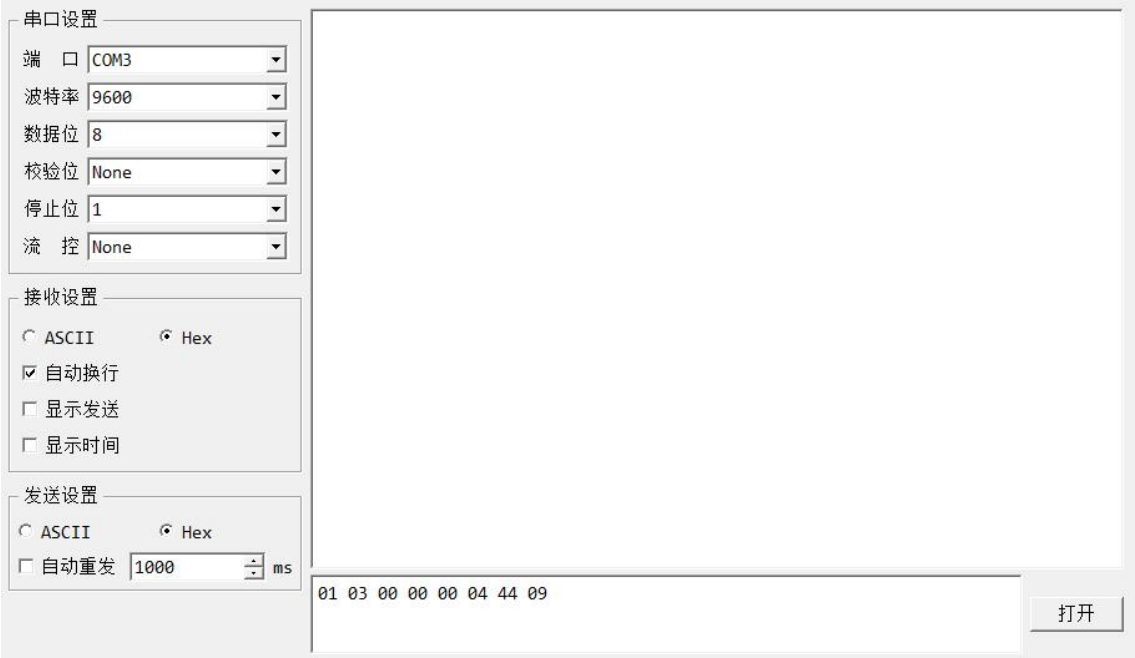
DX-EC206FRS Four-electrode digital conductivity sensor MODBUS communication protocol

Serial port debugging tool settings:



The **MODBUS** protocol is used for communication between the sensor and the host computer. The frame format adopts **RTU** mode, the baud rate is **9600bps**, the data bit is **8bit**, **no** parity bit, and **1** stop bit. **The time interval for reading data should not be less than 500 milliseconds**. The specific agreement is as follows:

1. command format

Read data:

a) read data instruction frame

	Add	function code	Register address	number of registers	CRC check code (low byte first))
Bytes	01	03	XX XX	XX XX	XX XX

b) Read data response frame:

	Add	function code	Number of bytes	Response data	CRC check code (low byte first)
Bytes	01	03	XX	XX…XX	XX XX

Write data：

a) Write data instruction frame

	Add	function code	Register address	write data	CRC check code (low byte first)
Bytes	01	06	XX XX	XX XX	XX XX

b) Write data response frame (same as Write data instruction frame)

	Add	function code	Register address	Write data	CRC check code (low byte first)
Bytes	01	06	XX XX	XX XX	XX XX

2. Read measurement data

Read the measurement data of the sensor. The conductivity value (mS/cm) and temperature value (°C) of the sensor can be read from 4 consecutive MODBUS registers whose starting address is 0x0000.

Example:

Request Frame: 01 03 00 00 00 04 44 09

Response frame: 01 03 08 03 E8 00 03 00 FA 00 01 18 3D

Data interpretation：

01 - Address

03 - Function code

08 - Number of bytes

03 E8 00 03 - 03 E8 is the conductivity value in hexadecimal, which is converted to 1000 in decimal; it should be noted that since the conductivity does not have negative numbers, in order to maximize the range of the sensor, the conductivity value is **an unsigned number (unsigned)** output, so the conductivity value should be processed as **an unsigned number (unsigned)** when programming. 00 03 is the decimal place of the conductivity value in hexadecimal, converted to decimal is 3, which means there are 3 decimal places, that is, the read conductivity value is 1.000mS/cm .

00 FA 00 01 - 00 FA is the temperature value in hexadecimal, converted to decimal is 250, 00 01 is the number of decimal places of the temperature in hexadecimal, converted to decimal is 1, which means there is 1 decimal place, that is The temperature read was 25.0°C. Negative temperature is output in 16-bit two's complement form, such as FF38 means -200; in short, when programming, you only need to regard the received 16-bit binary number as a **signed number (signed)** to participate in the operation .

18 3D - CRC check code (low byte first)

3. Sensor calibration

Perform sensor calibration. Although the sensor has been calibrated before leaving the factory, the actual use environment may be different from the laboratory. If there is an error in the measurement result of the sensor, the measurement data of the sensor can be corrected by the following operations.

Notice:

①When sending a calibration command, if the response frame is consistent with the request frame, it means the operation is successful. If not, it means the operation failed. For detailed return data, please refer to the "**4 Error Response**" section.

②It takes a certain amount of time (not more than 30s) to execute some calibration commands, please wait for the execution to finish before performing other operations。

3.1 Temperature calibration

When the temperature of the sensor has a deviation, the temperature offset value of the sensor can be read or set through the MODBUS register with address 0x1010. When reading this register, the sensor returns the temperature offset value × 10； When setting this register, the written data is the **actual temperature value** × 10 .

Before calibrating, please make sure the temperature sensor is free of attachments, place the sensor in a solution with a known temperature value, and wait for the data to stabilize. Taking 30.0°C as an example, execute the command as follows:

Request frame: 01 06 10 10 01 2C 8C 82

Response frame: 01 06 10 10 01 2C 8C 82

Data interpretation：

01	- address
06	- function code
10 10	- register address
01 2C	- 30.0℃ × Hexadecimal value of 1 0
8C 82	- CRC check code (low byte first)

After executing this command, the sensor will automatically calculate the temperature offset value and save it.

3.2 Conductivity calibration

Conductivity calibration is divided into two modes: zero-point calibration and single-point slope calibration, zero-point calibration and multi-point slope calibration.

a) Zero-point calibration and one-point slope calibration

Users can set the zero-point calibration and single-point slope calibration of conductivity through the MODBUS registers with addresses 0x1000 (or 0x1050) and 0x1004.

Zero point calibration

Before calibration, please make sure that the graphite electrode is free of attachments and dry. Place the sensor in the air. After the data is stable, execute the following command:
Request frame: 01 06 10 00 00 00 8D 0A
Response frame: 01 06 10 00 00 00 8D 0A

After executing this command, the sensor will be cleared and saved.

Single Point Slope Calibration

Before calibrating, please make sure that the graphite electrode is free of attachments, place the sensor in a standard solution with known conductivity value, and wait for the data to stabilize. Taking the standard solution of 12.88mS/cm as an example, execute the command as follows:
Request frame: 01 06 10 04 05 08 CE 5D
Response frame: 01 06 10 04 05 08 CE 5D

Data interpretation：

01	- address
06	- function code
10 04	- register address
05 08	- standard solution 12.88mS/cm×100 × Hexadecimal value
CE 5D	- CRC check code (low byte first)

After executing this command, the sensor will automatically calculate the slope and save it.

b) Zero point calibration and multi-point slope calibration

Users can set the zero point calibration and multi-point slope calibration of the conductivity through the MODBUS registers with addresses 0x1000 (or 0x1050) and 0x1054, 0x1058, 0x105C, 0x1060, 0x1064.

Zero point calibration

Before calibrating, please make sure that the graphite electrode is free of attachments and is dry, put the sensor in the air, and after the data is stable, execute the following command:
Request frame: 01 06 10 50 00 00 8D 1B

Response frame: 01 06 10 50 00 00 8D 1B

After executing this command, the sensor will be cleared and saved.

Multi-point slope calibration

The device supports up to 5 points of slope calibration, and the user can choose any number of points from 1 to 5 for calibration. The calibration principle is shown in Figure 1. There are 5 calibration buffers Cal1-Cal5 in the sensor, the user can set the value of Cal1-Cal5 through the corresponding MODBUS register, when the user calibrates a certain Cal, the program will automatically calculate the slope of the two adjacent Cal and save.

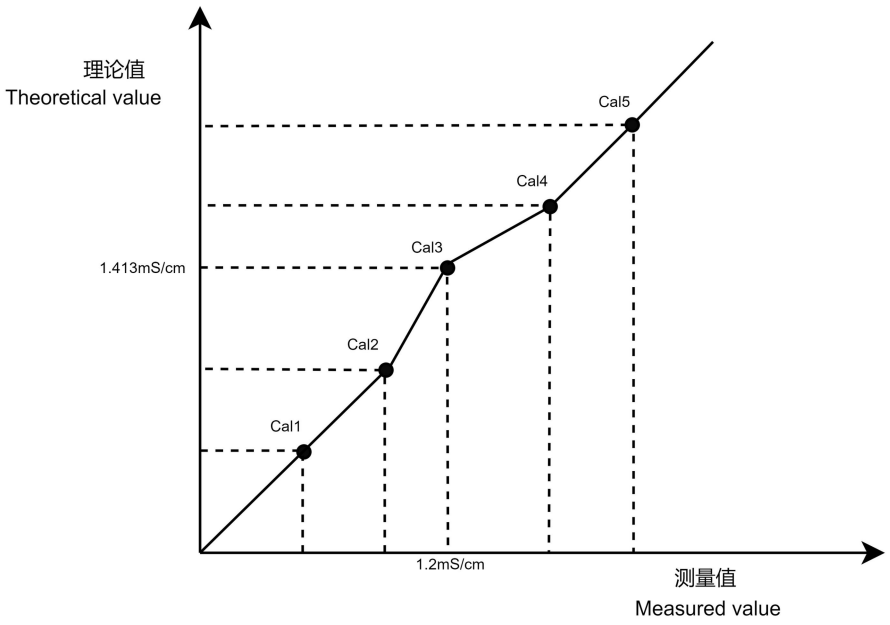


Figure 1

Taking Figure 1 as an example, the user placed the sensor in a 1.41mS/cm standard solution, and the measured value of the sensor was 1.20mS/cm, which is obviously inaccurate and needs to be calibrated. Then the command should be executed as follows:

Request frame: 01 06 10 5C 00 8D 8D 7D

Response frame: 01 06 10 5C 00 8D 8D 7D

Data interpretation：

01	- address
06	- function code
10 5C	- Register address of Cal3
00 8D	- standard solution 1.41mS/cm×100 × Hexadecimal value
8D 7D	- CRC check code (low byte first)

After executing this command, the sensor will automatically calculate the slope and save it. The relationship between the measured value and the theoretical value of the sensor after calibration should be as shown in the figure below.

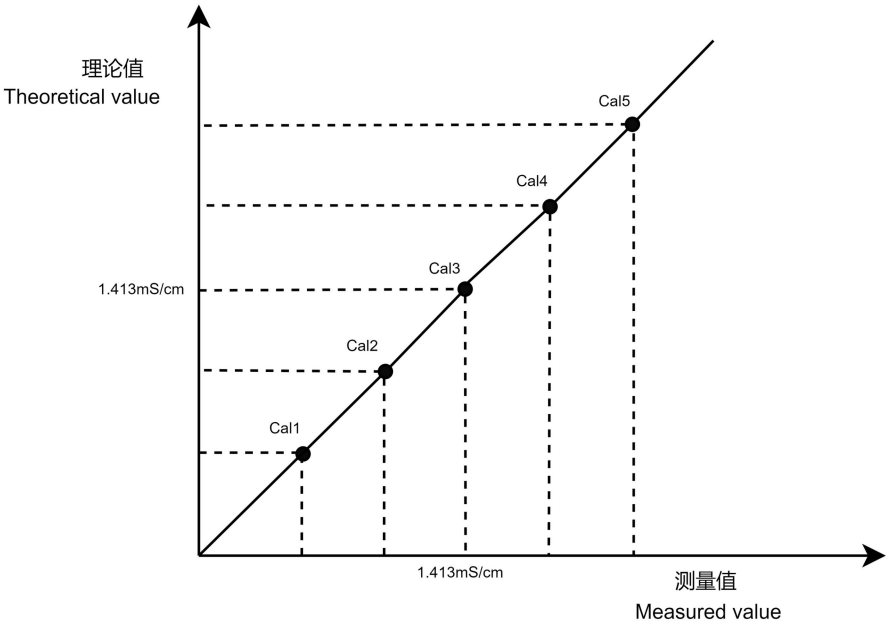


Figure 2

It should be noted that users can calibrate the value of Cal1-Cal5 according to their needs, but the calibration must follow the rules of Cal5> Cal4> Cal3> Cal2> Cal1 and must be carried out under the same environmental conditions. The factory default values of Cal1-Cal5 are as

follows:

Calibration point	Default
Cal1	0.01mS/cm
Cal2	0.084mS/cm
Cal3	1.413mS/cm
Cal4	12.88mS/cm
Cal5	60.00mS/cm

3.3 Calibration restore factory function

To delete the user's calibration data, you can set Calibration restore factory function through the MODBUS register with the address 0x2002. Calibration restore factory functio is only valid for the following functions:

①Temperature offset
②Conductivity offset
③Conductivity zero point
④Conductivity slope (all slopes)

3.5 Modify sensor address

The default factory address of the sensor is 1, and the broadcast address is 255. The communication address of the sensor can be read or set through the MODBUS register whose address is 0x2002.

Taking the sensor address 1 changed to 15 as an example, execute the command as follows:
Request frame: 01 06 20 02 00 0F 63 CE
Response frame: 01 06 20 02 00 0F 63 CE

Data interpretation：
01 - address
06 - function code

20 02 - Register address

00 0F - Hexadecimal value of destination address 15

63 CE - CRC check code (low byte first)

After executing this command, the address of the sensor will be modified and saved.

4. Error response

If the sensor cannot execute the upper computer command correctly, it will return the following format:

Definition	Address	Function Code	Error code	CRC check code
Data	ADDR	80H+FUN	CODE	CRC16
Number of bytes	1	1	1	2

▲ ADDR：Address

▲ FUN： Function Code

▲ CODE：Error code

01 – Function code error

02 – Register address error

03 – Data error

▲ CRC16：CRC check code

If error code 0x03 is returned when executing the "**3 sensor calibration**" command, it may be caused by excessive data fluctuation or unreasonable input parameters. Please wait until the data is stable and the input parameters are correct before performing the calibration operation.

5. Function list

Register address	Name	Explanation	Number of registers	Access method
0x0000	Conductivity +	4 double-byte integers, which	4（8 bytes）	Read

	temperature	are the conductivity value (mS/cm), the decimal place of the conductivity value, the temperature value (℃), and the decimal place of the temperature value.		
0x1000 (or 0x1050)	Conductivity Zero Calibration	Calibrate in air and write data as 0.	1（2 bytes）	Write
0x1004	Conductivity Single Point Slope Calibration	Calibrate in a known standard solution, and write it as the conductivity value of the standard solution (mS/cm×100). The data range is 0~60000.	1（2 bytes）	Write
0x1054	Conductivity Multipoint Slope Calibration 1	Calibrate in a known standard solution, write or read the conductivity value (mS/cm×100) of the standard solution. The data range is 0~60000.	1（2 bytes）	Read/Write
0x1058	Conductivity Multipoint Slope Calibration 2	Calibrate in a known standard solution, write or read the conductivity value (mS/cm×100) of the standard solution. The data range is 0~60000.	1（2 bytes）	Read/Write
0x105C	Conductivity Multipoint Slope Calibration 3	Calibrate in a known standard solution, write or read the conductivity value (mS/cm×100) of the standard solution. The data range is 0~60000.	1（2 bytes）	Read/Write
0x1060	Conductivity Multipoint Slope Calibration 4	Calibrate in a known standard solution, write or read the conductivity value (mS/cm×100) of the standard solution. The data range is 0~60000.	1（2 bytes）	Read/Write
0x1064	Conductivity Multipoint Slope Calibration 5	Calibrate in a known standard solution, write or read the conductivity value (mS/cm×100) of the standard solution. The data range is 0~60000.	1（2 bytes）	Read/Write
0x1010	Automatic calculation of temperature offset	Calibrated in the solution, the written data is the actual temperature value × 10, and the data range is -200~1200. The read data is temperature offset	1（2 bytes）	Read/Write

		x 10.		
0x8004	Set Conductivity Offset	Write or read the conductivity offset (mS/cm×100) register. Data range -30000~30000.	1（2 bytes）	Read/Write
0x8005	Set temperature offset	Write or read temperature offset (℃ × 10) Register. Data range: - 1000~1000.	1（2 bytes）	Read/Write
0x2002	Sensor address	Write or read sensor communication address. The data range is 1~127, and the default is 1. Broadcast address 255.	1（2 bytes）	Read/Write
0x2020	Reset sensor	The calibration value is restored to the default value, and the written data is 0. Note: After the sensor is reset, it needs to be calibrated again before it can be used.	1（2 bytes）	Write
0x8210	Get hardware version	Returns the hardware version string	4（8 bytes）	Read
0x8220	Get software version	Returns the software version string	4（8 bytes）	Read