

HWR330B Moisture Content Oil Characterisation Sensor

user manual

(5.0.1)



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Representations

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This manual describes how to use the HWR330B Water Content Oil Characterisation Sensor (hereinafter referred to as the HWR330B) and consists of the following four sections:

1. testing tools;
2. configuration connections;
3. communication protocols;
4. test instructions.

1 Test Tools

1.1 Hardware Tools

- ① One laptop or desktop computer with a USB port;
- ② One HWR330B;
- ③ One test oil sample;
- ④ One M8 6-core cable of 2 metres length;
- ⑤ One USB-RS485 converter;
- ⑥ One +24V DC regulated power supply.

1.2 software tool

- ① USB-RS485 Converter Driver



PL2303_Prolific_DriverInstaller_v110.rar

- ② serial communications software



ModbusPoll6.3.rar

If users need, related software can be obtained from our technical staff.

2 Configuring Connections

2.1 Installation of serial drivers and serial communication software

It is recommended that you turn off any antivirus software on your computer before installing the software, otherwise the installation may fail due to errors or missing files.

2.1.1 Installing the serial port driver

According to the serial communication software, install the corresponding driver. After the driver is installed, you can check the installation result under Computer -> Management -> Device Manager -> Port Directory, and the interface after successful installation is shown in Figure 1:

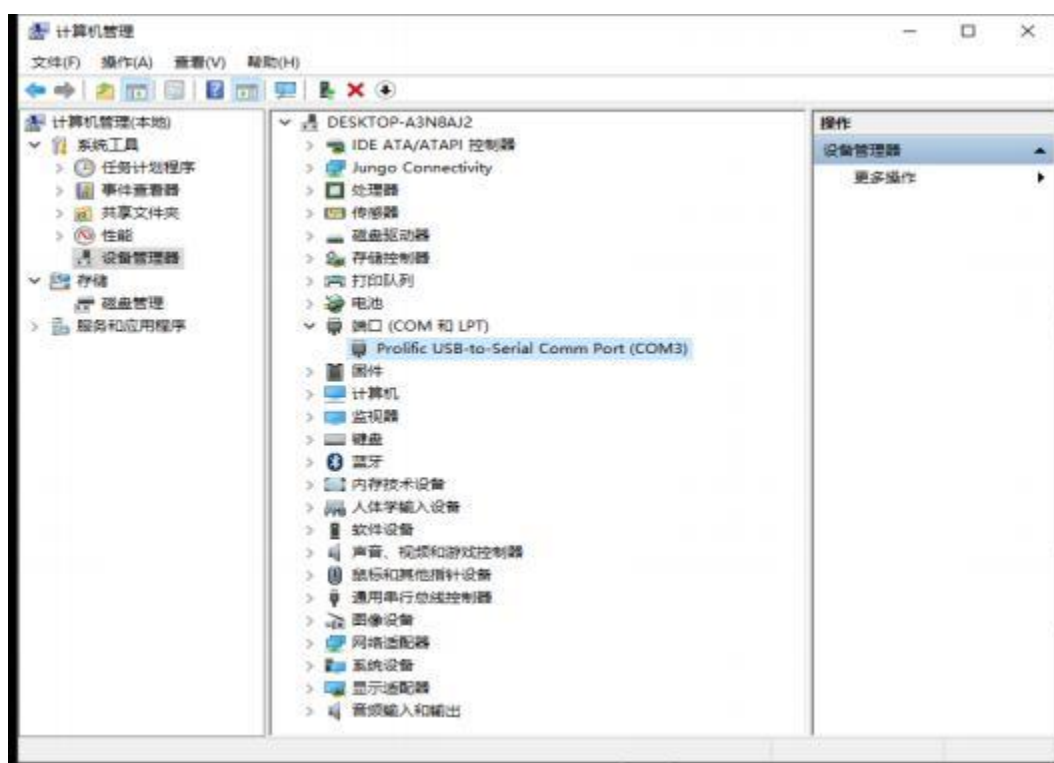


Figure 1 Serial Driver Installation Successful Interface

2.1.2 Installation of serial communication software

Follow the Modbus Poll software prompts for installation and setup.

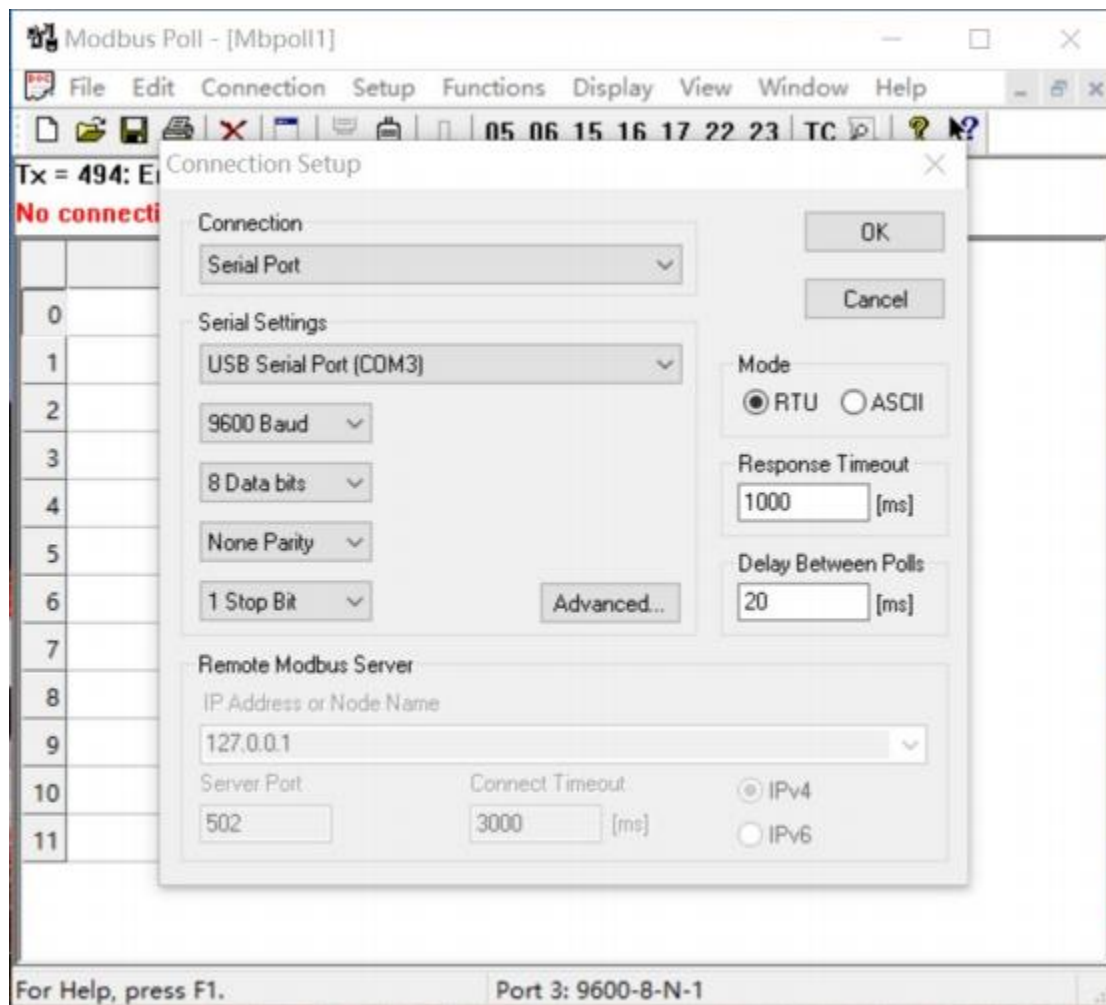


Figure 2 Modbus Poll Software Serial Port Parameter Settings

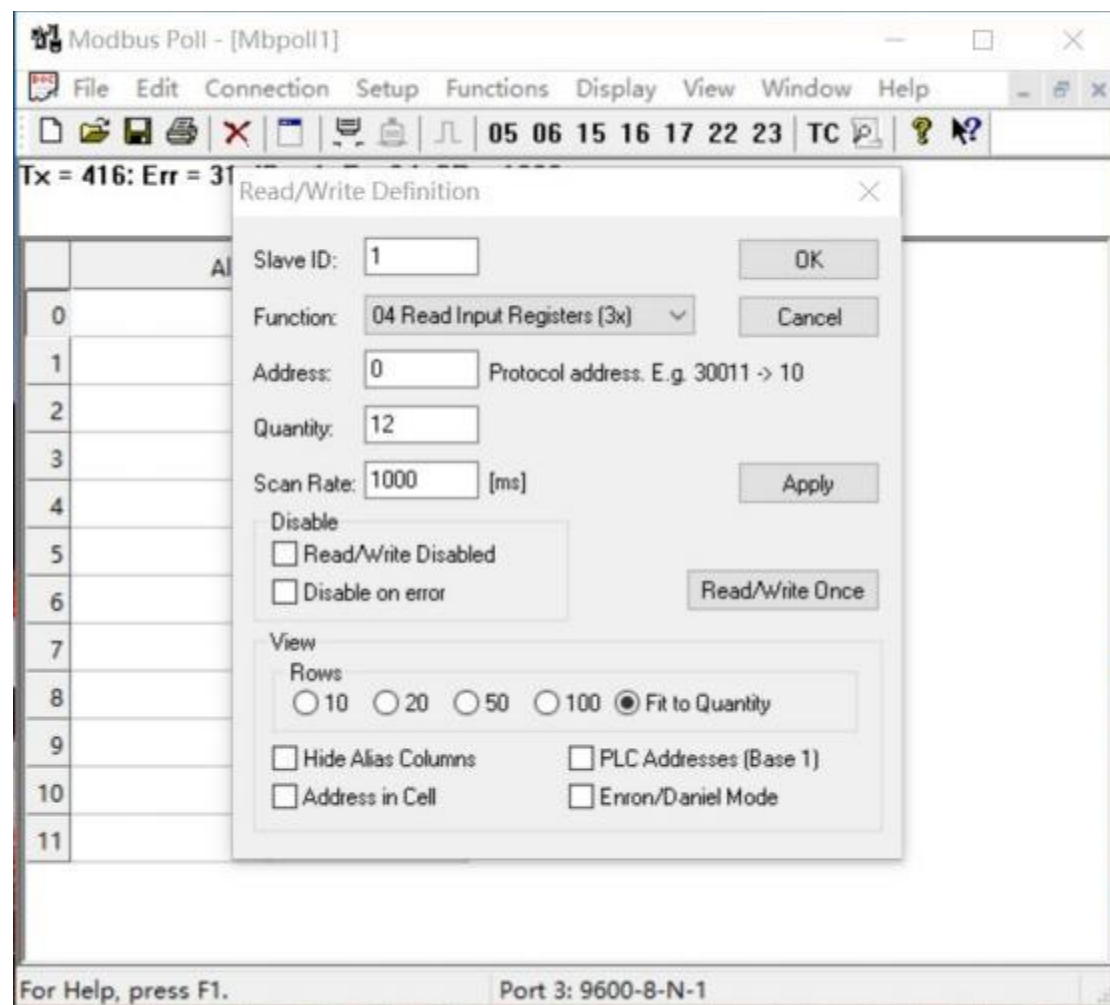


Figure 3 Modbus Poll Software Read/Write Settings

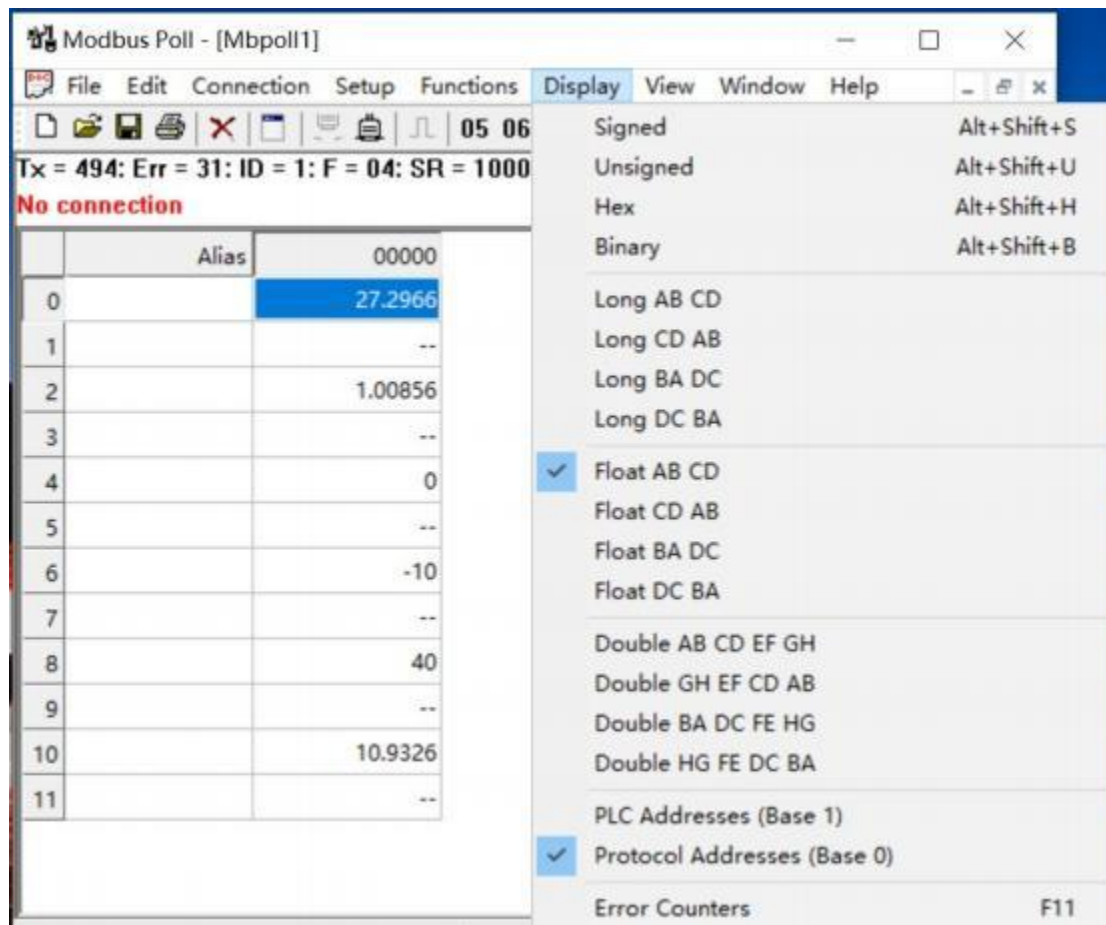
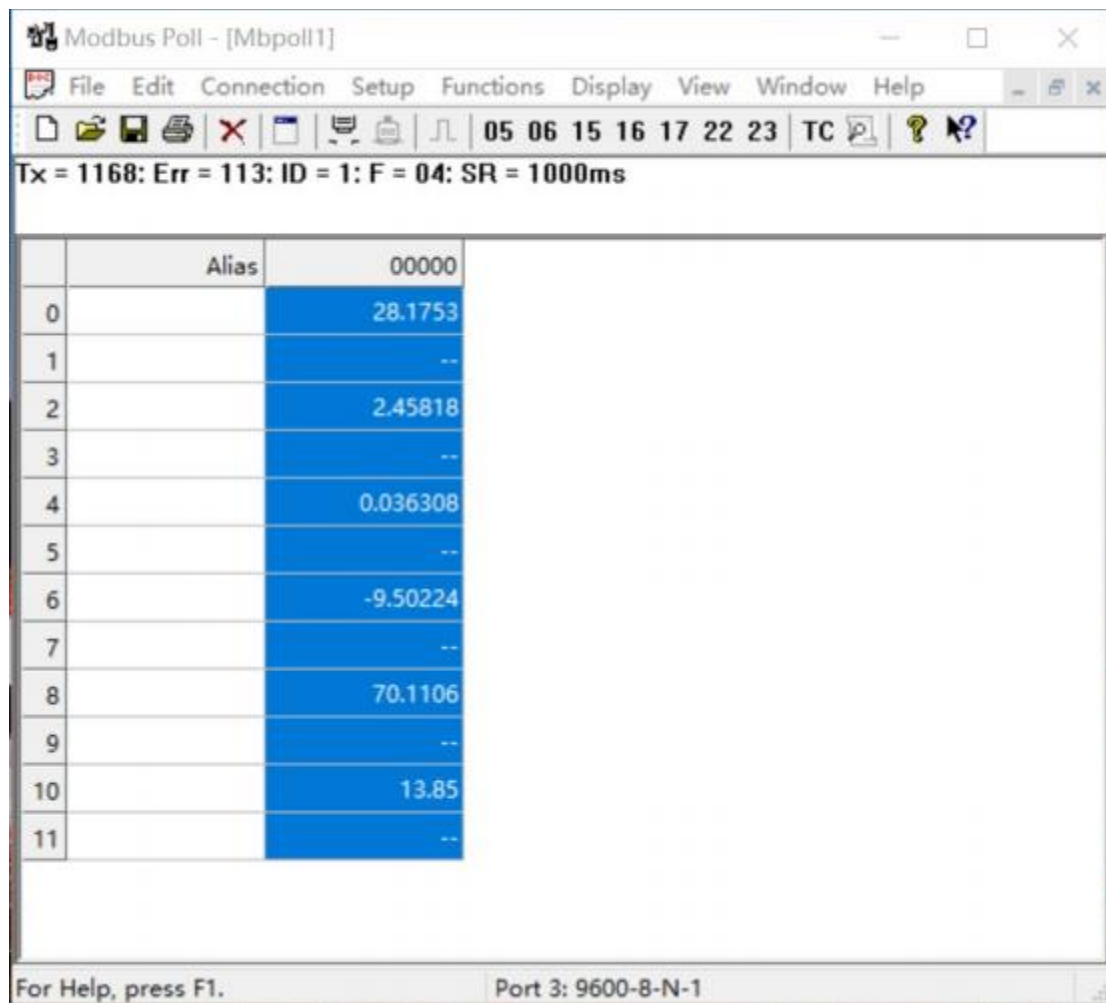


Figure 4 Modbus Poll Software Data Display Settings



The screenshot shows the Modbus Poll software window titled 'Modbus Poll - [Mbpoll1]'. The status bar at the top indicates 'Tx = 1168: Err = 113: ID = 1: F = 04: SR = 1000ms'. The main display area contains a table with 12 rows and 3 columns. The first column is labeled 'Alias' and the second column is labeled '00000'. The third column contains numerical values. The values are: 28.1753, --, 2.45818, --, 0.036308, --, -9.50224, --, 70.1106, --, 13.85, and --. The status bar at the bottom indicates 'For Help, press F1.' and 'Port 3: 9600-8-N-1'.

	Alias	00000
0		28.1753
1		--
2		2.45818
3		--
4		0.036308
5		--
6		-9.50224
7		--
8		70.1106
9		--
10		13.85
11		--

Figure 5 Modbus Poll Software Communication Interface

Figure 5 shows the data for temperature 28.1753 ° C, dielectric constant 2.45818, moisture content 0.036308 %, oil quality -9.50224, water content index 70.1106, capacitance 13.85 pF.

2.2 communication line connection

Connect the communication lines as shown in Figure 6. Measurement results can be read normally about 2s after the power is turned on. It is important that the HWR330B probe is fully immersed in the oil (no air bubbles in the probe air holes) during testing or normal use, otherwise the measurement results will not characterise the current condition of the oil sample.



Fig 6 Schematic diagram of communication line connection

3 communication protocol

HWR330B provides a standard RS485 communication interface to communicate with the host using Modbus RTU protocol. In a complete online monitoring system, the master control device acts as the host and HWR330B acts as the slave. Each communication handshake always consists of an access request from the master and a response from the slave.

GB/T19582-2008 Specification for Industrial Automation Network Based on Modbus Protocol.

3.1 data format

3.1.1 data frame format

The format of each byte (frame) sent by HWR330B fully follows the GB/T19582-2008 standard of the

MODBUS communication protocol, function codes support reading, writing, batch writing, etc. The CRC checksum: (CRC-16/MODBUS $x^{16}+x^{15}+x^2+1$) starts from 'address code' to 'data'. The data frame consists of start bit, information bit and stop bit, 10 bits in total, as shown in Figure 7.

Frame format (10-bit):

start bit	D0	D1	D2	D3	D4	D5	D6	D7	stop bit
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Figure 7 Data frame format

Specific definitions are given below:

Bit 1: Start bit ('0' valid);

Bits 2 to 9: Information bits;

Bit 10: Stop bit ('1' valid);

3.1.2 message format

The format of each message received and sent by the system is as follows:

——address
 ——function code
 ——Amount of data
 ——Data 1
 ——...
 ——Data n
 ——CRC16 calibration

3.2 Communication parameters

3.2.1 Serial port settings

parametric	causality
baud	9600
data bit	8-bit
parity check	uncalibrated
stop bit	1-bit

Table 1 Serial Port Settings

3.2.2 Modbus function code

function code	define
04 (0x04)	Read Input Register
06 (0x06)	Write Single Register
16 (0x10)	Write multiple registers

Table 2 Modbus Function Codes

3.2.3 Modbus operable register

NO.	starting address	function code	length of a character	Stored content	clarification
1	0x0000	0x04	2	Temp	Datatype: float ABCD ; unit: °C
2	0x0002		2	dielectric constant	Datatype: float ABCD ; unit: -
3	0x0004		2	moisture content	Datatype: float ABCD ; unit: %
4	0x0006		2	oil quality	Datatype: float ABCD ; unit: -
5	0x0008		2	water content index	Datatype: float ABCD ; unit: -
6	0x000A		2	capacitors	Datatype: float ABCD ; unit: pF
7	0x9000	0x04	1	address	Datatype: unsigned int
		0x06			

Note: float Single-precision floating-point data, compliant with IEEE754 standard.

Table 3 Modbus operable registers

3.3 data retrieval

Example of reading HWR330B data message [HWR330B address is 1, temperature 28.1753 ° C, dielectric constant 2.45818, water content 0.036308 %, oil quality -9.50224, water content index 70.1106, capacitance 13.85 pF].

request		responsive		
domain name	(hexadecimal)	domain name	(hexadecimal)	
address	01	address	01	
function code	04	function code	04	
data home address Hi	00	Number of data bytes	18	
data home address Lo	00	temp	41	
Number of data characters Hi	00		E1	
Number of data characters Lo	0C		67	
CRC16 Lo	F0		04	
CRC16 Hi	0F	dielectric constant	40	
			1D	
			52	
			D2	
	moisture content	3D		
		14		
		B7		
		B3		
	oil quality	C1		
		18		
		09		
		2D		
	water content index	42		
		8C		
		38		
		A1		
	capacitors	41		
		5D		
		99		
		9A		
	CRC16 Lo	1C		
	CRC16 Hi	C6		

Table 4 Example of reading HWR330B data message

3.4 Address Settings

The factory default address of HWR330B is 1. The address setting range is 1 to 100, and 0 is the broadcast address.

3.4.1 Enquiry Address

Example of a query address message [HWR330B Current address is 1]

request		responsive	
domain name	(hexadecimal)	domain name	(hexadecimal)
broadcast address	00	broadcast address	00
function code	04	function code	04
starting address Hi	90	Number of data bytes	02
starting address Lo	00	current address	01
Number of data characters Hi	00	Current Address Backup	01
Number of data characters Lo	01	CRC16 Lo	44
CRC16 Lo	1D	CRC16 Hi	A0
CRC16 Hi	1B		

Table 5 Example of query HWR330B address message

3.4.2 Change address

Example of a Modify Address Message [HWR330B address changed from 1 to 2.].

request		responsive	
domain name	(hexadecimal)	domain name	(hexadecimal)
current address	01	current address	01
function code	06	function code	06
data home address Hi	90	data home address Hi	90
data home address Lo	00	data home address Lo	00
Setting the address Hi	00	Setting the address Hi	00
Setting the address Lo	02	Setting the address Lo	02
CRC16 Lo	25	CRC16 Lo	25
CRC16 Hi	0B	CRC16 Hi	0B

Table 6 Example of Modify HWR330B Address Message

3.5 4–20mA analogue output

3.5.1 4–20mA Output Channel Definition

Ch1 is the temperature (°C)

Ch2 is dielectric constant (-) or water content (%), oil quality (-), water content indicator (-)

3.5.2 4–20mA Range Definition

Iout	4mA	12mA	20mA
Ch1	-40.0 °C	40.0 °C	120.0 °C
Ch2	0.0 %	5.0 %	10.0 %

Note: Depending on the customer's order, ch1 and ch2 ranges can be selected flexibly, the above table is an example.

Table 7 4–20mA Range Definitions

3.5.3 4–20mA output connection

The HWR330B uses a 3-wire 4-20mA current loop analogue output, wired as follows.

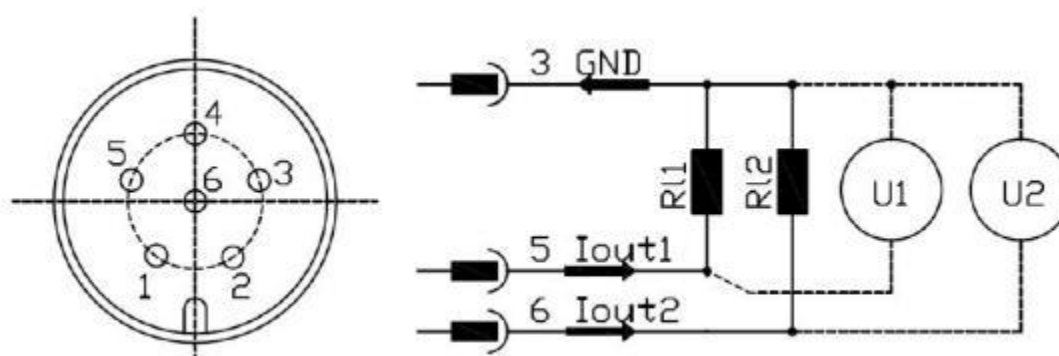


Figure 8 4–20mA Current Loop Connection Diagram

Attention:

- 1) The red wire (corresponding to pin 1 of M8 connector) is connected to DC24V;
- 2) The black wire (corresponding to pin 3 of M8 connector) is connected to GND.
- 3) HWR330B has two 4–20mA 3-wire analogue outputs, channel 1 for temperature and channel 2 for moisture content (or as per order);
- 4) The yellow wire (corresponding to pin 5 of M8 connector) is connected to the positive input terminal of the user's 4–20mA sampling module; at the same time, the negative output terminal of the loop is connected back to the black wire GND, forming a 4–20mA current loop; this channel represents temperature;
- 5) Orange wire (or blue wire of the old model, corresponding to pin 6 of M8 connector) is connected to the positive terminal of the other 4–20mA sampling

module input of the user; at the same time, the negative terminal of the output of this circuit is connected back to GND of the black wire to form a 4-20mA current loop; this channel represents the water content;

- 6) **Special note:** Users need to make sure that the 4-20mA loop load resistors RL1 and RL2 are included in the user's 4-20mA acquisition module or in the 4-20mA input channel of PLC, and should not connect an ammeter in series to the loop to measure the 4-20mA current value without any load;

- 7) Load Resistors (RL1, RL2)

In order to achieve the rated operating characteristics of the HWR330B, the load resistors RL1 and RL2 should be $\leq 500\Omega$ and $\geq 100\Omega$, and it is recommended that the user choose 500Ω high-precision, low-temperature-drift sampling resistors. In this case, the HWR330B can work normally under 22V-28V DC external power supply.

3.5.4 4-20mA Output conversion formula

norm	Measurement range	formulas
temp	-40.0 ... 120.0 °C	$T = (I_{out} - 4) * 160 / (20 - 4) - 40.0$
moisture content	0.0 ... 10.0 %	$W = (I_{out} - 4) * 10 / (20 - 4) + 0.0$

Note: The above measurement ranges are examples for the convenience of the customer's understanding and are subject to modification as agreed in the order.

Table 8 4-20mA conversion formula

3.5.5 DDU smart meter

The HWR330B can be equipped with an optional DDU intelligent display meter for your convenience in the field.



Figure 9 DDU Smart Meter

The instrument comes with +24VDC power output (P+ and P- terminals), HWR330B does not need external power supply. The power supply ground (P- terminal) and analogue input signal ground (C terminal) are not common ground, and need to be shorted with a shielded wire.



Fig. 10 Cable connection between instrument terminal and HWR330B



WARNING: Please make sure to check the above wiring sequence is correct and operate with caution, otherwise it will be possible to wiring error and causeshort-circuit, over-voltage and other causes of damage to the instrument, resulting in failure to communicate.

4 Test Description

4.1 Wiring Definitions

The HWR330B has an M8 1*6 connector (male) on the tail with the following interface definition:

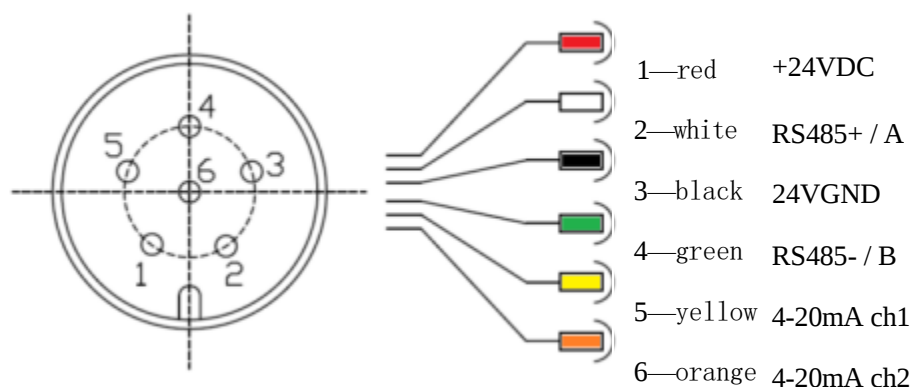


Figure 11 Connector Interface Definitions

4.2 test step

Step 1: Connect the test line according to Figure 6.

Step 2: Set up the communication software and test whether the communication connection of the whole line is normal. If it is normal, then perform step 3; if it is not normal, then check the line connection carefully and troubleshoot the problem.

Step 3: Clean the HWR330B probe with petroleum ether until there is no visible oil on the surface of the probe and blow it dry with an instrument air source; this must be done before the HWR330B can be used.

Step 4: Use a 25mL or larger measuring cup to measure a suitable amount of oil sample, with the oil level at a level that will just submerge the HWR330B mounting tube.

The level of oil should be just enough to submerge the threads of the HWR330B mounting pipe, and there should not be any obvious air bubbles in the air holes of the probe. Step 5: Connect the HWR330B and power up for testing.