yateks®

YTS-M-1

Micro-moisture Content Sensor

User Manual

Warning: Please read the user manual carefully before using

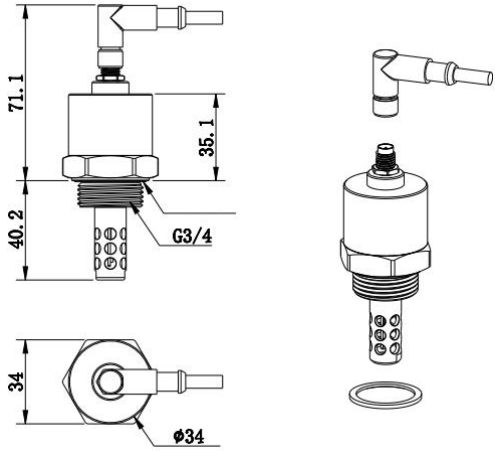
Contents

1. Product Overview

Monitoring the micro-moisture of lubricating oil and hydraulic oil in large-scale continuous operation equipment, heavy machinery equipment and other equipment has an irreplaceable role in ensuring the normal operation of these key equipment. Because the presence of moisture will damage the oil film, cause the failure of additives, cause corrosion of metal parts, shorten the oil service life, and even cause an unplanned shutdown of large machinery, causing serious safety accidents and economic losses. For generator sets and transformers, moisture will destroy the oil's insulating properties and threaten the safety of power equipment and personnel.

The unique moisture sensing probe designed at the front end of the YTS-M-1 micro-moisture sensor can capture the change of electrical characteristics of the oil-water mixture in real-time, compensate the data through a high-precision temperature probe, and obtain the moisture content in oil through an optimization algorithm.

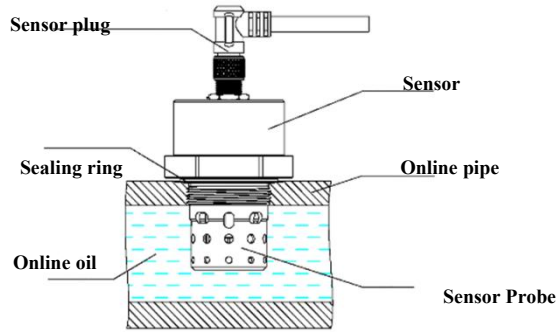
2. Product Structure



Unit：mm

3. Installation method

The sensor is fixed to the measuring cell or tank using a G3/4 external threaded connection. The mounting interface is to be pre-pressurised and sealed with a smooth flat surface and the sensor's own gasket. The sensor is to be tightened in place during installation.



CAUTION: The sensor probe must be fully intruded into the oil.

4. Technical Specifications

Sensor measurements

Parameter	Range	Accuracy
Temperature	-40～120 ℃	±0.3℃（25℃）
Water activity (saturation)	0~1 aw	±0.02aw（0～0.6）
		±0.03aw（0.6～0.9）
		±0.04aw（0.9～1）
Moisture content (dissolved water)	0~5000ppm	±10%)

Note: The sensor factory default calibration according to 68 # antiwear hydraulic oil (can be customised oil calibration range 0 ~ 100/1000/2000/4000/5000ppm optional); measurement accuracy is the average of multiple measurements in the laboratory environment and static testing, field conditions due to the external environment may have deviations.

Sensor specifications

Indicator	Description	
Signal output	RS485 Modbus RTU	Standard
	CAN 2.0B（optional）	pick one of two
Analog signal	4～20mA （optional）	
Response time	Data refreshed once per second	
Working voltage	DC12～32V（RS485） DC20～32V（4-20mA)	

Working current	＜20mA（RS485） ＜40mA（4～20mA）
Working temperature	-40℃~ 85℃
Liquid temperature	-40℃~ 120℃
Storage temperature	-40℃~ 85℃
Detect probe allowable pressure	≤ 15bar
Detect probe allowable flow rate	≤0.3 m/s
IP rate	IP66
Detect probe material	Stainless Steel 316
Threaded interface	G3/4
Electronic interface	M8*1, 6 Core
Cable connector	6 core, 2 meters length，24AWG
Weight	136g
Applicable oil	Commonly used mineral oil, synthetic and semi-synthetic lubricating oil, hydraulic oil, transformer oil, etc.

5. Features

1. Continuous and rapid detection of water activity (aw) in oil.

2. Accurately measure the micro-moisture content (dissolved water) in oil.

3. Stable long-term operation in harsh environments.

4. Compact structure, easy system integration, on-site calibration of integrated modules.

5. High oil resistance and pressure resistance.

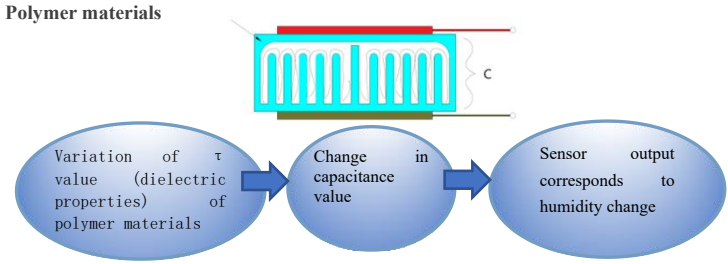
6.Supports multi-mode signal output

6. Measuring principle

1) Temperature

The principle of temperature measurement is realised on the basis of the temperature characteristics of the platinum resistor. When the platinum resistor is placed in an environment at the temperature to be measured, its resistance value changes with the temperature. Based on the temperature characteristic curve of the platinum resistor, the temperature of the environment can be determined by measuring the resistance value of the platinum.

1）Water activity and trace moisture



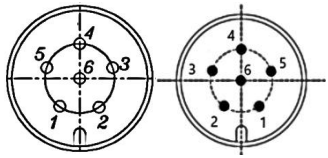
The sensor uses polymer material as the moisture-sensitive conversion element to achieve dynamic equilibrium of water through the process of water absorption and dehydration. The dielectric coefficient of water is much larger than that of simple polymer material, and the dielectric coefficient of polymer material after water absorption has obvious changes due to the change of adsorbed water content, which causes the change of capacitance value, and the sensor outputs the amount of change corresponding to the water activity. Based on the characteristics of the oil, the corresponding

water content is calculated.

7. Communication interface and protocol

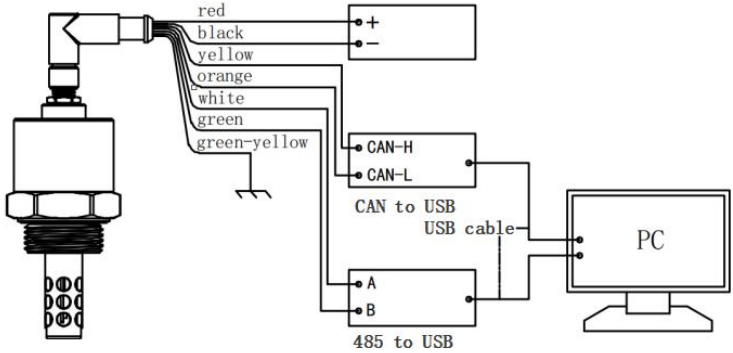
7.1 Communication interface

The sensor supports both RS485 and CAN communication connections, and the communication cable wiring is defined in the figure below.

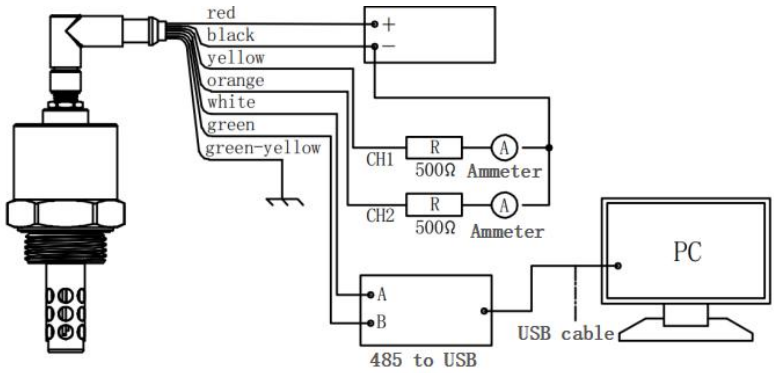


Sensor port Cable port

Interface Diagram



RS485+CAN Connection Diagram



RS485+ analog connection diagram

Number	Cable color	Definition
1	Red	DC24V+
2	White	RS485+/A
3	Black	DC24V-
4	Green	RS485-/B
5	Yellow	4～20mA CH1/CAN_H
6	Orange	4～20mA CH2/CAN_L
7	Kelly	GND

7.2 RS485 serial Port Settings

The instrument provides standard RS485 communication interface, and adopts Modbus RTU communication protocol to communicate with the host. In a complete online monitoring system, the master control device acts as the host and the product acts as the slave. Each communication handshake is always issued by the host to request access, and the slave responds.

GB/T19582-2008 Industrial Automation Network Specification Based on

Modbus Protocol.

7.2.1 Serial port settings

Table 2 Sensor serial communication default settings

Specification	Property
Address	5
Baud rate	9600
Data Bit	8
Parity check	None
Stop bit	1

7.2.2 Modbus function code

Table 3 Sensor Modbus Function Codes

Function code		**Definition**
03	0x03	Read Holding Register
04	0x04	Read Input Register
06	0x06	Write Single Register
16	0x10	Write Multiple Registers

1） **Holding register (0x04 function code)**

Table 4 Modbus Input Registers

Register address	Nature	Read/ write	16 bit word length	Data type	Instruction
0x0000	Temperature	Read	1	signed short	Measured value/10 equals actual value
0x0001	Water activity	Read	1	signed short	Measured value/1000 equals actual value
0x0002	Moisture content	Read	1	signed short	

7.2.3 Communication example

1) Read current address

Example of reading the current address of the sensor [Sensor current address is 1]:

Request		Respond	
Domain name	**Hexadecimal**	**Domain name**	**Hexadecimal**
Address code	00	Address code	00
Function code	03	Function code	03
Data start address Hi	00	Data byte length	08
Data start address Lo	00	Current address	01
Number of data Hi	00	No definition	FF
Number of data Lo	00	No definition	FF
CRC16 Lo	44	No definition	FF
CRC16 Hi	1B	No definition	FF
		No definition	00
		No definition	00

	No definition	00
	CRC16 Lo	6E
	CRC16 Hi	14

2) Modify address

Example of changing the sensor address [change the sensor from the current address 1 to address 5]:

Request		**Respond**	
Domain name	**Hexadecimal**	**Domain name**	**Hexadecimal**
Current address	01	Current address	01
Function code	03	Function code	03
Data start address Hi	00	Data start address Hi	00
Data start address Lo	01	Data start address Lo	01
New address Hi	00	New address Hi	00
New address Lo	02	New address Lo	02
CRC16 Lo	95	CRC16 Lo	95
CRC16 Hi	CB	CRC16 Hi	CB

3）All data read and parsed

Request		Respond	
Domain name	**Hexadecimal**	**Domain name**	**Hexadecimal**
Address	01	Address	01
Function code	04	Function code	04
Data start address Hi	00	Data bytes	06
Data start address Lo	00	Temperature	01 20
Data item Hi	00	Water activity	01 82
Data item Lo	03	Moisture content	00 20
CRC16 Lo	B0	CRC16 Lo	40
CRC16 Hi	0B	CRC16 Hi	89
Tx：01 04 00 00 00 03 B0 0B Rx：01 04 06 01 20 01 82 00 20 40 89			

Notes:

1) The data type is signed short, parse example: 0x0120 (temperature) value is 288/10 = 28.8℃; 0x0182 (water activity) value is 386/1000 = 0.386aw.

2)To read the desired data individually, you can set the data start address according to the input register table address of different models.

3)CRC checksum is used (CRC-16/Modbus x16+x15+x2+1).

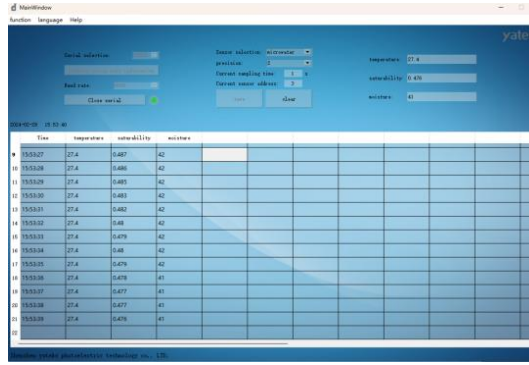
7.3 Show data communication testing

Users can communicate with the sensor through the 'Showdata' oil sample data display tool software for testing.

1） Connect the sensor according to the definition of the communication interface and power on, through the RS485 to USB converter connected to the computer, open the 'showdata' software.

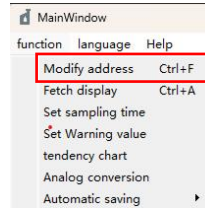
2) Select 'Serial Port Selection' and 'Sensor Selection' in turn, click 'Open Serial Port', and the test data will be displayed in the form of a list in real

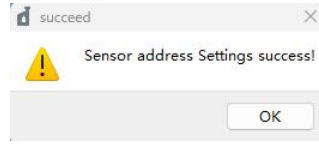
time after the sensor communication is successful.



3）Users can save data, clear and other operations as needed.

4）You can also modify the sensor address, after the sensor is successfully connected and the data display is normal, click on Modify Address in the function, select the address that needs to be modified (e.g., 3), click icon Apply to confirm, and then it will be OK when there is a pop-up window of the successful sensor address setting (as shown below).





Close the serial port and reconnect the serial port. When the current sensor address is displayed as 3, it means the address has been modified correctly.

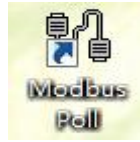
7.4 Modbus Poll communication test

Users can communicate with the sensor via Modbus Poll software for testing. The sensor can output three parameters: temperature, water activity, moisture, The register uses the 0x04 function code and the data type is signed short.

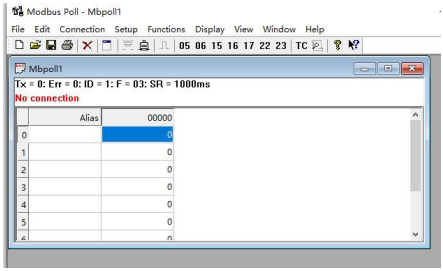
Registered address	**Parameter**	**Read/write**	**16 bite word length**	**Data type**
0x0000	Temperature	Read	1	signed short
0x0002	Water activity	Read	1	signed short
0x0004	Moisture content	Read	1	signed short

The Modbus Poll software communication setup process is as follows:

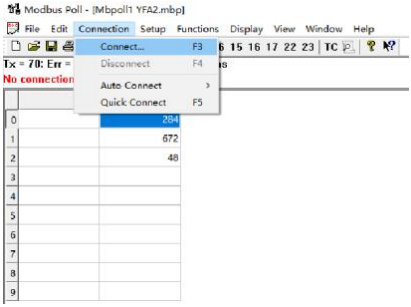
1) Install Modbus Poll software and RS485 driver on PC.



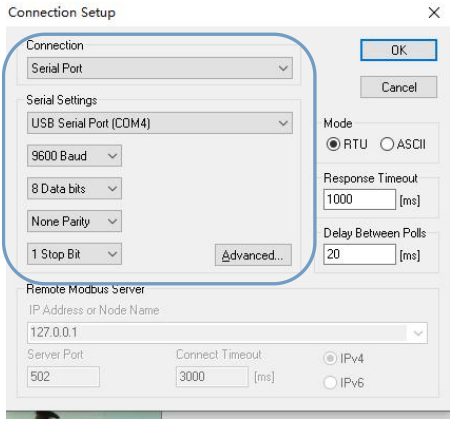
2）Open Modbus Poll software, its interface is shown below.



3 ） Click "Connection" in the menu and select "Connect" in the drop-down menu:

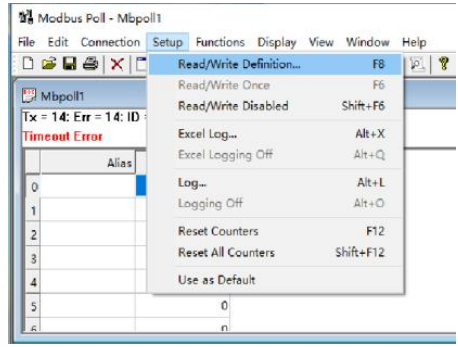


In the pop-up "Connection setup" dialogue box, according to the computer connection, select the corresponding USB port, confirm that the other parameters are consistent with the following figure, click "OK" button.

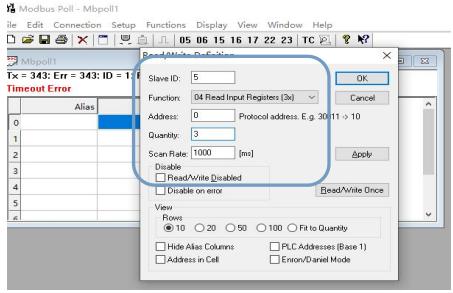


4） Then click the "Setup" item in the menu, and select the "Read/Write

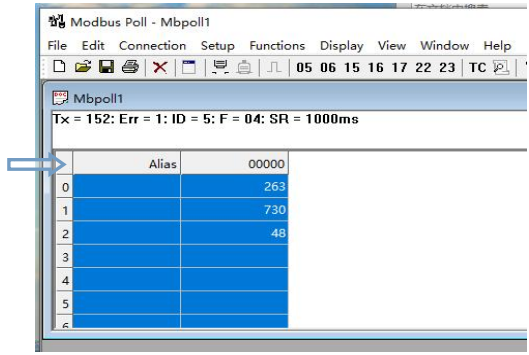
Definition" option in the drop-down menu.



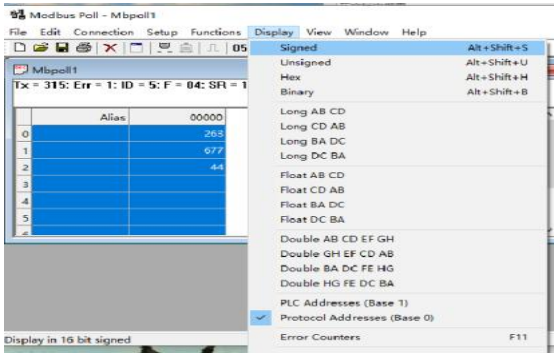
Enter the sensor ID in the "Slave ID" field and set the other parameters as shown in the figure below, and click the OK button when the setting is completed.



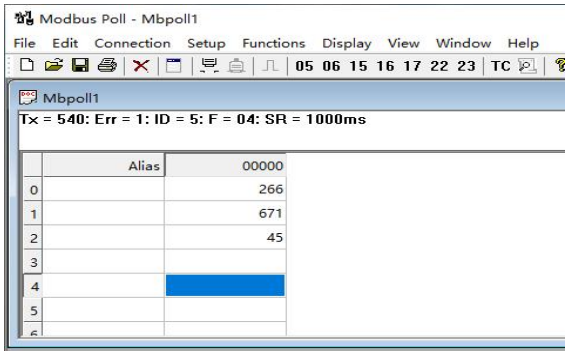
5）Click on the arrow in the figure below to make the data display screen turn blue:



6）Click the "Display" option in the menu, tick "Signed" in the drop-down menu to complete the setup:

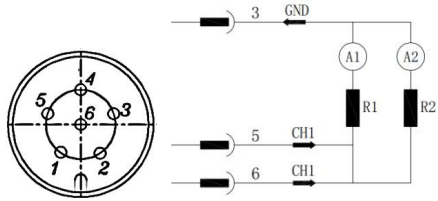


7）The communication interface after the above settings are completed is shown in the figure below. The figure indicates that the temperature is 26.6° C, the water activity is 0.671aw, and the water content is 45ppm.



7.5 4～20mA Analog communication protocol

The sensor adopts three-wire common ground current loop analogue output mode, channel 1 is temperature output, channel 2 is water activity output (or according to the order requirements), wiring schematic as follows:



4～20mA wiring diagram

Notice:

1) The red wire (corresponding to pin 1 of the M8 connector) is connected to the power supply DC 24V;

2) The black wire (corresponding to pin 3 of the M8 connector) is connected to GND.

3) The yellow wire (corresponding to pin 5 of the M8 connector) is connected to the user's 4-20mA sampling module input positive terminal; at the same time, the loop output negative terminal is connected back to the black line GND to form a 4-20mA current loop; this channel represents the temperature.

4) The orange wire (corresponding to the 6-pin M8 connector) is connected to another 4-20mA sampling module input positive terminal of the user; at the same time, the output negative terminal of this loop is connected back to the black line GND to form a 4-20mA current loop; this channel represents power Viscosity (or as required by order).

5) In order to ensure the best working characteristics of the sensor, the resistance values of the load resistors RL1 and RL2 must be within the range of 100-500Ω. It is recommended to use 500Ω high-precision, low-temperature drift sampling resistors.

6) The user needs to confirm whether the load resistance has been included in the PLC acquisition module. It is forbidden for the sensor to connect to the current loop to work without any load resistance, or directly connect the ammeter in series without any load resistance to measure the current value of 4-20mA, otherwise it may damage to the sensor.

YTS-M-1 sensor Analog data conversion example
For example:

Output channel	Parameter & Range
Ch1	Temperature: -40～120 ℃
Ch2	Water activity: 0~1aw （default）
Ch2	Water content：0～1000ppm（optional）

Calculation formula:

$$X = (Iout - 4) * \frac{Tmax - Tmin}{20 - 4} + Tmin$$

Notes:

1. X is the calculated value of the sensor parameter to be measured;
2. Iout is the output current record value of Ch1 or Ch2, unit is mA;
3. Tmax is the maximum value of the corresponding parameter;
4. Tmin is the minimum value of the corresponding parameter;

Example:

Measure the temperature value of the output terminal of sensor Ch1 (yellow line), and test the normal power-on of the sensor, and the measured output current of Ch1 is 10mA; the maximum value of the known temperature range is 120°C, and the minimum value is -40°C.

$$Temperature(℃) = (10 - 4) * \frac{120 + 40}{20 - 4} - 40$$

Calculate the corresponding temperature value of 20℃ when the sensor Ch1 outputs 10mA.

7.6 CAN Communication Protocol (optional)

Signal output: CAN2.0B based on J1939

Baud rate: 250K (default)
Broadcast data period: 30s (default)

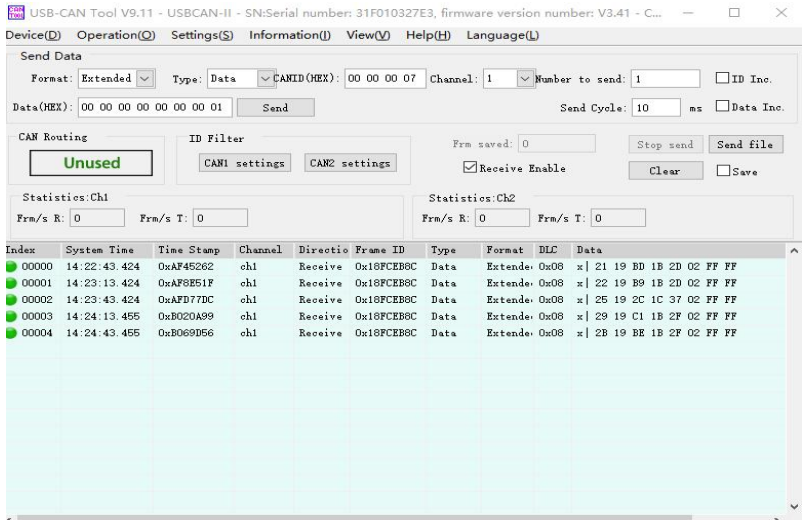
- CAN Data Frames Description:

Number	Parameter	priority level	PGN	Source address	Byte location	Byte length
1	Temperature	6	64747	140	1	2
2	Water activity	6	64747	140	3	2
3	Moisture content	6	64747	140	5	2

- CAN Data Analysis Description Table:

Number	Parameter	Resolution	Range	offset
1	Temperature	0.01℃	-40～120℃	-40℃
2	Water activity	0.0001aw	0～1aw	0aw
3	Moisture content	0.1ppm	0～5000ppm	0ppm

- The raw data are as follows:



- One of the data parses：

CAN ID（default）	Frame type	Frame format	Data length	Data
0x18FCEB8C	Data frame	Extended frame	8	x| 2B 19 BE 1B 2F 02 FF FF

Temperature： 6443（0x192B）× 0.01℃ - 40.00℃ = 24.43℃

Water activity：7102(0x1BBE) × 0.0001aw = 0.7102aw

Moisture content：559(0x022F) × 0.1ppm = 55.9ppm

8. Precautions for use Cleaning the sensor

1) Disconnect power to the unit and remove the sensor.

2) Take a glass container and add clean n-heptane (C7H16) liquid. If n-heptane is not available, paraffin or a wash oil of the same fraction can also be used.

3) Place the sensor probe into the glass container (C7H16 liquid should not go over the flange or below the threads) and rinse off the oil for 1 minute maximum.

4) After cleaning, dry the probe with purge air (<2kgf/cm²).

Note: The use of n-heptane (C7H16) in a ventilated environment requires protection from open flames.

9. Precautions for use

1) Users in accordance with GB/T 3836.15 standards, combined with the site's working conditions, to develop a specific regular inspection and

continuous monitoring system.

2)Explosive gas environment is strictly prohibited to open the cover with electricity.

3) If any fault is found, it must be repaired by professional personnel.

4)The internal components of the product shall not be disassembled or replaced at will.

5)There is a risk of ignition by collision or friction in the product casing, care must be taken to prevent collision and friction during installation and use.

6) Please keep the sensor probe clean, dirty or blocked may affect the measurement accuracy.

7)Do not change the models, specifications and parameters of the components in the product circuit.

10.Troubleshooting

Fault	Possible cause	Solution
No output signal	Not powered	Check for correct power supply
	Incorrectly wired	Defining wiring by wiring
	Sensor ID mismatch	Enter correct ID
Data exception	Clogged oil channel Check oil line.	Check oil channel to ensure they are unobstructed
	Clogged sensor probes	Clogged sensor probes
	Other reasons such as damaged sensors	return to factory for repair
	Sensor calibration issues	Contact Yateks

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