1 触发 DO 1 triggered
4	Alarm2	指示灯点亮 The indicator light is on	DO 2 触发 DO 2 triggered
5	Fault	指示灯亮 The indicator light is on	故障触发，传感器接线异常 Fault triggered, abnormal sensor wiring
6	Alarm3	指示灯点亮 The indicator light is on	DO 3 触发 DO 3 triggered
7	Alarm4	指示灯点亮 The indicator light is on	DO 4 触发 DO 4 triggered
8	Run	指示灯闪烁 The indicator light is flashing	装置系统正常运行 The device system is operating normally
9	SET	按键按下 Press the button	选择操作功能或返回上一级菜单 Select the operation function or return to the previous menu
10	◀	按键按下 Press the button	查看数据或数字量增减 View changes in data or numerical quantities
11	▶	按键按下 Press the button	查看数据或数字量增减 View changes in data or numerical quantities
12	↵	按键按下 Press the button	确定功能或进入下一级菜单 Confirm the function or enter the next level menu

2.2 系统上电

2.2 System Power On

依照说明正确接线后，接通工作电源，"**Run**"闪烁，即进入测量状态。

After correctly connecting the wires according to the instructions, turn on the working power supply, and the "**Run**" will flash, indicating that it has entered the measurement state.

2.3 系统设置模式

2.3 System Setting Mode

2.3.1 进入/退出系统设置模式
2.3.1 Enter/Exit System Settings Mode

在正常情况下，仪表处于正常工作状态，此时按下 SET 键大于 3 秒，会进入系统设置模式，进入系统设置模式前，首先需要输入正确的密码（出厂时一般设置为 0000）。

Under normal circumstances, the instrument is in normal working condition. Pressing the SET button for more than 3 seconds will enter the system settings mode. Before entering the system settings mode, the correct password (usually set to 0000 at the factory) needs to be entered first.

进入系统设置模式的具体操作如下：

The specific operation to enter the system settings mode is as follows:

(1) 按住 SET 键，直至画面显示"**Prog**"，再单击回车键，显示"**code**"，提示要输入密码，再单击回车键出现"**0000**"，按左右方向键减小或增大数值大小至正确的密码；

(1) Press and hold the SET key until the screen displays "**Prog**", then click the Enter key to display "**code**" and prompt for password input. Click the Enter key again to display "**0000**", and press the left and right arrow keys to decrease or increase the value size to the correct password;

(2) 密码正确，则画面显示"**PASS**"，单击回车即进入系统设置的最高一层菜单。

(2) If the password is correct, the screen will display "**PASS**". Click enter to enter the highest level menu of the system settings.

系统设置包括报警点设置（菜单"**SET**"），回滞量及报警延时设置（菜单"**HyS**"），显示模式设置（菜单"**DISP**"），通讯设置（菜单"**BUS**"），设置新密码（菜单"**n.cod**"），查看软件版本号（菜单"**UErn**"）。

The system settings include alarm point settings (menu "**SET**"), hysteresis and alarm delay settings (menu "**HyS**"), display mode settings (menu "**DISP**"), communication settings (menu "**BUS**"), setting a new password (menu "**n.cod**"), and checking the software version number (menu "**UErn**").

2.3.2 系统设置模式下的操作
2.3.2 Operation in System Setting Mode

进入系统设置模式后，选择菜单状态进入。

After entering the system settings mode, select the menu status to enter.

(1)"**SET**"状态设置

(1) "**SET**" status setting

密码设置成功，进入系统设置模式以后，按左或右方向键直到显示"**SET**"，回车确认后显示"**CH1**"，再次回车后显示"**ON**"或"**OFF**"，可按左或右方向键选择。选择"**OFF**"，回车，即屏蔽通道 1 的温度测量和监控，画面返回"**CH1**"；选择"**ON**"，回车，即打开通道 1 的温度测量和监控，并显示"**AL1**"，即通道 1 的报警点 1 的设定，回车进入显示"**ON**"或"**OFF**"，可按左或右方向键选择。选择"**OFF**"，回车，即屏蔽通道 1 的"**AL1**"报警设置，画面返回"**AL1**"；选择"**ON**"，回车，即打开通道 1 的"**AL1**"报警设置，画面显示"**HI**"或"**LO**"，首先按左或右键选择设定报警点 1 的报警趋势，"**HI**"表示高越限报警，"**LO**"表示低越限报警，回车确认后画面显示"**AL1**"的报警出口("**1**"或"**2**"或"**3**"或"**4**")，可按左或右方向键选择对应报警出口，回车，画面显示设定具体数值，按左右方向键减小或增大数值大小，达到要求后回车确定，系统返回"**AL1**"。

Password setting successful. After entering the system settings mode, press the left or right arrow keys until "**SET**" is displayed. Enter to confirm and display "**CH1**". Enter again and display "**ON**" or "**OFF**". You can press the left or right arrow keys to select. Select "**OFF**", press enter to block the temperature measurement and monitoring of channel 1, and the screen returns to "**CH1**"; Select "**ON**", press enter to open the temperature measurement and monitoring of channel 1, and display "**AL1**", which is the setting of alarm point 1 for channel 1. Press enter to display

"ON" or "OFF", which can be selected by pressing the left or right directional keys. Select "OFF" and press enter to disable the "AL1" alarm setting for channel 1, and the screen will return to "AL1"; Select "ON" and press Enter to open the "AL1" alarm setting for channel 1. The screen will display "HI" or "LO". First, press the left or right button to select the alarm trend for set alarm point 1. "HI" represents high limit alarm, "LO" represents low limit alarm. After pressing Enter to confirm, the screen will display the alarm exit for "AL1" ("1" or "2" or "3" or "4"). You can press the left or right arrow keys to select the corresponding alarm exit. Press Enter to display the specific value set. Press the left or right arrow keys to decrease or increase the value size. Once the requirement is met, press Enter to confirm and the system will return to "AL1".

在"AL1"状态下按左或右键选择"AL2"，即通道 1 的报警点 2 的设定，设定方法与"AL1"完全相同。

Press the left or right button in the "AL1" state to select "AL2", which is the setting of alarm point 2 for channel 1. The setting method is exactly the same as "AL1".

在"AL1"状态下按左或右键选择"AO"，回车后显示"ON"或"OFF"，可按左或右方向键选择。选择"OFF"，回车，即屏蔽通道 1 的"AO"变送输出(4~20mA)，画面返回"AO"；选择"ON"，回车，即打开通道 1 的"AO"变送输出(4~20mA)，并显示"1-L"，即变送输出 4mA 对应的最小温度值，按左右方向键减小或增大数值大小，达到要求后回车确定，界面显示"1-H"，即变送输出 20mA 对应的最大温度值，按左右方向键减小或增大数值大小，达到要求后回车确定,系统返回"AO"。

Press the left or right arrow key to select "AO" in the "AL1" state, and press enter to display "ON" or "OFF", which can be selected by pressing the left or right arrow keys. Select "OFF" and press enter to block the "AO" transmission output (4-20mA) of channel 1, and the screen returns to "AO"; Select "ON" and press Enter to open the "AO" transmission output (4~20mA) of channel 1, and display "1-L", which is the minimum temperature value corresponding to the 4mA transmission output. Press the left and right directional keys to decrease or increase the value size, and press Enter to confirm when the requirement is met. The interface displays "1-H", which is the maximum temperature value corresponding to the 20mA transmission output. Press the left and right directional keys to decrease or increase the value size, and press Enter to confirm when the requirement is met. The system returns to "AO".

在"AL1"、"AL2"或"AO"状态下，按"SET"键返回"CH1"，此时再按左或右键选择可进入其他通道的设置，设置方法与通道 1 完全相同。

In the "AL1", "AL2" or "AO" state, press the "SET" key to return to "CH1", and then press the left or right button to select to enter the settings of other channels. The setting method is exactly the same as that of channel 1.

在"CH1"、"CH2"、"CH3"等状态下按"SET"键返回最高一层菜单"SET"。

Press the "SET" key in states such as "CH1", "CH2", "CH3" to return to the highest level menu "SET".

(2)"HyS"状态设置

(2) "HyS" status setting

进入系统设置模式以后，按左或右方向键直到显示"HyS"，即设置报警的回滞量和报警延时。按回车键进入,选择"HyS1"设定所有通道报警 1 的回滞量；选择"HyS2"设定所有通道报警 2 的回滞量；选择"HyS3"设定所有通道报警 3 的回滞量;选择"HyS4"设定所有通道报警 4 的回滞量,选择"DEL1"、"DEL2"、"DEL3"、"DEL4"分别设置对应告警输出的设定报警延时时间。**报警延时设定的范围是 0~100，而单位并非秒，假定现设定报警延时值为 4，即连续"4"次测得某一通道的温度处于报警位置，才触发报警。**

After entering the system settings mode, press the left or right arrow keys until "HyS" is displayed, which sets the hysteresis and alarm delay for the alarm. Press the enter key to enter, select "HyS1" to set the hysteresis of all channel alarms 1; Select "HyS2" to set the hysteresis of alarm 2 for all channels; Select "HyS3" to set the hysteresis of all channel alarms 3; Select "HyS4" to set the hysteresis of all channel alarms 4, and Select "DEL1", "DEL2", "DEL3", and "DEL4" to respectively set the alarm delay time for the corresponding alarm output. **The range of alarm delay setting is 0-100, and the unit is not seconds. Assuming that the alarm delay value is set to 4, that is, the temperature of a certain channel is measured continuously for "4" times to be in the alarm position before**

triggering the alarm.

(3)"**DISP**"状态设置

(3) "**DISP** "status setting

进入系统设置模式以后，按左或右方向键直到显示"**DISP**"，按回车键进入"**cyc**"状态，即设置循环显示各通道温度值的间隔时间，回车进入数值设置，设置范围 0～20，其中 0 表示正常模式下静态显示某一通道的温度值，其余数值即正常模式下循环显示的间隔时间（单位：秒）。回车确认后返回"**cyc**""状态,按"**SET**"键返回层菜单"**DISP**"。

After entering the system settings mode, press the left or right arrow keys until "**DISP**" is displayed, then press enter to enter the "**cyc**" state, which sets the interval time for cyclically displaying the temperature values of each channel. Enter to enter the numerical settings, with a range of 0-20, where 0 represents the static display of the temperature value of a certain channel in normal mode, and the remaining values are the interval time (unit: seconds) for cyclically displaying in normal mode. After confirming with Enter, return to the "**cyc**" state and press the "**SET**" key to return to the layer menu "**DISP**".

设定静态显示，在正常模式下按住左或右键不放，可快速切换到需要的通道温度显示，并保持。

Set static display, hold down the left or right button in normal mode to quickly switch to the desired channel temperature display and maintain it.

设定循环显示，在正常模式下按住右键不放，可加快循环显示速度。

Set the loop display and hold down the right button in normal mode to speed up the loop display.

(4)"**BUS**"状态设置

(4) "**BUS** "status setting

进入系统设置模式以后，按左或右方向键直到显示"**BUS**"，即通讯设定，回车确认后显示"**Addr**"状态，再次回车后就可以设置地址的值，通过左或右方向键改变地址值，按回车确认后返回"**Addr**"状态，按左或右方向键选择"**Baud**"状态，回车进入后通过左或右方向键选择合适的波特率，按回车键确认退出。

After entering the system settings mode, press the left or right arrow keys until "**BUS**" is displayed, which is the communication setting. Press Enter to confirm and display the "**Addr**" status. Press Enter again to set the address value. Use the left or right arrow keys to change the address value. Press Enter to confirm and return to the "**Addr**" status. Press the left or right arrow keys to select the "**Baud**" status. Press Enter to enter and select the appropriate baud rate using the left or right arrow keys. Press Enter to confirm and exit.

显示状态 Display status	解释 Explain	可设定范围 Customizable range
Addr	通讯地址 Postal address	0001～0247
Baud	通讯波特率 Baud rate	1200、2400、4800、9600、19200

(5)"**n.cod**"状态设置

(5) "**n.cod**"status setting

进入系统设置模式以后，按左或右方向键直到显示"**n.cod**"，即设置新的系统密码，按回车进入后，按左或右键输入合适的新密码后，按回车确认。

After entering the system settings mode, press the left or right arrow keys until "**n.cod**" is displayed, which sets the new system password. Press Enter to enter, press the left or right arrow keys to enter the appropriate new password, and press Enter to confirm.

(6)"**UErn**"状态设置

(6) "**UErn**"status setting

进入系统设置模式以后，按左或右方向键直到显示"**UErn**"，即查看产品软件版本号，按回车后进入查看状态。

After entering the system settings mode, press the left or right arrow keys until "**UErn**" is displayed to view the product software version number. Press Enter to enter the viewing mode.

2.3.3 保存设置选择
2.3.3 Save Settings Selection

全部参数设置完成后，在上述六个状态中的任意一个状态下按**"SET"**键，进入**"SAUE"**状态，即保存数据。此时，按回车键保存设置的内容，按**"SET"**键直接退出系统设置模式，不保存所设置的内容，返回正常模式后按原有参数运行。

After all parameter settings are completed, press the "**SET**" key in any of the six states mentioned above to enter the "**SAUE**" state, which saves data. At this point, press the enter key to save the settings, press the "**SET**" key to exit the system settings mode directly, do not save the settings, return to normal mode and run according to the original parameters.

2.3.4 用户编程流程图

START 按住"SET"键大于2秒

Prog — CodE — CodE 0000 — PASS — SEt — CH1 — CH2 — CH4方法 同CH1

HL1 — HL1 on — HL1 oFF — HL1 HI — HL1 Lo — HL1 0090

设置AL2方法 同AL1

Ao — Ao on — Ao oFF — -060 — H-L — 024.0

设置HYS2~HYS4、DEL2~DEL4方法 同HYS1、DEL1

HYS — HYS1 — HYS1 0005 — DEL1 — DEL1 0005

dISP — LCd — LCd 0005

buS — Addr — Addr 0001 — bAud — bAud 9600

nLod — nLod 0000 — VErn — VErn 100

SAVE 保存设置，返回测量 / 不保存设置，返回测量

2.3.4 User Programming Flowchart

START — Press and hold the 'SET' key for more than 3 seconds

Pro9 → Code → Code 0000 → PASS → SEt

SEt → CH1 → CH1 OFF → LH1 OFF → AL1 → AL1 OFF → AL1 HI → AL1 0090

Set CH2~CH4, The method is the same as CH1

Set AL2, The method is the same as AL1.

AL2 → Ao → Ao ON → Ao -t-L 060 → Ao t-H 0240 → Ao OFF

HYS → HYS1 → HYS1 0005
DEL1 → DEL1 0005

Set HYS2、HYS3、HYS4 and DEL2、DEL3、DEL4, The methods is same as HYS1 and DEL1

dISP → CYC → CYC 0005

buS → Addr → Addr 0001
bAud → bAud 9600

nLod → nLod 0000
UErn → UErn 100

SAUE — Do not save settings, Return to measurement / Save settings, Return to measurement

3 通讯指南

3 Communication Guide

在本章主要讲述如何利用软件通过通讯口来操控该系列仪表。本章内容的掌握需要您具有 MODBUS 协议的知识储备并且通读了本册其他章节所有内容，对本产品功能和应用概念有较全面的了解。

This chapter mainly discusses how to use software to control this series of instruments through communication ports. To master the content of this chapter, you need to have a knowledge reserve of MODBUS protocol and have read all the contents of other chapters in this book, so as to have a comprehensive understanding of the functions and application concepts of this product.

本章内容包括：MODBUS 协议简述，通讯应用格式详解，本机的应用细节及参量地址表。

This chapter includes a brief introduction to the MODBUS protocol, a detailed explanation of communication application formats, application details of the device, and a parameter address table.

3.1 协议简述

3.1 Protocol Overview

3.1.1 传输方式
3.1.1 Transmission Method

传输方式是指一个数据帧内，一系列独立的数据结构以及用于传输的数据的有限规则，下面定义了与 MODBUS 协议（RTU 方式）相兼容的传输方式。

The transmission method refers to a series of independent data structures and limited rules for transmitting data within a data frame. The following defines a transmission method compatible with the MODBUS protocol (RTU method).

每个字节的位

The bits of each byte

- 1 个起始位
- 1 starting position
- 8 个数据位，最小的有效位先发送
- 8 data bits, with the smallest significant bit sent first
- 无奇偶校验位
- No parity check bits
- 1 个停止位
- 1 stop position

错误检测：CRC（循环冗余校验）

Error detection: CRC (cyclic redundancy check)

3.1.2 协议
3.1.2 Protocol

当数据帧到达终端设备时，它通过一个简单的"端口"进入被寻址的设备，该设备去掉数据帧的"信封"（数据头），读取数据，如果没有错误，就执行数据所请求的任务，然后，它将自己生成的数据加入到取得的"信封"中，把数据帧返回给发送者。返回的响应数据帧中包含了以下内容：终端从机地址（Address）、被执行了的命令（Function）、执行命令生成的被请求数据（Data）和一个校验码（Check）。发生任何错误都不会有成功的响应。

When the data frame reaches the terminal device, it enters the addressed device through a simple "port". The device removes the "envelope" (header) of the data frame, reads the data, and if there are no errors, executes the task requested by the data. Then, it adds the generated data to the obtained "envelope" and returns the data frame to the sender. The returned response data frame contains the following content: the terminal slave address (Address), the

executed command (Function), the requested data generated by executing the command (Data), and a checksum (Check). There will be no successful response if any errors occur.

3.1.2.1 数据帧格式

3.1.2.1 Data Frame Format

Address	Function	Data	Check
8-bits	8-bits	N×8-bits	16-bits

3.1.2.2 地址域

3.1.2.2 Address Domain

地址域在帧的开始部分，由一个字节（8 位二进制码）组成，十进制为 0～255，在我们的系统中只留用 1～247，其它地址保留。这些位标明了用户指定的终端设备地址，该设备将接收来自与之相连的主机数据。每个终端设备的地址必须是唯一的，仅仅被寻址到的终端会响应包含了该地址的查询。当终端发送回一个响应，响应中的从机地址数据便告诉了主机哪台终端正与之进行通讯。

The address field is located at the beginning of the frame and consists of one byte (8-bit binary code) with decimal values ranging from 0 to 255. In our system, only 1 to 247 are reserved, while other addresses are reserved. These bits indicate the user specified terminal device address, which will receive data from the host connected to it. The address of each terminal device must be unique, and only the addressed terminal will respond to queries containing that address. When a terminal sends back a response, the slave address data in the response tells the host which terminal is communicating with it.

3.1.2.3 功能域

3.1.2.3 Functional Domain

功能域代码告诉了被寻址到的终端执行何种功能。下表列出了该系列仪表用到的功能码，以及它们的意义和功能。

The functional domain code tells the addressed terminal what function to perform. The following table lists the function codes used in this series of instruments, as well as their meanings and functions.

代码 Code	意义 Significance	行为 Behavior
03、04	读数据寄存器 Read data register	获得一个或多个寄存器的当前二进制值 Obtain the current binary value of one or more registers
16	预置多寄存器 Preset Multiple Registers	设定二进制值到一系列多寄存器中 Set binary values to a series of multiple registers

3.1.2.4 数据域

3.1.2.4 Data Domain

数据域包括了终端执行特定功能所需要的数据或者终端响应查询时采集到的数据。这些数据的内容可能是数值、参考地址或者设置值。例如：功能域码告诉终端读取一个寄存器，数据域则要指明从哪个寄存器开始及读取多少个数据，内嵌的地址和数据依照类型和从机之间的不同内容而有所不同。

The data domain includes the data required by the terminal to perform specific functions or the data collected by the terminal in response to queries. The content of these data may be numerical values, reference addresses, or set values. For example, the function field code tells the terminal to read a register, while the data field indicates which register to start from and how many data to read. The embedded address and data vary depending on the type and content between the slaves.

3.1.2.5 错误校验域

3.1.2.5 Error verification field

该域允许主机和终端检查传输过程中的错误。有时，由于电噪声和其它干扰，一组数据在从一个设备传输到另一个设备时在线路上可能会发生一些改变，出错校验能够保证主机或者终端不去响应那些传输过程中

发生了改变的数据，这就提高了系统的安全性和效率，错误校验使用了 16 位循环冗余的方法。

This domain allows hosts and terminals to check for errors during transmission. Sometimes, due to electrical noise and other interference, a set of data may undergo some changes on the line when transmitted from one device to another. Error checking can ensure that the host or terminal does not respond to the data that has changed during the transmission process, which improves the security and efficiency of the system. Error checking uses a 16 bit cyclic redundancy method.

3.1.3 错误检测的方法

3.1.3 Error detection methods

错误校验（CRC）域占用两个字节，包含了一个 16 位的二进制值。CRC 值有传输设备计算出来，然后附加到数据帧上，接收设备在接收数据时重新计算 CRC 值，然后与就收到的 CRC 域中的值进行比较，如果这两个值不相等，就发生了错误。

The Error Check (CRC) field occupies two bytes and contains a 16 bit binary value. The CRC value is calculated by the transmitting device and then attached to the data frame. The receiving device recalculates the CRC value when receiving the data and compares it with the value in the received CRC field. If these two values are not equal, an error occurs.

CRC 运算时，首先将一个 16 位的寄存器预置为全 1，然后连续把数据帧中的每个字节中的 8 位与该寄存器的当前值进行运算，仅仅每个字节的 8 个数据位参与生成 CRC，起始位和终止位以及可能使用的奇偶位都不影响 CRC。在生成 CRC 时，每个字节的 8 位与寄存器中的内容进行异或，然后将结果向低位移位，高位则用 0 补充，最低位（LSB）移出并检测，如果是 1，该寄存器就与一个预设的固定值（0A001H）进行一次异或运算，如果最低位为 0，则不作任何处理。

When performing CRC operation, a 16 bit register is first pre-set to all 1s, and then the 8 bits in each byte of the data frame are continuously operated with the current value of the register. Only the 8 data bits in each byte participate in generating CRC, and the start and end bits, as well as the possible use of even bits, do not affect CRC. When generating CRC, each byte's 8 bits are XORed with the contents of the register, and the result is shifted to the lower bits, supplemented with 0 for the higher bits, and the least significant bit (LSB) is removed and detected. If it is 1, the register performs an XOR operation with a preset fixed value (0A001H). If the least significant bit is 0, no processing is performed.

上述处理重复进行，直到执行完了 8 次移位操作，当最后一位（第 8 位）移位完成以后，下一个 8 位字节与寄存器的当前值进行异或运算，同样进行上述的另一个 8 次移位异或操作，当数据帧中的所有字节都作了处理，生成的最终值就是 CRC 值。

The above process is repeated until 8 shift operations are completed. After the last bit (8th bit) is shifted, the next 8-bit byte is XORed with the current value of the register. Another 8 shift XOR operations are performed as described above. When all bytes in the data frame are processed, the final value generated is the CRC value.

生成一个 CRC 的流程为：

The process of generating a CRC is as follows:

1、预置一个 16 位寄存器为 0FFFFH（全 1），称之为 CRC 寄存器。

1、Pre set a 16 bit register as 0FFFFH (all 1s), called the CRC register.

2、把数据帧的第一个字节的 8 位与 CRC 寄存器中的低字节进行异或运算，结果存回 CRC 寄存器。

2、XOR the first byte of the data frame with the low byte in the CRC register, and store the result back in the CRC register.

3、将 CRC 寄存器向右移一位，最高位填以 0，最低位移出并检测。

3、Move the CRC register to the right by one bit, fill the highest bit with 0, move the lowest bit out and check.

4、如果最低位为 0：重复第三步（下一次移位）；如果最低位为 1：将 CRC 寄存器与一个预设的固定值（0A001H）进行异或运算。

4、If the lowest bit is 0: repeat step three (next shift); If the lowest bit is 1: XOR the CRC register with a preset

fixed value (0A001H).

5、重复第三步和第四步直到 8 次移位。这样处理完了一个完整的 8 位。

5、Repeat steps three and four until 8 shifts are made. This completes a complete 8-bit process.

6、重复第 2 步到第 5 步来处理下一个 8 位，直到所有的字节处理结束。

6、Repeat steps 2 to 5 to process the next 8 bits until all byte processing is complete.

7、最终 CRC 寄存器的值就是 CRC 的值。

7、The final value of the CRC register is the CRC value.

此外，还有一种利用预设的表格计算 CRC 的方法，它的主要特点是计算速度快，但是表格需要较大的存储空间，该方法此处不再赘述，请参阅相关资料。

In addition, there is a method of calculating CRC using a preset table, which is characterized by fast calculation speed but requires a large storage space for the table. This method will not be repeated here, please refer to relevant materials.

3.2 通讯应用格式详解

3.2 Detailed explanation of communication application formats

本节所举实例将尽可能的使用如下表所示的格式，（数字为 16 进制）。

The examples given in this section will use the format shown in the table below as much as possible, with numbers in hexadecimal.

Addr	Fun	Data start reg hi	Data start reg lo	Data #of reg hi	Data #of reg lo	CRC16 lo	CRC16 hi
01H	03H	00H	00H	00H	03H	05H	CBH

Addr：从机地址

Addr: Slave address

Fun：功能码

Fun: Function code

Data start reg hi：数据起始地址 寄存器高字节

Data start reg hi: High byte of data start address register

Data start reg lo：数据起始地址 寄存器低字节

Data start reg lo: Low byte of data start address register

Data #of reg hi：数据读取个数 寄存器高字节

Data # of reg hi: Number of data read, register high byte

Data #of reg lo：数据读取个数 寄存器低字节

Data # of reg lo: Number of data read, register low byte

CRC16 hi：循环冗余校验 高字节

CRC16 hi: cyclic redundancy check high byte

CRC16 lo：循环冗余校验 低字节

CRC16 lo:cyclic redundancy check low Byte

3.2.1 读数据（功能码 03/04）

3.2.1 Data Reading (Function Code 03/04)

- 查询数据帧
- Query data frames

此功能允许用户获得设备采集与记录的数据及系统参数。主机一次请求的数据个数没有限制，但不能超出定义的地址范围。

This feature allows users to obtain data and system parameters collected and recorded by the device. There is no

limit to the number of data requests a host can make at once, but it cannot exceed the defined address range.

下面的例子是从 01 号从机读 3 个采集到的基本数据（数据帧中的每个地址占用 2 个字节）T1、T2、T3，其中 T1 的地址为 0006H，T2 的地址为 0007H，T3 的地址为 0008H。

The following example is the basic data collected from machine reading of 3 data points (each address in the data frame occupies 2 bytes) T1, T2, T3, where T1 has an address of 0006H, T2 has an address of 0007H, and T3 has an address of 0008H.

Addr	Fun	Data start Addr hi	Data start Addr lo	Data #of Reg hi	Data #of Reg lo	CRC16 lo	CRC16 hi
01H	03H	00H	06H	00H	03H	E5	CA

- 响应数据帧
- Response data frame

响应数据帧包括从机地址、功能码、数据的数量、采集的数据和 CRC 错误校验。

The response data frame includes the slave address, function code, quantity of data, collected data, and CRC error check.

下面的例子是读取 T1、T2、T3（T1=016AH，T2=016BH，T3=0169H）的响应。

The following example is reading the responses of T1, T2, and T3 (T1=016AH, T2=016BH, T3=0169H).

Addr	Fun	Byte Count	Data1 Hi	Data1 Lo	Data2 Hi	Data2 Lo	Data3 Hi	Data3 Lo	CRC16 Lo	CRC16 Hi
01H	03H	06H	01H	6AH	01H	6BH	01H	69H	89H	33H

3.2.2 预置多寄存器（功能码 16）

3.2.2 Preset multiple registers (function code 16)

- 查询数据帧
- Query data frames

功能码 16 允许用户改变多个寄存器的内容，该仪表中系统参数等可用此功能码写入。

Function code 16 allows users to change the contents of multiple registers, and system parameters in the instrument can be written using this function code.

下面的例子是预置 ARTM8 或 ARTM16，设定温度显示的间隔时间为 4 秒，并关闭通道 1 和通道 2 的温度测量。显示控制字的地址为 0003H，通道开/关状态控制寄存器的地址为 0004H。

The following example is to preset ARTM8 or ARTM16, set the temperature display interval time to 4 seconds, and turn off the temperature measurement of channel 1 and channel 2. The address of the display control word is 0003H, and the address of the channel on/off status control register is 0004H.

Addr	Fun	Data start hi	Data start lo	Data #of reg hi	Data #of reg lo	Byte Count	Value1 Hi	Value1 Lo	Value2 Hi	Value2 Lo	CRC16 Lo	CRC16 hi
01H	10H	00H	03H	00H	02H	04H	00H	04H	FFH	FCH	B3H	CAH

- 响应数据帧
- Response data frame

对于预置寄存器请求的正常响应数是在寄存器值改变后回应机器地址、功能码、数据起始地址、数据个数、CRC 校验码。

The normal response number for preset register requests is to respond to the machine address, function code, data starting address, number of data, and CRC check code after the register value changes.

Addr	Fun	Data start Addr hi	Data start Addr lo	Data #of Reg hi	Data #of Reg lo	CRC16 lo	CRC16 hi
01H	10H	00H	03H	00H	02H	B1H	C8H

3.3 参量地址表

3.3 Parameter Address Table

地址 Address	参数 Parameter	属性[1] Attribute[1]	数值范围 Numerical range	数据类型 Data type
0000H 高字节 High byte	仪表型号 Instrument model	R	1：ARTM4	word
0000H 低字节 Low byte	传感器类型 Sensor type	R/W	0：Pt100；1：Pt1000	word
0001H	保护密码 Password	R/W	0000~9999	word
0002H 高字节	通讯地址 Postal address	R/W	0001~0247	word
0002H 低字节	通讯波特率 Baud rate	R/W	0~4：1200、2400、4800、9600、19200	word
0003H	显示控制字 Display control words	R/W	0~20，0 表示静态显示 ，其余表示循环显示的间隔时间 0~20, 0 represents static display, and the rest represents the interval time of cyclic display	word
0004H	1~4 通道投退 1~4 channels for switching on and off	R/W	每一位分别对应一个通道的状态： 0-退出，1-投入 Each one corresponds to the status of a channel: 0-Exit, 1-Investment	word
0005H	1~4 通道传感器状态 1~4 channel sensor status	R	每一位分别对应一个通道传感器的状态：0-正常，1-错误 Each position corresponds to the status of a channel sensor: 0-normal, 1-error	word
0006H	通道 1 温度测量值 Temperature measurement value of channel 1	R	PT100：-100 - 600($\times$10)[2]； PT1000：-100 - 300($\times$10)[2]。	word

0007H	通道 2 温度测量值 Temperature measurement value of channel 2	R	PT100：-100 - 600(×10)[2]； PT1000：-100 - 300(×10)[2]。	word
0008H	通道 3 温度测量值 Temperature measurement value of channel 3	R	PT100：-100 - 600(×10)[2]； PT1000：-100 - 300(×10)[2]。	word
0009H	通道 4 温度测量值 Temperature measurement value of channel 4	R	PT100：-100 - 600(×10)[2]； PT1000：-100 - 300(×10)[2]。	word
000AH	1~4 通道 AL1 告警投退 Channel 1~4 AL1 alarm on/off	R/W	0-退出，1-投入 1-0-Exit, 1-Investment	word
000BH	1~4 通道 AL2 告警投退 Channel 1~4 AL2 alarm on/off	R/W	0-退出，1-投入 1-0-Exit, 1-Investment	word
000CH	1~4 通道 AL1 报警模式 Channel 1~4 AL1 alarm mode	R/W	0-退出，1-高温，2-低温 1-0-Exit, 1-High Temperature, 2-Low Temperature	word
000DH	1~4 通道 AL2 报警模式 Channel 1~4 AL2 alarm mode	R/W	0-退出，1-高温，2-低温 0-Exit, 1-High Temperature, 2-Low Temperature	word
000EH	AL1 对应的 DO 出口 DO export corresponding to AL1	R/W	0~3：DO1、DO2、DO3、DO4	word
000FH	AL2 对应的 DO 出口 DO export corresponding to AL2	R/W	0~3：DO1、DO2、DO3、DO4	word
0010H	通道 1-AL1 告警定值 Channel 1-AL1 alarm setting	R/W	范围：-100 ~ 600(×10)[2] Range: -100~600(×10)[2]	word
0011H	通道 1-AL2 告警定值 Channel 1-AL2 alarm setting	R/W	范围：-100 ~ 600(×10)[2] Range: -100~600(×10)[2]	word
0012H	通道 2-AL1 告警定值 Channel 2-AL1 alarm setting	R/W	范围：-100 ~ 600(×10)[2] Range: -100~600(×10)[2]	word

0013H	通道 2-AL2 告警定值 Channel 2-AL2 alarm setting	R/W	范围：-100～600(×10)[2] Range: -100~600(×10)[2]	word
0014H	通道 3-AL1 告警定值 Channel 3-AL1 alarm setting	R/W	范围：-100～600(×10)[2] Range: -100~600(×10)[2]	word
0015H	通道 3-AL2 告警定值 Channel 3-AL2 alarm setting	R/W	范围：-100～600(×10)[2] Range: -100~600(×10)[2]	word
0016H	通道 4-AL1 告警定值 Channel4-AL1 alarm setting	R/W	范围：-100～600(×10)[2] Range: -100~600(×10)[2]	word
0017H	通道 4-AL2 告警定值 Channel 4-AL2 alarm setting	R/W	范围：-100～600(×10)[2] Range: -100~600(×10)[2]	word
0018H	AO 投退 AO investment or withdrawal	R/W	0-退出，1-投入 0-Exit, 1-Investment	word
0019H	AO 最小值对应温度值 AO minimum value corresponds to temperature value	R/W	范围：-100～600(×10)[2] Range: -100~600(×10)[2]	word
0020H	AO 最大值对应温度值 The maximum AO value corresponds to the temperature value	R/W	范围：-100～600(×10)[2] Range: -100~600(×10)[2]	word
0021H ~0024H	DO1~DO4 告警回滞量 DO1~DO4 alarm hysteresis	R/W	范围：0～100 Range: 0~100	Word*4
0025H ~0028H	DO1~DO4 告警延时次数 DO1~DO4 alarm delay times	R/W	范围：0～100 Range: 0~100	word*4
0029H	保留 retain	——	——	——
002AH	1~4 通道 AL1 告警触发状态 Channel 1~4 AL1 alarm triggered status	R/W	第 0~3 位分别对应 1~4 路 The 0-3 positions correspond to channels 1-4 respectively 0-未告警，1-告警	word

			0- No alarm, 1- Alarm	
002BH	1~4 通道 AL2 告警触发状态 Channel 1~4 AL2 alarm triggered status	R/W	第 0~3 位分别对应 1~4 路 The 0-3 positions correspond to channels 1-4 respectively 0-未告警，1-告警 0- No alarm, 1- Alarm	word
002CH	1~4 通道传感器故障状态 1~4 channel sensor fault status	R/W	第 0~3 位分别对应 1~4 路 The 0-3 positions correspond to channels 1-4 respectively 0-正常，1-故障 0-Normal, 1-Fault	word
002DH	1~4 通道传感器故障类型 Types of sensor faults in channels 1~4	R/W	0：未断线；1：接线 A 断线； 2：接线 B 断线；4：接线 C 断线。	word
002EH	AO 模拟量输出值 AO analog output value	R/W	4~20mA(×100)[2]	word

注：**[1]R-只读；W-写；R/W-读/写。[2]读取时实际值乘以括号中的相应倍数后上传，写入时应乘以括号中的倍数后写入。**

Note: [1] R-read; W-write；R/W-read/write. [2] When reading, the actual value should be multiplied by the corresponding multiple in parentheses before uploading, and when writing, it should be multiplied by the multiple in parentheses before writing.