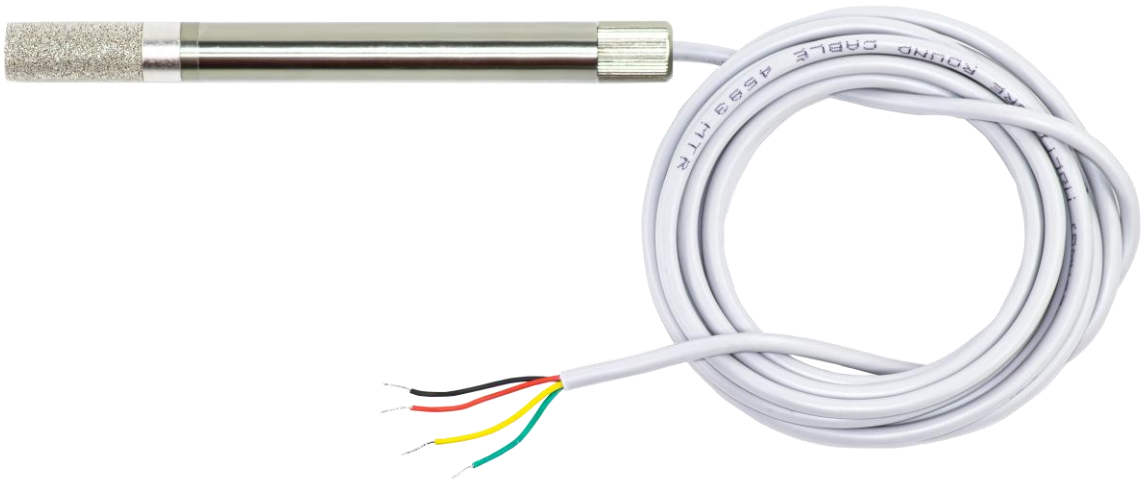
7Semi

RS-485 Temperature & Humidity + VOC/NOx Index Probe

Version 1.0



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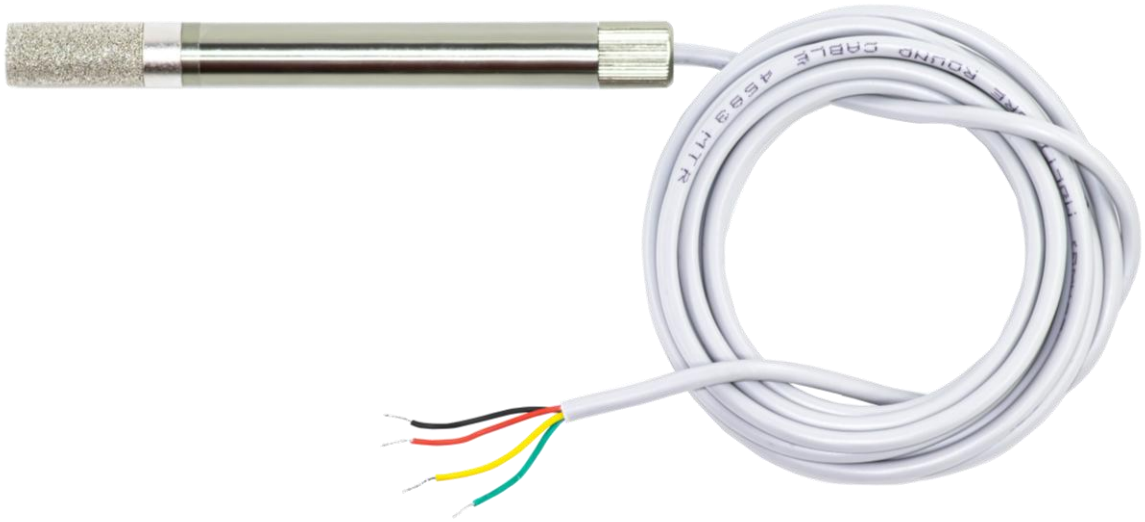
1.Introduction



This RS-485 Modbus RTU device is a compact environmental monitoring node that measures temperature, humidity, and air quality parameters. It is designed for continuous operation in industrial and indoor environments, providing accurate digital data through a standard Modbus RTU interface. The onboard microcontroller handles signal processing, data averaging, and communication timing automatically, ensuring stable readings and reliable response to host requests.

Built for long-term reliability, the device includes watchdog protection, flash-based data persistence. Its firmware performs intelligent conditioning and calibration to maintain consistent performance over time. A soft-reset feature safely powers down the sensing elements before restart, and a temporary recovery address allows users to connect easily after power-up. this unit fits seamlessly into HVAC, industrial, and environmental control systems.

1.1 Features

- Compact RS-485 Modbus RTU environmental monitoring node
- Measures temperature, humidity, and air quality levels (VOC/NOx equivalent indices)
- Configurable baud rates: 9600, 19200, 38400, 57600, and 115200 bps
- I²C bus auto-recovery
- Adjustable measurement period (250 ms – 10 s) and calibration offsets for T/RH
- Compatible with Modbus tools like QModMaster for testing and validation

2.Technical specification

The 7Semi RS-485 Temperature & Humidity + VOC/NOx Index Probe is an industrial-grade Modbus RTU device built for accurate environmental sensing and seamless system integration. It measures temperature, relative humidity, and air-quality indices (VOC and NOx) with configurable sampling intervals from 250 ms to 10 s. Operating over an RS-485 bus with selectable baud rates (9600 – 115200 bps), it supports standard Modbus function codes for reliable communication. All user settings—such as device ID, baud rate, and calibration offsets—are stored in non-volatile flash memory with CRC protection.

The probe outputs VOC and NOx indices on a 1 – 500 scale, where higher values indicate increased pollutant levels. Typical clean indoor air shows a VOC Index between 50 and 150, while the NOx Index may start at 1 during the initial conditioning phase and rise as the sensor stabilizes. Compact, low-power, and designed with features like watchdog monitoring, brown-out reset, and I²C bus recovery, it ensures stable 24/7 operation for HVAC, industrial automation, and indoor air-quality monitoring.

Applications

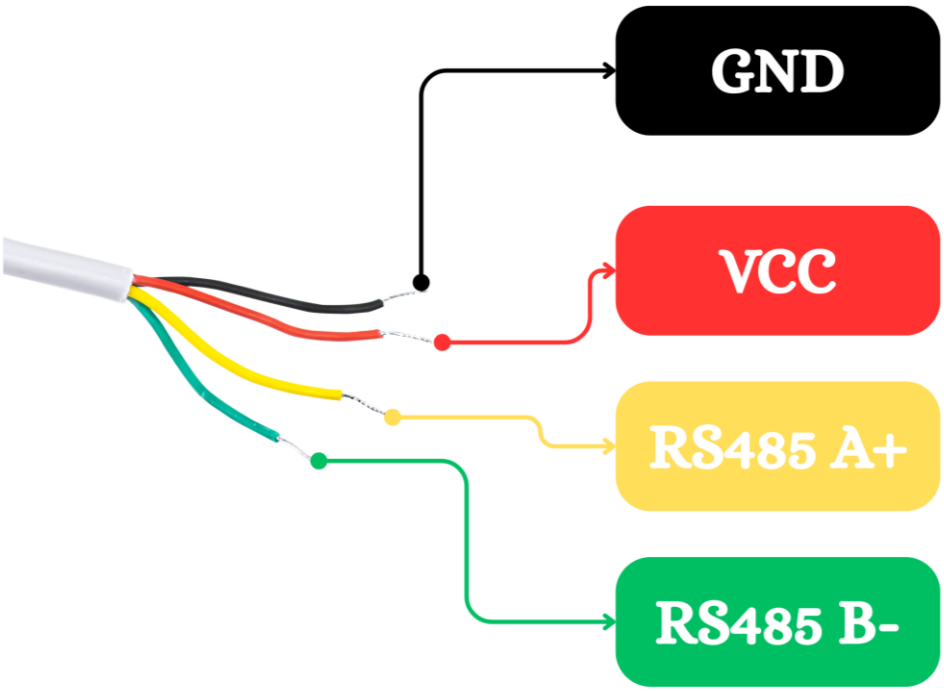
- HVAC systems for indoor air quality monitoring and control
- Industrial process and factory environment monitoring
- Smart building automation and ventilation management
- Data centers and server room climate supervision
- Greenhouses and agricultural environmental control
- Air purification and filtration system performance tracking
- Laboratory and cleanroom environmental stability monitoring
- Smart city and IoT-based air quality sensing networks

2.1 General specifications

- **Temperature Measurement Range:** -40 ~ 125°C
- **Humidity Measurement Range:** 0 ~ 100% RH
- **Temperature Accuracy:** ±0.1°C (25°C)
- **Humidity Accuracy:** ±1% RH (25°C)
- **Air Quality Output:** VOC Index (1 – 500), NOx Index (1 – 500)
- **Sampling Period:** Configurable 0.25 – 10 s (default 1 s)
- **Power Supply Voltage:** 9 ~ 36V (DC)
- **Communication Interface:** RS-485 (half-duplex)
- **Product Size:** 200mm(L) × 15.7mm(D) / 7.87 × 0.62 inch
- **Output Signal:** RS-485 signal
- **Communication Protocol:** Standard MODBUS RTU protocol (8N1 format)
- **Baud Rate:** 9600 (default); configurable to 19200, 38400, 57600, 115200
- **Display Resolution:** Temperature: 0.1°C; Humidity: 0.1% RH

3. Hardware setup

3.1 Pinouts

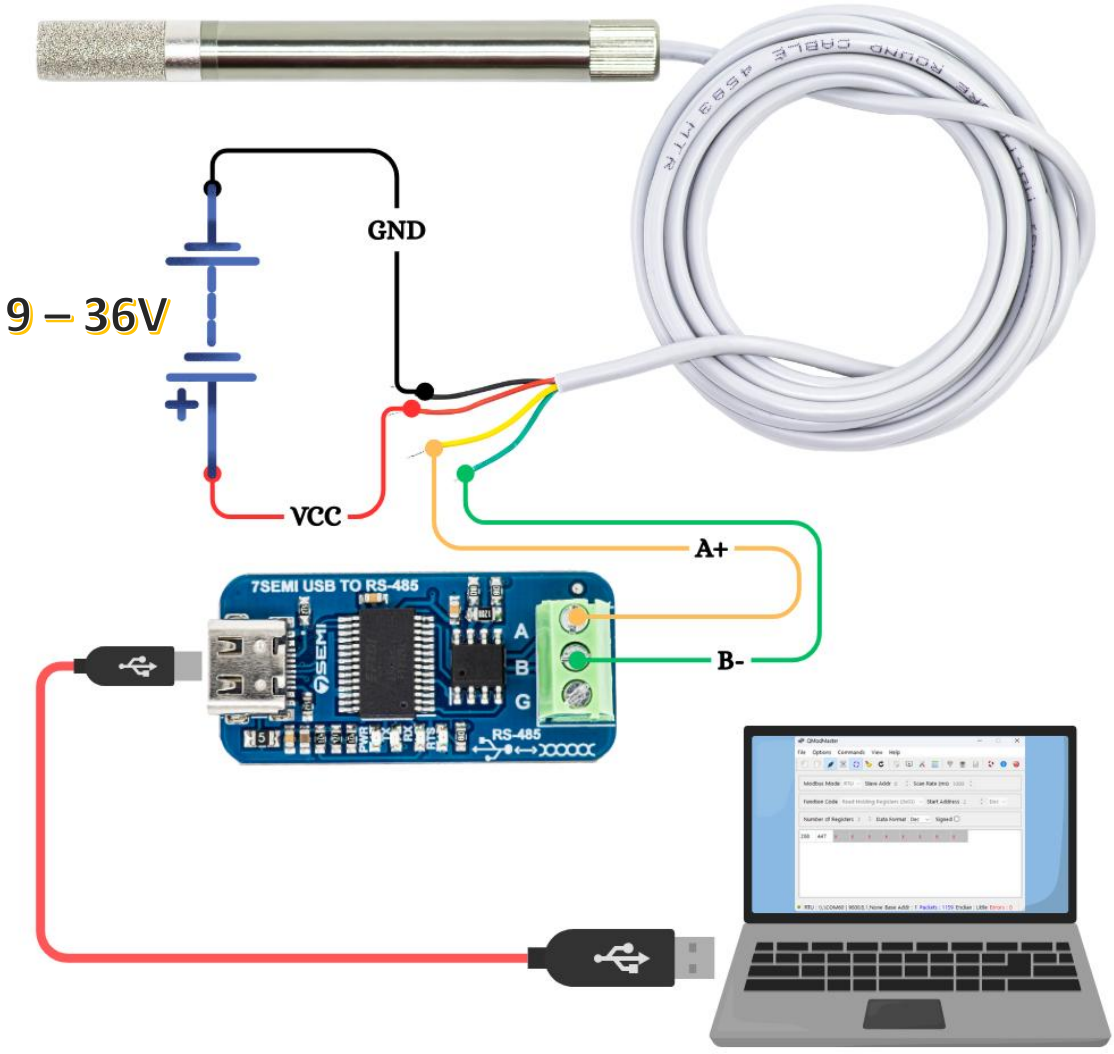


Wire Color	Function
Yellow	RS485 A+
Green	RS485 B−
Red	VCC
Black	GND

Connection Guidelines

- Power Supply: Connect the red wire to a 9–36V DC power source and the black wire to ground (GND). Ensure the power supply is stable and within the rated voltage range.
- RS485 Communication: Connect the yellow wire to RS485 A+ and the white wire to RS485 B−. Use twisted-pair shielded cable for longer transmission distances and improved noise immunity.

3.2 Hardware connection



4.RS485 Communication Protocol

The 7Semi RS485 Temperature & Humidity + VOC/NOx Index Probe Sensor utilizes the Modbus RTU protocol for digital communication over the RS485 interface. Modbus RTU is a robust, standardized protocol used widely in industrial automation for reliable communication between field devices and control systems such as PLCs, HMIs, SCADA systems, and data loggers.

This sensor acts as a Modbus slave, waiting for requests from a Modbus master and responding with the requested data. All Modbus messages are transmitted in a binary format with CRC (Cyclic Redundancy Check) error detection to ensure communication integrity

Supported Modbus Function Codes

Function Code	Description
0x03	Read Holding Registers
0x04	Read Input Registers
0x06	Write Single Register
0x10	Write Multiple Registers

- The sensor supports **function code `0x03`**, **function code `0x04`**, **function code `0x06`** and **function code `0x10`**, which allows reading holding register values (such as temperature, humidity, VOC and NOx), Read Input Registers (Mirror of 0x03), Write Single Register and Write Multiple Registers

Register Address Mapping - Address quick reference (Base Addr = 1)

Register Address	Purpose	Start Address (Dec)
0x0000	Temperature (T) ×100 (int16)	1
0x0001	Humidity RH ×100 (uint16)	2
0x0002	VOC raw	3
0x0003	NOx raw	4
0x0004	VOC Index	5
0x0005	NOx Index	6

0x00E0	diag_mb_crc_err	225
0x00E1	diag_mb_except	226
0x00E2	diag_i2c	227
0x00E4	Uptime high	229
0x00E5	Uptime low	230
0x00E6	Reset reason	231
0x00F0	Status	241
0x00FE	Firmware version	255
0x0100	Real slave ID	257
0x0101	New slave ID	258
0x0200	T offset	513
0x0202	Measurement period	515
0x0206	RH offset	519
0x0210	Baud code	529

- The sensor provides temperature, humidity, raw VOC, raw NOx, VOC index and NOx index data in 16-bit unsigned integer format. To convert the raw data into human-readable values, divide the received value by 100 for T and RH.
- Tip: for **signed** values (0x0000, 0x0200, 0x0206) tick **Data Format → Signed** in QModMaster.

➢ Testing Steps For QModMaster

1) Basic sensor read

1. **Slave Address :** Keep original slave address(1…247)
2. **Function Code:** Read Holding Registers (0x03)
3. **Start Address: 1**
4. **Number of Registers: 6**
5. **Signed: ON**
    - Expect T and RH as integers ×100. E.g., `2579` → 25.79 °C; `6665` → 66.65 %RH.
    - Also read: RAW VOC, RAW NOx, VOC Index (1…500), NOx Index (1…500).

2) Warm-up & status bits

1. Read **Start Address 241**, **Count 1** (0x00F0).
    - Immediately after boot, bit2 (value 4) = **WARMUP**; clears after ~5 s.
    - bit0 (value 1) = humidity/temperature sensor OK.
    - bit3 (value 8) = gas sensor comms OK; bit4 (value 16) = in 10 s conditioning.

3) Uptime counter

1. Read **Start Address 229**, **Count 2** (0x00E4..0x00E5).
    - Combine: **seconds = (hi<<16) + lo**; it should increase each read.

4) Firmware version

1. Read **Start Address 255**, **Count 1** (0x00FE).
    - You should see **0x0100 = 256 decimal** for v**1.0**.

5) Real ID discovery (no matter which ID you queried)

1. Read **Start Address 257**, **Count 1** (0x0100).
    - Returns the device's **actual** slave ID.

6) Change measurement period (persisted)

1. **Function:** *Write Single Register (0x06)*
2. **Start Address: 515** (0x0202)
3. **Value:** e.g. **1000** (ms)
    - Observe new readings update every ~1 s. Power-cycle and re-read: value remains.

7) Apply offsets (persisted)

- **Temp offset** −0.50 °C: Write **Start 513** (0x0200) with **−50**.
    - If QModMaster won't accept "−50", enter **65536 − 50 = 65486**.
- **RH offset** +1.25 %RH: Write **Start 519** (0x0206) with **125**.
- Re-read T/RH (Step 1) and verify the shifts. Power-cycle → still there.

8) Baud-rate change with safe switch

1. Write **Start 529** (0x0210) with a **baud code**:

- 0=9600, 1=19200, 2=38400, 3=57600, 4=115200.

2. You'll get a normal reply at the **old** baud; then the device switches.
3. In QModMaster, **Options → Port**: change to the new baud; keep the same Slave Addr.
4. Re-read T/RH/RAW VOC/RAW NOX/VOC Index/ NOx Index to confirm.

9) Change slave ID

1. In the main window of QmodMaster, change Function Code to Write Single Register (0x06) (sometimes shown as *Preset Single Register*).
2. Set Start Address to 258 (Dec).
3. Number of Registers: 1.
4. Data Format: Dec (so you can enter the ID as a decimal number).
5. In the value grid (first cell), type the new ID (valid range 1…247).
6. Click Read/Write button, here your slave ID change Successfully.
7. Switch to the new ID and confirm.
    - After the brief reboot, change Slave Address in QModMaster to the new ID.
    - To verify, set Function Code to Read Holding Registers (0x03).
    - Start Address = 1, Number of Registers = 6.

10) How to actually recover the ID

If you don't know the current ID, Turn off for 2 second and On it, for the next ~10 s, talk to Slave = 1 (your code's recovery alias).

1. Immediately in QModMaster:
    - Set Slave Addr = 1 (the recovery alias).
    - Function Code: 0x03 Read Holding Registers.
    - Start Address = 257, Number of Registers = 1.
    - Data format = Dec
2. Hit Read.
    - If wiring and baudrate are correct, the register at address 1 will return the *real* slave ID stored in flash.
    - Example: If it returns 7, then your device will answer only to ID = 7 after the 10-second recovery period ends.
3. After that, switch QModMaster's Slave Addr to that returned ID for normal operation.

11) Broadcast write (ID 0, no reply)

1. Set **Slave Addr = 0** (broadcast).
2. **Function:** *Write Multiple Registers (0x10)*
3. **Start Address: 515** (0x0202), **Number of Registers: 1**.

4. In the data cell type **2000** (ms) and send.
    - There is **no reply** by design; QModMaster may show a timeout—**that's expected**.
    - If you have multiple nodes, all should adopt the new period.

12) Read diagnostics

- **CRC errors**: Start **225** (0x00E0) = 0 =>OK
- **Exceptions**: Start **226** (0x00E1) = 0 =>OK
- **I²C error counter:** Start **227** (0x00E2)) = 0 =>OK
    - To bump **exceptions**, try writing to a read-only address (e.g., Write 0x06 to **Start 1**)—the firmware will reject it and increment the counter.

13) Input registers mirror (0x04)

- Repeat Step 1 but select **Function 0x04 (Read Input Registers)** and the same addresses.
    - You should get identical values (mirror of the read-only map).

14)Optional: Device Identification (MEI 0x2B/0x0E)

- QModMaster usually doesn't send 0x2B. If you have **Modbus Poll** or **modpoll**, you can query the MEI "Device ID" to read strings 7semi**, Industry RS-485 Temperature & Humidity + VOC/NOx Index Probe**, and version 1.0.

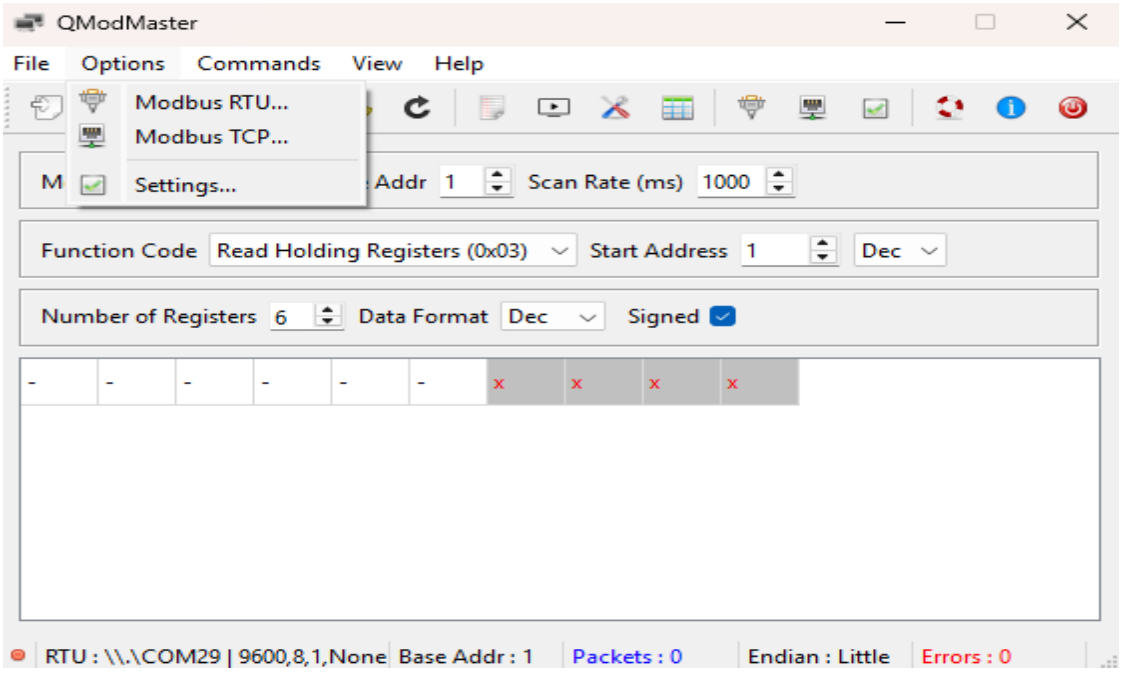
Baud Rate Setting

Decimal Code	Baud Rate
0	9600 bps
1	19200 bps
2	38400 bps
3	57600 bps
4	115200 bps

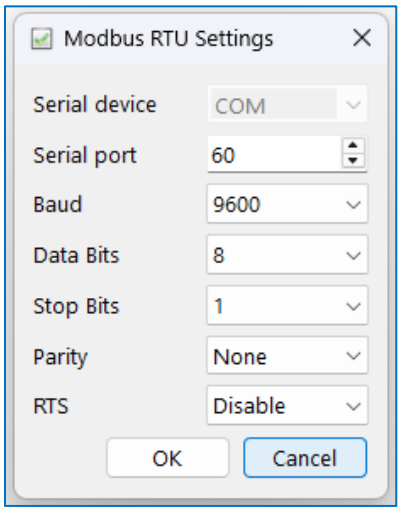
4.1 Modbus output

Follow the steps below for the software setup:-

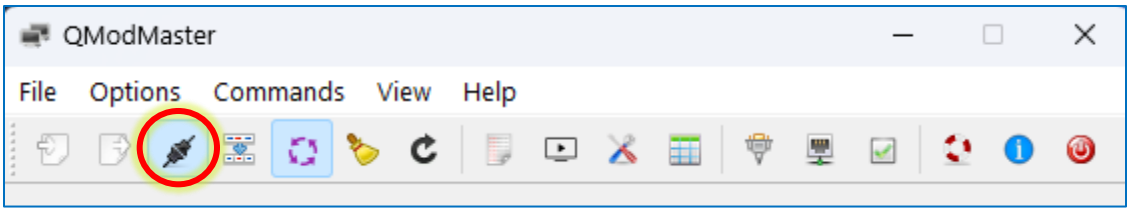
1. Open the software **(qModMaster-Win64-exe-0.5.3-beta)**
2. Go to *Options* → *Modbus RTU*



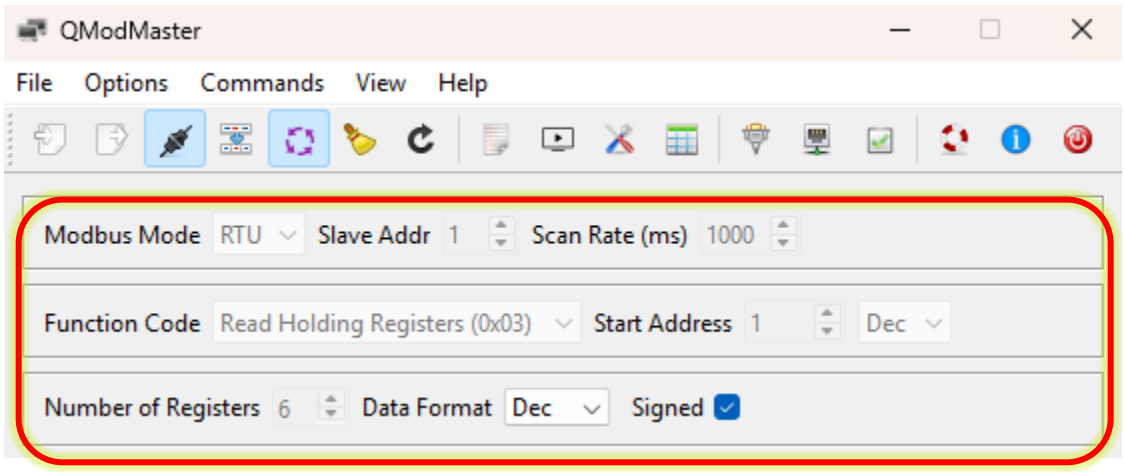
3. Check your COM port in device manager and select the other settings as per the image below. Click *OK*



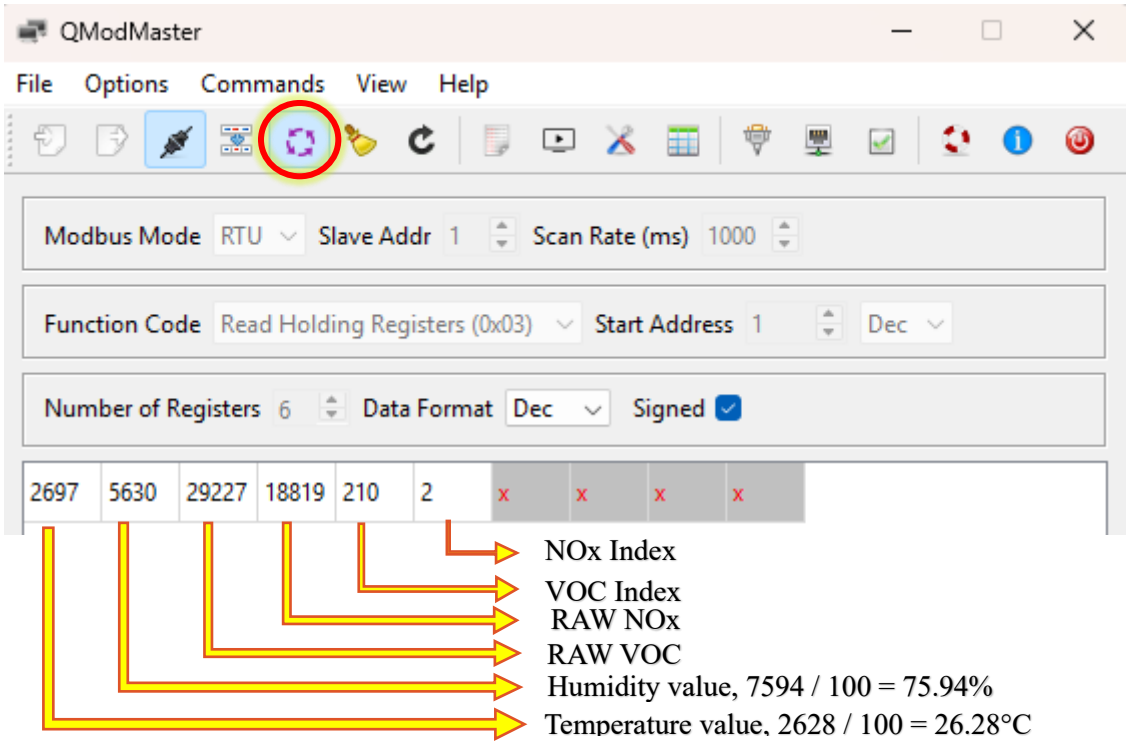
4. Connect your system to the correct COM port and click on this icon.



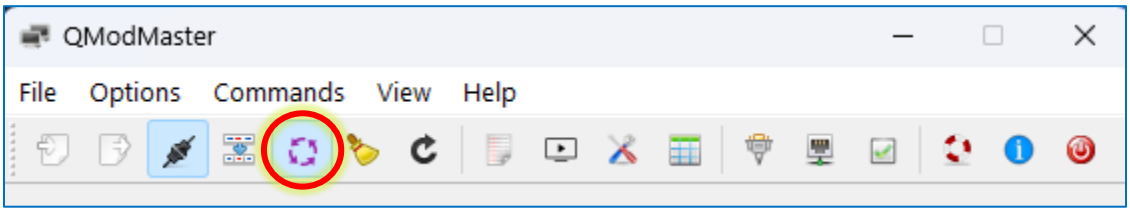
5. Also, make sure the following parameters are set properly.



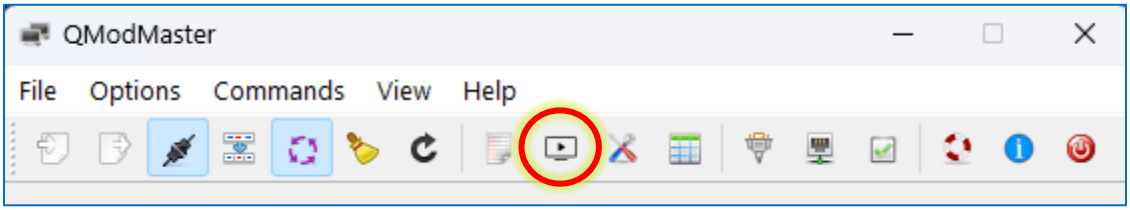
6. Now to check the data, click on this icon.



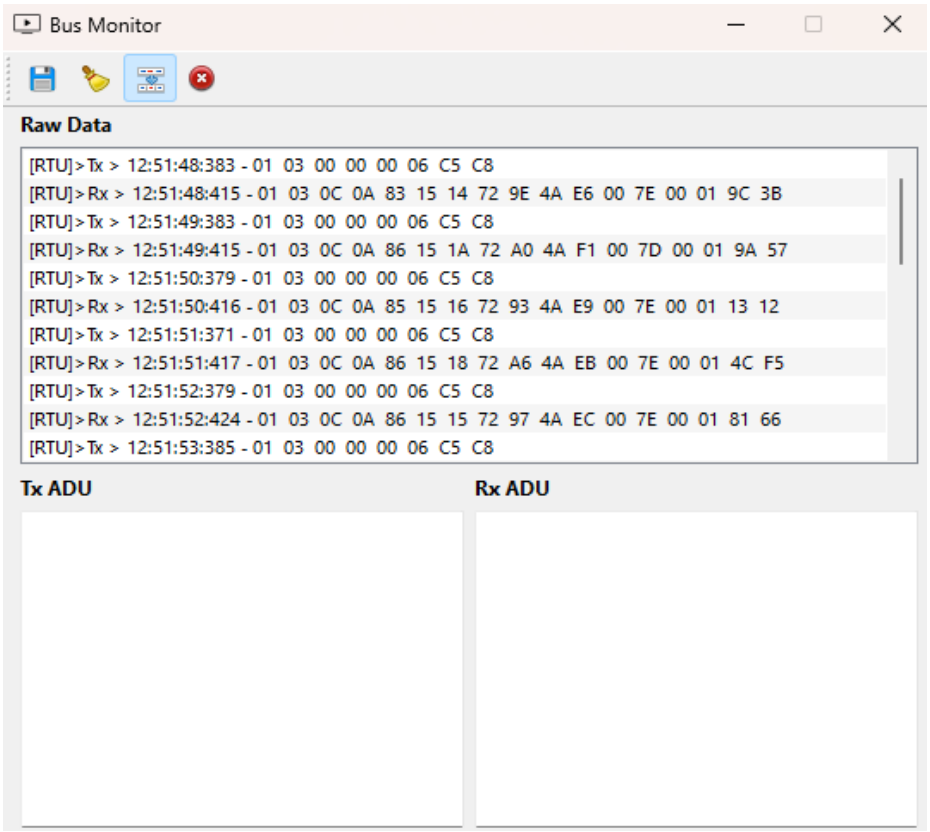
7. If you want to display the values continuously based upon the scan rate then click on this icon.

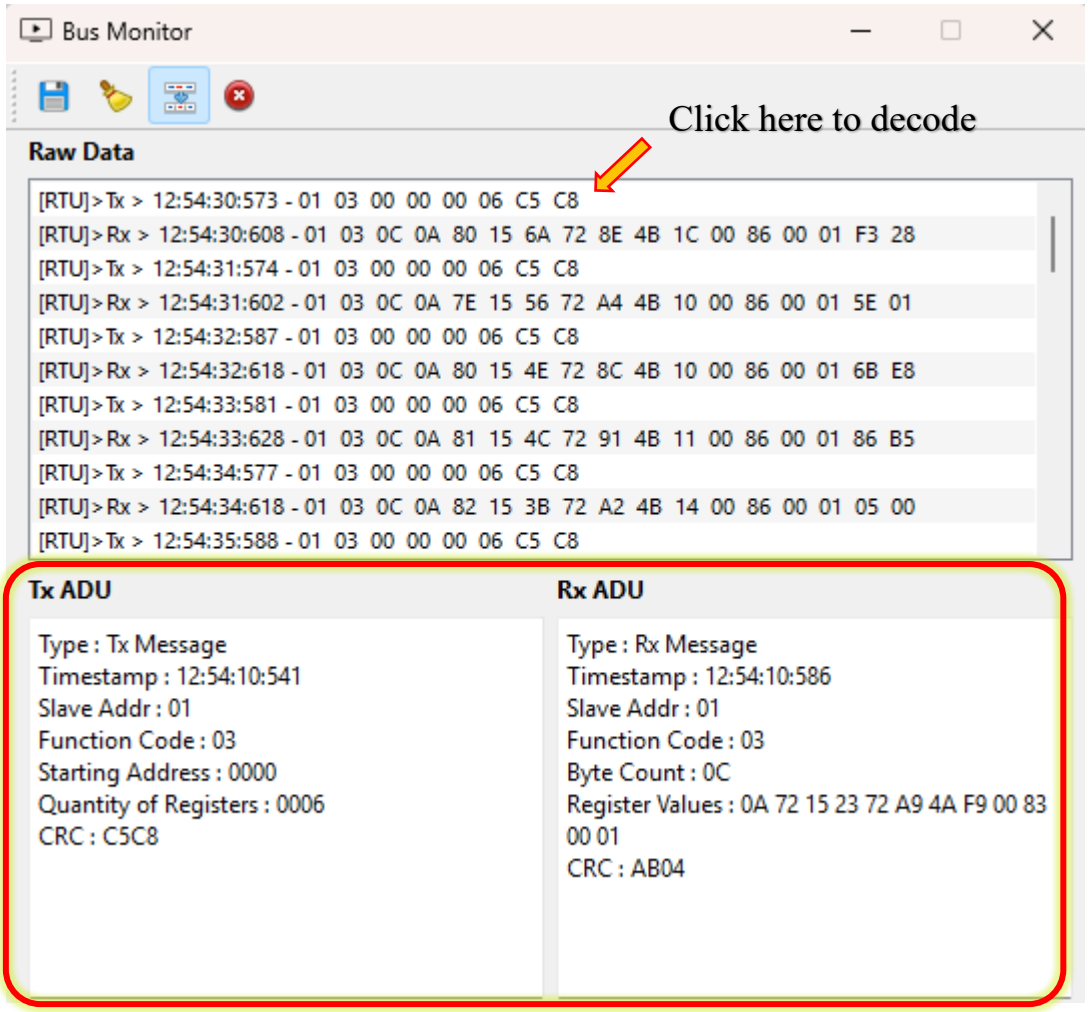


If you want to see the values in more detail you can click on this icon.



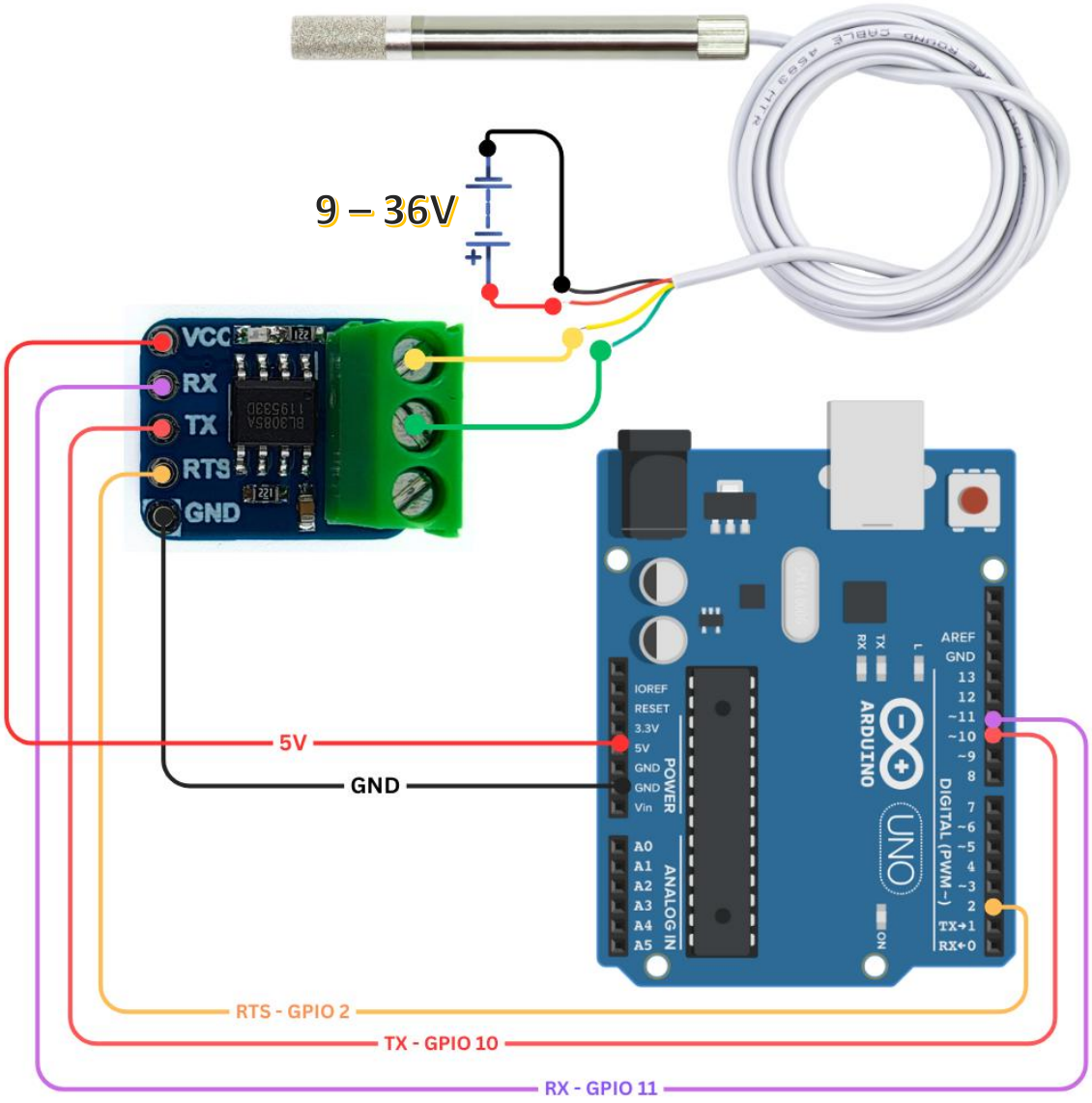
A new window will open to display the readings. To display data, follow step 6.




Bus Monitor
Click here to decode
Raw Data
[RTU] > Tx > 12:54:30:573 - 01 03 00 00 00 06 C5 C8
[RTU] > Rx > 12:54:30:608 - 01 03 0C 0A 80 15 6A 72 8E 4B 1C 00 86 00 01 F3 28
[RTU] > Tx > 12:54:31:574 - 01 03 00 00 00 06 C5 C8
[RTU] > Rx > 12:54:31:602 - 01 03 0C 0A 7E 15 56 72 A4 4B 10 00 86 00 01 5E 01
[RTU] > Tx > 12:54:32:587 - 01 03 00 00 00 06 C5 C8
[RTU] > Rx > 12:54:32:618 - 01 03 0C 0A 80 15 4E 72 8C 4B 10 00 86 00 01 6B E8
[RTU] > Tx > 12:54:33:581 - 01 03 00 00 00 06 C5 C8
[RTU] > Rx > 12:54:33:628 - 01 03 0C 0A 81 15 4C 72 91 4B 11 00 86 00 01 86 B5
[RTU] > Tx > 12:54:34:577 - 01 03 00 00 00 06 C5 C8
[RTU] > Rx > 12:54:34:618 - 01 03 0C 0A 82 15 3B 72 A2 4B 14 00 86 00 01 05 00
[RTU] > Tx > 12:54:35:588 - 01 03 00 00 00 06 C5 C8
Tx ADU
Type : Tx Message
Timestamp : 12:54:10:541
Slave Addr : 01
Function Code : 03
Starting Address : 0000
Quantity of Registers : 0006
CRC : C5C8
Rx ADU
Type : Rx Message
Timestamp : 12:54:10:586
Slave Addr : 01
Function Code : 03
Byte Count : 0C
Register Values : 0A 72 15 23 72 A9 4A F9 00 83 00 01
CRC : AB04

4.2 How to open the probe?

4.3 Connection and sample code for Arduino



How to Install 7Semi Arduino Library

- **Install the Arduino IDE** on your computer.
- Once installed, **open the Arduino IDE**.
- Go to **Library Manager** and search for **"7Semi-RS485-Temperature-Humidity-Probe-Arduino-Library."**
- **Install** the library from the search results.
- After installation, navigate to **File → Examples → Basic → Example Usage**, and open the **"Basic.ino"** example.
- **Upload** the example code to your Arduino board.
- Set the **baud rate to 115200** in the Serial Monitor.
- You should now **see the output** displayed on the Serial Monitor.

Sample code link for manual download:- "*RS485-sensor-probe*"

Sample output image:-

```
T = 27.04 °C,  RH = 55.73 %
RAW_VOC = 29566, RAW_NOx = 18698
VOC Index = 58  (1…500),  NOx Index = 2  (1…500)
---------------------------------
T = 27.01 °C,  RH = 55.72 %
RAW_VOC = 29544, RAW_NOx = 18703
VOC Index = 58  (1…500),  NOx Index = 2  (1…500)
---------------------------------
T = 27.02 °C,  RH = 55.75 %
RAW_VOC = 29554, RAW_NOx = 18710
VOC Index = 58  (1…500),  NOx Index = 2  (1…500)
---------------------------------
T = 27.03 °C,  RH = 55.76 %
RAW_VOC = 29553, RAW_NOx = 18707
VOC Index = 58  (1…500),  NOx Index = 2  (1…500)
---------------------------------
T = 27.02 °C,  RH = 55.82 %
RAW_VOC = 29545, RAW_NOx = 18714
VOC Index = 58  (1…500),  NOx Index = 2  (1…500)
---------------------------------
```

5.Mechanical specification