# TURBIDITY SENSOR WITH MODBUS RTU OUTPUT MBRTU-TBD

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| | JUL-2021 |
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*This document is applied for the following products*

# 1. Introduction

**MBRTU-TBD** is an advanced digital turbidity sensor for water quality monitoring, adopt the principle of scattered light, the design method of using infrared LED light source and optical fiber conduction light path. The filter design is added inside, which has strong anti-interference ability. Built in temperature sensor, automatic temperature compensation, suitable for online long-term monitoring of the environment.

**PROCESS TURBIDITY SENSOR WITH MODBUS OUTPUT
MBRTU-TBD**



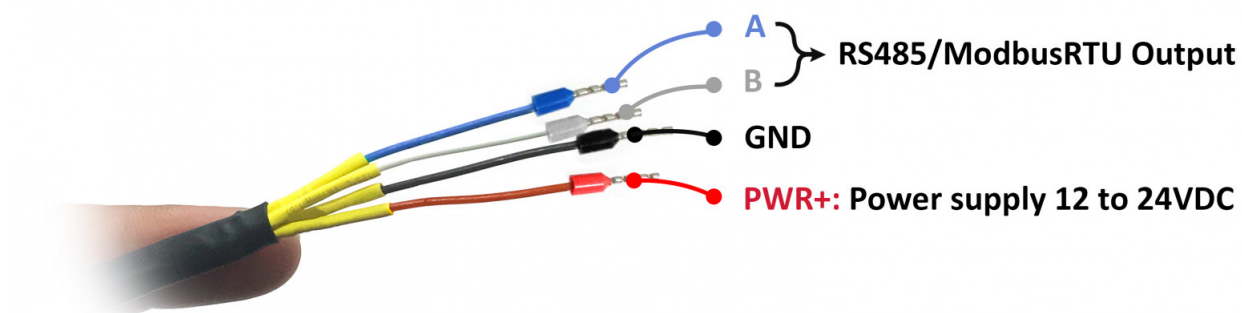MBRTU-TBD-H1.PNG

# 2. Specification

## Features

1. Digital sensor, direct output RS-485 digital signal, support Modbus / RTU
2. Principle of 90° Angle Scattering Light, the built-in temperature can be compensated automatically;
3. Optical fiber structure, strong resistance to external light interference
4. Infrared LED light source, add filter design, anti light interference, good stability
5. The surface shall be treated with anti-corrosion and passivation
6. Low power consumption and anti-interference design of internal circuit

## Technical Data

| Item | Specifications |
|---|---|
| **Output** | RS-485,MODBUS/RTU |
| **Measuring method** | 90° scattered light method |
| **Range** | 0 ~ 1000NTU or 0 ~ 100NTU |
| **Accuracy** | ±5% indication value or ±3NTU, choose the greater (0 ~ 1000NTU)<br>± 3% indication or ± 2 NTU, choose is greater (0-100 NTU)<br>±0.5℃ |
| **Resolution** | 0.1NTU, 0.1℃ |
| **Working environment** | 0 ~ 50℃, <0.6MPa |
| **Calibration method** | Two-point calibration |
| **Response time** | 30s T90 |
| **Temperature Compensation** | Automatic temperature compensation (Pt1000) |
| **Power Supply** | 12-24VDC±10%, 10mA; |
| **Size** | Diameter 30mm; Length 166.5mm; |
| **Protection level** | IP68 ; The water depth is 20 meters; |
| **Service life** | 3 years or above |
| **Cable length** | 5m |
| **Sensor housing material** | PVC |

# 4. Wiring

Please wiring as shown below:



| Wire color | Description |
|---|---|
| **Brown** | Power (12-24VDC) |
| **Black** | GND |
| **Blue** | RS485A |
| **White** | RS485B |
| **Bare line** | Shielding Layer |

**Cable line** :  4 line AWG-24 or AWG-26 Shielding Wire.

# 5. Maintenance and Precautions

## 5.1 Maintenance

- Inductive electrode is basically maintenance free; It is recommended to clean up the sensor probe attachment every 30 days; Avoid the use of hard objects to cause the damage of the light guide part of the measuring probe during cleaning; Please wipe with a soft damp cloth.
- It is recommended to clean the outer surface of the sensor with water flow. If there is still debris residue, please wipe it with a wet soft cloth.

## 5.2 Note

- Installation measurement: avoid the installation measurement at the place where the water flow is turbulent, and reduce the influence of water bubbles on the measurement. Keep the measuring probe 2cm away from the bottom.
- The probe of the sensor is fouling or attached with more organisms, so the cleaning force can be increased appropriately. Slight scratch on the probe surface does not affect the normal use of the sensor. But pay attention not to penetrate the shell of the probe.
- Suggestion: the protective cover of our company should be selected to prevent the influence of microbial attachment on the measurement results.

## 5.3 Other

| Problem | Possible Causes | Solution |
|---|---|---|
| The operation interface cannot be connected or the measurement results are not displayed | Wrong cable connection | Check the wiring mode |
| | Wrong sensor address | Check the address for errors |
| The measured value is too high, too low or the value is continuously unstable | The sensor probe is attached by foreign objects | Clean the sensor probe surface |
| | Other | Contact after sales |

# 6. Modbus RTU Protocol

## 6.1 Information frame format

The default data format for Modbus communication of this sensor is:

| MODBUS-RTU | |
|---|---|
| Baud rate | 9600 (default) |
| Device address | 1 (default) |
| Data bits | 8 bit |
| Parity check | None |
| Stop bit | 1bit |

- **Function code 03:** Read (R) register value
- **Function code 06:** Write (W) single register value

# 6.2 Register Address:

| Register Address (hex) | Name | R/W | Introductions | Number of registers (byte) | Data type |
|---|---|---|---|---|---|
| 0x0100 | Temperature value | R | °C value x10 (for example: the temperature of 25.6°C is displayed as 256, the default is 1 decimal.) | 1 (2 bytes) | unsigned short |
| 0x0101 | Turbidity value | R | NTU value x10 (for example, the turbidity value of 15.1ntu is displayed as 151, with 1 decimal place by default.) | 1 (2 bytes) | unsigned short |
| 0x1000 | Temperature calibration | R/W | Temperature calibration: the written data is the actual temperature value X10; Read out data is temperature calibration offset X10. | 1 (2 bytes) | unsigned short |
| 0x1001 | Zero point calibration | R/W | Zero point calibration in air. The data written during calibration is 0. | 1 (2 bytes) | unsigned short |
| 0x1003 | Slope calibration | R/W | Calibrate in the known standard solution (50% - 100% range), and write the data as the actual value of the standard solution × 10. | 1 (2 bytes) | unsigned short |
| 0x2000 | Sensor address | R/W | The default is 1, and the data range is 1-127. | 1 (2 bytes) | unsigned short |
| 0x2003 | Baud rate setting | R/W | The default is 9600. Write 0 is 4800; Write 1 is 9600; Write 2 is 19200. | 1 (2 bytes) | unsigned short |
| 0x2020 | Restore factory settings | W | The calibration value is restored to the default value and the written data is 0. Note that the sensor needs to be calibrated again after reset. | 1 (2 bytes) | unsigned short |

# 6.3 Data structure type

**Integer**

unsigned int (unsigned short)

The data consists of two integers.

| XXXX XXXX | XXXX XXXX |
|---|---|
| Byte1 | Byte0 |

**Float**

Float, According to IEEE 754 (single precision);

The data consists of 1 sign bit, 8-bit exponent, and a 23 bit mantissa .

| XXXX XXXX | XXXX XXXX | XXXX XXXX | XXXX XXXX |
|---|---|---|---|
| Byte3 | Byte2 | Byte1 | Byte0 |
| Sign bit | Exp digit | | F decimal |

# 6.4 Modbus RTU command:

## 6.4.1 Function code 03h: read register value

**Host send:**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|
| ADR | 03H | Start register high byte | Start register low byte | Register number high byte | Number of registers low byte | CRC low byte | CRC high byte |

The first byte ADR: slave address code (= 001 ~ 254)

Byte 2 03h: read register value function code

Byte 3 and 4: start address of register to be read

To read the FCC instrument,

Bytes 5 and 6: number of registers to read

Bytes 7 and 8: CRC16 checksums from bytes 1 to 6

**Slave return:**

| 1 | 2 | 3 | 4 , 5 | 6 , 7 | | M-1 , M | M+1 | M+2 |
|---|---|---|---|---|---|---|---|---|
| ADR | 03H | total bytes | Register data 1 | Register data 2 | ...... | Register data M | CRC low byte | CRC high byte |

The first byte ADR: slave address code (= 001 ~ 254)

Byte 2 03h: return to read function code

The third byte: the total number of bytes from 4 to m (including 4 and m)

Bytes 4 to m: register data

Byte m + 1, M + 2: CRC16 check sum from byte 1 to M

When the slave receives an error, the slave returns the error:

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| ADR | 83H | Information code | CRC low byte | CRC high byte |

The first byte ADR: slave address code (= 001 ~ 254)

Byte 2 83h: error reading register value

Byte 3 information code: 01 - function code error

03 - data error

Bytes 4 and 5: CRC16 checksums from bytes 1 to 3

## 6.4.2 Function code 06h: write single register value

Host send

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|
| ADR | 06 | Register high byte address | Register low byte address | Data high byte | Data low byte | CRC code Low byte | CRC code High byte |

When the slave receives correctly, the slave sends back:

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

| ADR | 06 | Register high byte address | Register low byte address | Data high byte | Data low byte | CRC code Low byte | CRC code High byte |
|-----|----|---------------------------|---------------------------|----------------|---------------|-------------------|--------------------|

When the slave receives an error, the slave returns:

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| ADR | 86H | Error code information code | CRC code Low byte | CRC code High byte |

The first byte ADR: slave address code (= 001 ~ 254)

The second byte 86h: write register value error function code

Byte 3 error code information code: 01 - function code error

03 - data error

Byte 4 and 5: CRC check sum from byte 1 to 3

# 6.5 Command example

## 6.5.1 Default register

**a) Change slave address:**

> **Address:**0x2000 (42001)
>
> **Number of registers:** 1
>
> **Function code:** 0x06
>
> **Default sensor address:** 01

Change the Modbus device address of the sensor, and change the device address from 01 to 06. The example is as follows:

Send command: 01 06 20 00 00 06 02 08

Respond: 01 06 20 00 00 06 02 08; Note: the address is changed to 06 and stored after power failure.

**b) Baud rate:**

> **Address:** 0x2003 (42004)
>
> **Number of registers:** 1
>
> **Function code:** 0x06
>
> **Default value**: 1 (9600bps)
>
> **Supported values**: 0-2 (4800-19200bps)

The baud rate can be changed by the upper computer setting, and it can work without restart after the change. The baud rate saves the upper computer setting after power failure. Baud rate support 4800960019200. The baud rate of integer value allocation is as follows:

| Integer | Baud rate |
|---------|-----------|
| 0 | 4800 bps |
| 1 | 9600 bps |

| 2 | 19200 bps |
|---|---|

Send command: 01 06 20 03 <u>00 02</u> F3 CB

Respond: 01 06 20 03 00 02 F3 CB Note: the baud rate is changed to 19200bps and saved after power failure.

## 6.5.2 Function register

**a) Measuring temperature command:**

    **Address:** 0x0100 (40101)

    **Number of registers:** 1

    **Function code:** 0x03

    **Read sample values:** 19.2℃

Send command: 01 03 01 00 00 01 85 F6

Respond: 01 03 02 <u>00 C0</u> B8 14

Returns hexadecimal unsigned integer data, temperature value = integer / 10, 1 bit decimal place is reserved.

**b) Turbidity measurement instruction:**

    **Address:** 0x0101 (0x40102)

    **Number of registers:** 1

    **Function code:** 0x03

    **Read sample values:** 9.1 NTU

Send command: 01 03 01 01 00 01 D4 36

Respond: 01 03 02 <u>00 5B</u> F9 BF

Register returns hexadecimal unsigned integer data, turbidity value = integer / 10, 1 decimal place reserved.

**c) Continuous reading of temperature and turbidity instructions:**

    **Address:** 0x0100 (40101)

    **Number of registers:** 2

    **Function code:** 0x03

    **Read sample values:** Temperature 19.2 ℃ and turbidity 9.1 NTU

Send command: 01 03 01 00 00 02 C5 F7

Respond: 01 03 04 <u>00 C0</u> <u>00 5B</u> BB F4

Register returns hexadecimal unsigned integer data, temperature value = integer / 10, 1 decimal place reserved

Register returns hexadecimal unsigned integer data, turbidity value = integer / 10, 1 decimal place reserved.

**d) Humidity measurement command:**

    **Address:** 0x0107 (40108)

    **Number of registers:** 1

**Function code:** 0x03

**Read sample values:** relative humidity 40%

Send command: 01 03 01 07 00 01 34 37

Respond: 01 03 02 <u>01 90</u> B9 B8

Register returns hexadecimal unsigned integer data, humidity value = integer / 10, 1 decimal place reserved.

## 6.5.3 Calibration instruction

**a) Temperature calibration**

**Address:** 0x1000 (41001)

**Number of registers:** 1

**Function code:** 0x06

Calibration example: calibration at 25.8 ° C

Send command: 01 06 10 00 <u>01 02</u> 0D 5B

Respond: 01 06 10 00 01 02 0D 5B

The sensor needs to be calibrated in a constant temperature environment after the temperature indication no longer fluctuates.

**b) Turbidity zero calibration**

**Address:** 0x1001 (41002)

**Number of registers:** 1

**Function code:** 0x06

Calibration example: calibration in air

Send command: 01 06 10 01 <u>00 00</u> DC CA

Respond: 01 06 10 01 00 00 DC CA

**c) Turbidity slope calibration**

**Address:** 0x1003 (41004)

**Number of registers:** 1

**Function code:** 0x06

Calibration example: calibration in 50NTU turbidity solution

Send command: 01 06 10 03 <u>01 F4</u> 7D 1D

Respond: 01 06 10 03 01 F4 7D 1D

# 7. Dimensions

3/4" NPT

20.00 mm

150.00 mm

30.00 mm

MBRTU-TBD-H2.PNG

# 8. Contact