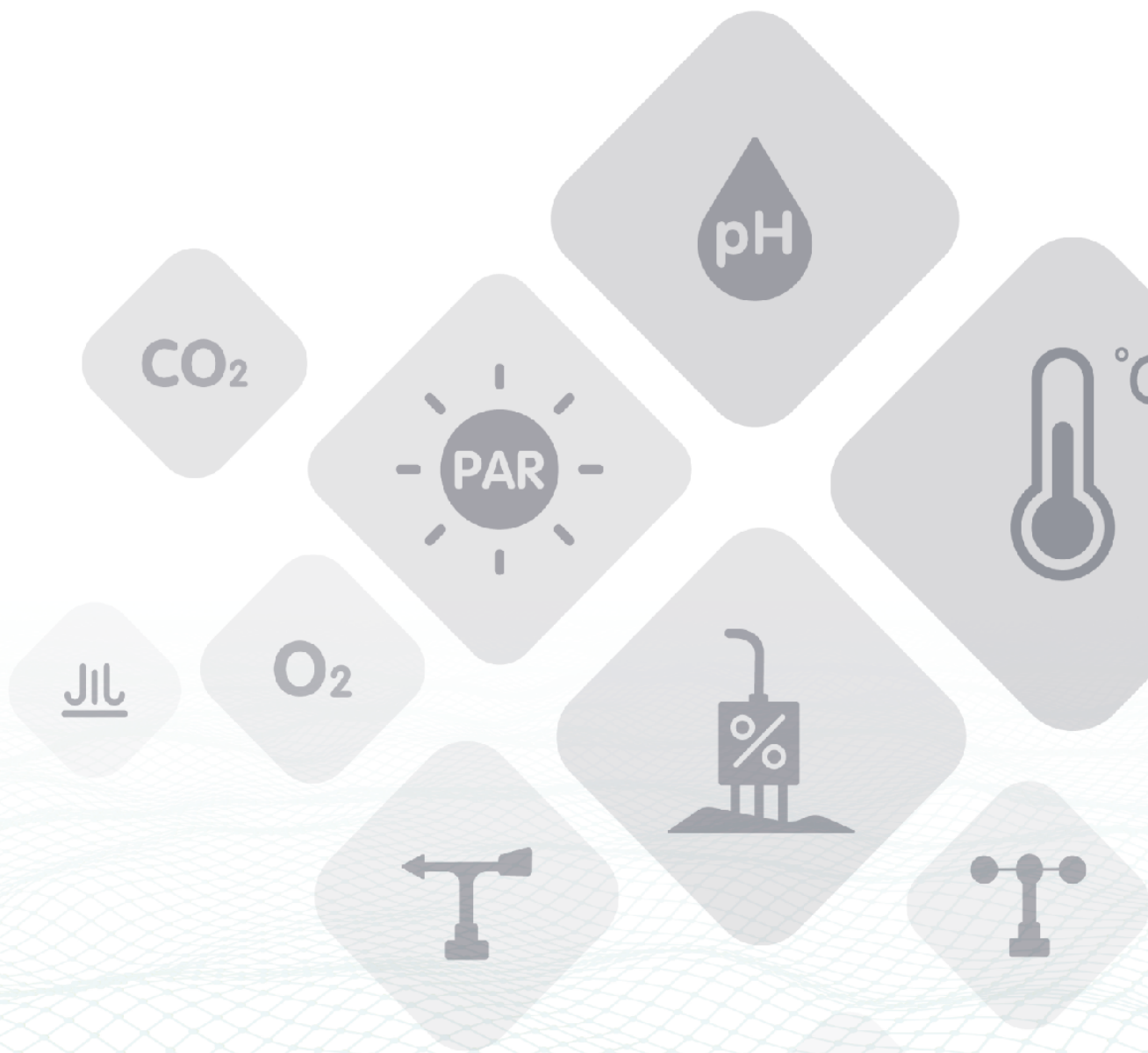




SENSECAP

RS485 Mini Soil Moisture, Temperature and EC Sensor (S-Temp&VWC&EC-05A)



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1 Introduction

The RS485 Mini Soil Moisture, Temperature and EC Sensor with Modbus-RTU interface is an accurate tool for monitoring volumetric water content (VWC), substrate temperature, and electrical conductivity in soil and soilless substrates. It is sealed with a resin-packaged plastic body and equipped with sensing rods that can be inserted directly into soil or substrate for long-term stable measurement. With integrated moisture, EC, and temperature measurement, low-power design, low salinity sensitivity, robust epoxy encapsulation, high accuracy, excellent stability, reverse power protection, and built-in TVS/ESD protection, the RS485 Mini Soil Moisture, Temperature and EC Sensor is suitable for scientific research, smart agriculture, hydroponic and horticulture, greenhouse monitoring, soil/substrate water balance, irrigation management, and solute/fertilizer movement.

Features

- Integrated with Moisture, EC, and Temperature measurement
- Digital sensor communicates over RS485 serial interface
- Modbus-RTU communications protocols
- Low-input voltage requirements for power supply
- Low-power design supports battery-operated data loggers
- Low salinity sensitivity
- Robust epoxy encapsulation resists corrosive environments
- High accuracy with excellent stability
- Reverse power protection and Built-in TVS/ESD protection

Applications

- Smart Agriculture, Hydroponic and Horticulture
- Greenhouse monitoring
- Soil/Substrate water balance
- Irrigation management
- Solute/fertilizer movement



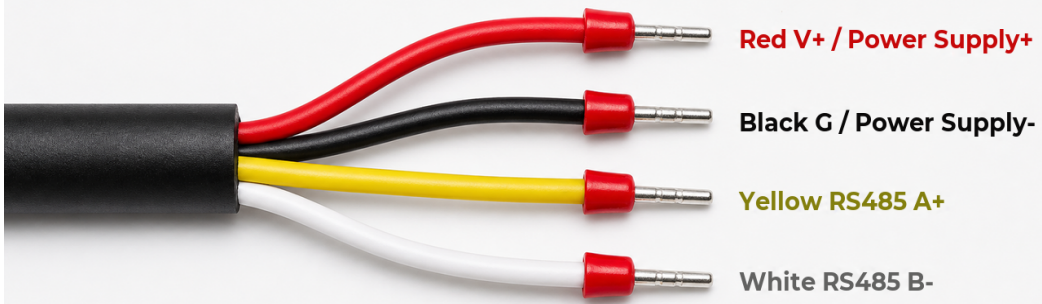
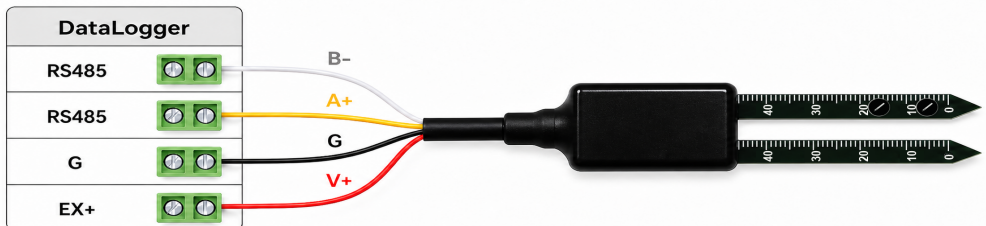
2 Specifications

Substrate Temperature Measurement	
Range	-40-80°C
Accuracy	±0.5°C (0-50°C), ±1.0°C (-40-80°C)
Resolution	0.1°C
Substrate Moisture Measurement	
Volumetric Water Content (VWC) Range	0-100% (air - water)
Volumetric Water Content (VWC) Accuracy	±3% (0%-50%), ±5% (50%-100%)
Volumetric Water Content (VWC) Resolution	0%-50%: 0.1%; 50%-100%: 0.5%
Substrate dielectric constant measurement	
Apparent Dielectric Permittivity Range	1-81 (air - water)
Apparent Dielectric Permittivity Accuracy	±1 (1.00-40.00); ±3 (40.00-81.00)
Apparent Dielectric Permittivity Resolution	1.00-40.00: ±0.1; 40.00-81.00: ±0.5
Substrate EC Measurement	
Range	0-20 dS/m(0-20000us/cm)
Accuracy	±5% (0-5 dS/m), ±10% (5-20 dS/m)
Resolution	0-5 dS/m: 0.01 dS/m; 5-20 dS/m: 0.1 dS/m
Temperature Compensation	0-50°C
General Parameters	
Product Model	S-Temp&VWC&EC-05A
Sensor Description	MT05R Soil Moisture, Temperature, and Electrical Conductivity (EC) sensor
Output Interface	RS485, Modbus-RTU

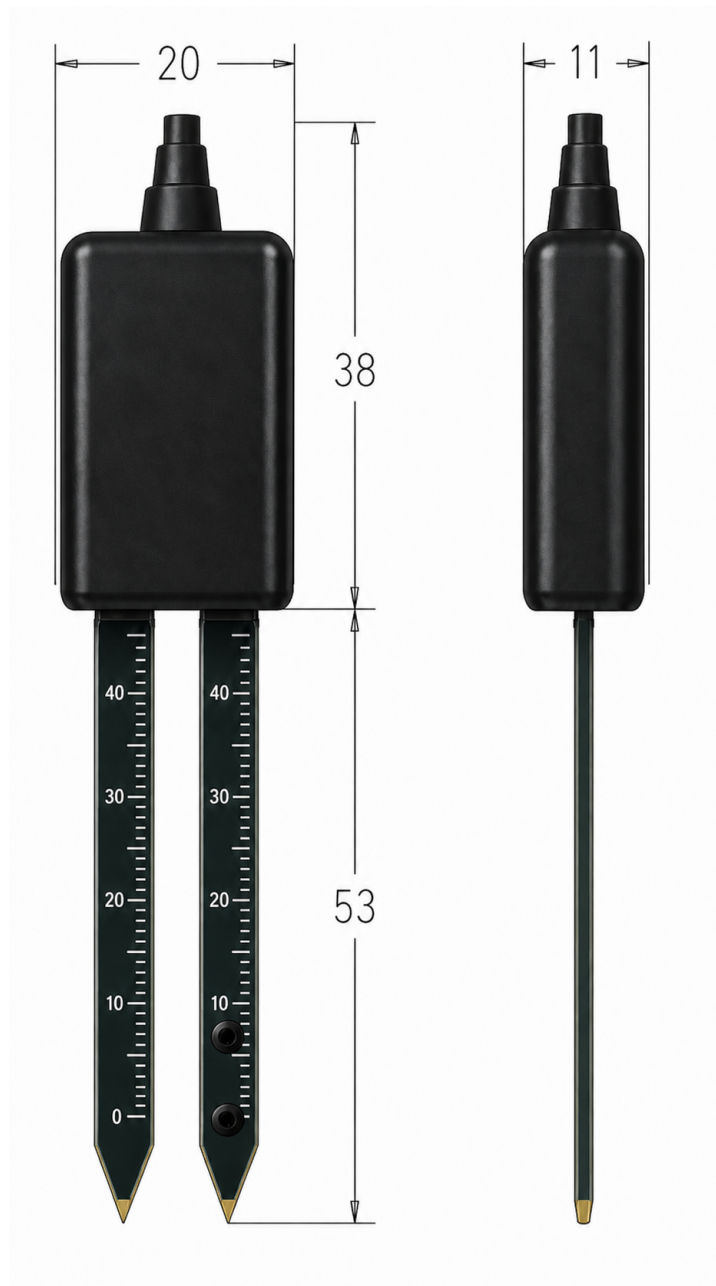
Protocol	Modbus-RTU
Default Serial Communication	Slave address: 1; baud rate: 9600 bps; data bits: 8; stop bits: 1 stop bit;
Power Supply	3.0-28V DC
IP Rating	IP68
Cable Length	2 meters
Operating Temperature	-40-80°C
Dimensions	20*11*95 mm
Sealing Encapsulation	Resin-packaged plastic body; robust epoxy encapsulation;
Installation	Rods fully inserted into the substrate; ensure good substrate contact

Electrical and Timing Characteristics			
Item	Minimum	Typical	Maximum
Supply Voltage (V+ to G), 3.0-28V DC	3.0 V DC	N/A	28 V DC
Power Line Slew Rate	1.0 V/ms	N/A	N/A
Current Drain (measuring), RS485	N/A	10 mA	15 mA
Current Drain (standby), RS485	N/A	300 uA	800 uA
Power-Up Time (RS485)	N/A	500 ms	N/A
Measurement Duration	N/A	100 ms	N/A

3 Wiring

Type	Wiring diagram
RS485 Interface	Cold pressed terminal  Red V+ / Power Supply+ Black G / Power Supply- Yellow RS485 A+ White RS485 B-
Connections	Wiring Diagram  DataLogger RS485 RS485 G EX+ B- A+ G V+

4 Dimensions



Unit: mm

5 RS485 Communication

5.1 Modbus Protocol

Modbus Protocol is widely used to establish master-slave communication between intelligent devices or sensors. A MODBUS message sent from a master to a slave contains the address of the slave, the function code (e.g. 'read register' or 'write register'), the data, and a checksum (LRC or CRC). The default serial communication settings are slave address 1, Modbus RTU, 9600bps, 8 data bits and 1 stop bit.

5.2 Modbus Register

Parameters	Register Addr. (HEX/DEC)	Data Type	Modbus Function Code(DEC)	Range and Comments	Default Value
SUBSTRATE_TEMPERATURE	0x0000 /0	INT16 RO	3/4	-4000-8000 indicates: -40.00-80.00 (°C); -4000-17600 indicates: -40.00-176.00 (°F)	N/A
SUBSTRATE_VWC	0x0001 /1	INT16 RO	3/4	0-10000 indicates 0.00-100.00 (%)	N/A
SUBSTRATE_BULK EC	0x0002 /2	INT16 RO	3/4	0-20000 indicates 0-20000 (us/cm)	N/A
RESERVED	0x0003 /3	UINT16 RO	3/4	0-40960 indicates 0.0-4096.0	N/A
SUBSTRATE_EPSILON	0x0004 /4	INT16 RO	3/4	0-8188 indicates 0.00-81.88	N/A
SUBSTRATE_PORE EC	0x0005 /5	INT16 RO	3/4	0-20000 indicates 0-20000 (us/cm)	N/A
SUBSTRATE_VWC_RAWAD	0x0006 /6	INT16 RO	3/4	0-4095	N/A
RESERVED	0x0007 /7	INT16 RO	3/4	Reserved	N/A
RESERVED	0x0008 /8	INT16 RO	3/4	Reserved	N/A
RESERVED	0x0009 /9	INT16 RO	3/4	Reserved	N/A
RESERVED	0x000A /10	INT16 RO	3/4	Reserved	N/A
RESERVED	0x000B /11	INT16 RO	3/4	Reserved	N/A
RESERVED	0x000C /12	INT16 RO	3/4	Reserved	0

RESERVED	0x000D /13	INT16 RO	3/4	Reserved	0
RESERVED	0x000E /14	INT16 RO	3/4	Reserved	0
RESERVED	0x000F /15	INT16 RO	3/4	Reserved	0
SUBSTRATE_TYPE	0x0020 /32	UINT16 RW	3/6/16	0: Soil Media 1: Soilless Media 2: User Defined Curve	0
TEMPERATURE_UNIT	0x0021 /33	UINT16 RW	3/6/16	0:°C 1:°F	0
MEASURE_METHOD	0x0022 /34	UINT16 RW	3/6/16	0: Measure continuously 1: Measure when register read command received	0
FLOATBYTEORDER	0x0023 /35	UINT16 RW	3/6/16	Configure floating point register byte order. 0: Big-endian [ABCD] 1: Little-endian[DCBA] 2: Big-endian byte swap [BADC] 3: Little-endian byte swap[CDAB]	3
RESERVED	0x0024 /36	UINT16 RW	3/6/16	RESERVED	0
RESERVED	0x0025 /37	UINT16 RW	3/6/16	RESERVED	0
SLAVE ADDRESS	0x0200/512	UINT16 RW	3/6/16	1-255	1
BAUDRATE	0x0201 /513	UINT16 RW	3/6/16	0-5 0: 1200bps 1: 2400bps 2: 4800bps 3: 9600bps 4: 19200bps 5: 38400bps	3:9600bps
PROTOCOL	0x0202 /514	UINT16 RW	3/6/16	0 0:Modbus RTU	0:Modbus RTU
PARITY	0x0203 /515	UINT16 RW	3/6/16	0-2 0:NONE 1:EVEN 2:ODD	0:NONE
DATABITS	0x0204 /516	UINT16 RW	3/6/16	1 1:8 databits	1:8 databits
STOPBITS	0x0205 /517	UINT16 RW	3/6/16	0-1 0:1 stop bit	0:1 stop bit

				1:2 stop bits	
RESERVED	0x0206 /518	UINT16 RW	3/6/16	Reserved	0
RESERVED	0x0207 /519	UINT16 RW	3/6/16	Reserved	0
USERSN	0x0220 /544 0x0221 /545 0x0222 /546 0x0223 /547	UINT16 RW	3/16	0x0000000000000000 000- 0xFFFFFFFFFFFFFFF FF	N/A
SUBSTRATE_TEM PERATURE_FLOAT	0x1000 /4096	FLOAT RO	3/4	-40.00-80.00 (°C); -40.00-176.00 (°F)	N/A
SUBSTRATE_VWC _FLOAT	0x1002 /4098	FLOAT RO	3/4	0.00-100.00 (%)	N/A
SUBSTRATE_BUL K EC_FLOAT	0x1004 /4100	FLOAT RO	3/4	0-20000 (us/cm)	N/A
SUBSTRATE_CALI BRATEDRAWCOU NTS_FLOAT	0x1006 /4102	FLOAT RO	3/4	0.00-4096.00	N/A
SUBSTRATE_EPSI LON_FLOAT	0x1008 /4104	FLOAT RO	3/4	0.00-81.88	N/A
SUBSTRATE_POR E EC_FLOAT	0x100A /4106	FLOAT RO	3/4	0-32000 (us/cm)	N/A
SUBSTRATE_VWC _RAWAD_FLOAT	0x100C /4108	FLOAT RO	3/4	0-4095	N/A
RESERVED_FLOA T	0x100E /4110	FLOAT RO	3/4	Reserved	N/A
RESERVED_FLOA T	0x1010 /4112	FLOAT RO	3/4	Reserved	N/A
RESERVED_FLOA T	0x1012 /4114	FLOAT RO	3/4	Reserved	0
RESERVED_FLOA T	0x1014 /4116	FLOAT RO	3/4	Reserved	0
RESERVED_FLOA T	0x1016 /4118	FLOAT RO	3/4	Reserved	0
RESERVED_FLOA T	0x1018 /4120	FLOAT RO	3/4	Reserved	0
RESERVED_FLOA T	0x101A /4122	FLOAT RO	3/4	Reserved	0
RESERVED_FLOA T	0x101C /4124	FLOAT RO	3/4	Reserved	0
RESERVED_FLOA T	0x101E /4126	FLOAT RO	3/4	Reserved	0

UINT16: 16-bit unsigned integer

INT16: 16-bit signed integer

RO: Register is Read Only

R/W: Register is Read/Write

HEX: Hexadecimal (data with 0x/0X prefix)

DEC: Decimal

FLOAT: Floating point register, the byte order is configured by the "Floating Point Register Byte Order, FLOATBYTEORDER" register. Please refer to "Modbus Register Detail"

Description” for more details.

The register value will be set as follows when there is a sensor error:

Error Value	Register Address	Error
-32768	0x0000-0x000F	Sensor Broken
-32768	0x1000-0x101E	Sensor Broken
-32765	0x0000-0x000F	Not Supported Value
-32765	0x1000-0x101E	Not Supported Value

5.3 Modbus Register Detail Description

SUBSTRATE_TEMPERATURE - Substrate Temperature, INT16 Format		
Range	-4000-8000 indicates -40.00-80.00 (Temperature Unit set to °C); -4000-17600 indicates -40.00-176.00 (Temperature Unit set to °F)	Default: N/A
Parameter Storage	N/A	

SUBSTRATE_TEMPERATURE_FLOAT - Substrate Temperature, FLOAT Format		
Range	-40.00-80.00 (Temperature Unit set to °C); -40.00-176.00 (Temperature Unit set to °F)	Default: N/A
Parameter Storage	N/A	

Note: The byte order is configured by the “Floating Point Register Byte Order, FLOATBYTEORDER” register.

SUBSTRATE_VWC - Substrate Volumetric Water Content, INT16 Format		
Range	0-10000 indicates 0-100.00 (%);	Default: N/A
Parameter Storage	N/A	

SUBSTRATE_VWC_FLOAT - Substrate Volumetric Water Content, FLOAT Format		
Range	0-100.00 (%)	Default: N/A
Parameter Storage	N/A	

Note: The byte order is configured by the “Floating Point Register Byte Order, FLOATBYTEORDER” register.

SUBSTRATE_BULKEC - Substrate Bulk EC, INT16 Format		
Range	0-20000 indicates 0-20000 (us/cm);	Default: N/A
Parameter Storage	N/A	

SUBSTRATE_BULKEC_FLOAT - Substrate Bulk EC, FLOAT Format		
Range	0-20000 (us/cm)	Default: N/A
Parameter Storage	N/A	

Note: The byte order is configured by the "Floating Point Register Byte Order, FLOATBYTEORDER" register.

SUBSTRATE_EPSILON - Substrate Epsilon, UINT16 Format		
Range	0-20000 indicates 0.00-200.00	Default: N/A
Parameter Storage	N/A	

SUBSTRATE_EPSILON_FLOAT - Substrate Epsilon, FLOAT Format		
Range	0.00-200.00	Default: N/A
Parameter Storage	N/A	

Note: The byte order is configured by the "Floating Point Register Byte Order, FLOATBYTEORDER" register.

SUBSTRATE_PORE EC - Substrate Pore EC, INT16 Format		
Range	0-32000 indicates 0-32000 (us/cm);	Default: N/A
Parameter Storage	N/A	

SUBSTRATE_PORE EC_FLOAT - Substrate Pore EC, FLOAT Format		
Range	0-32000 (us/cm)	Default: N/A
Parameter Storage	N/A	

Note: The byte order is configured by the "Floating Point Register Byte Order, FLOATBYTEORDER" register.

SUBSTRATE_VWC_RAWAD - Air Temperature, INT16 Format		
Range	0-4095	Default: N/A
Parameter Storage	N/A	

SUBSTRATE_VWC_RAWAD_FLOAT - Air Temperature, FLOAT Format		
Range	0-4095	Default: N/A
Parameter Storage	N/A	

Note: The byte order is configured by the "Floating Point Register Byte Order, FLOATBYTEORDER" register.

SUBSTRATE_TYPE--- Substrate Type, INT16 Format		
Data Range	0: Soil Media 1: Soilless Media (like rockwool, cocopeat) 2: User Defined Curve	Default: 0
Parameter Storage	YES	

TEMPERATURE_UNIT--- Temperature Unit, INT16 Format		
Data Range	0: °C 1: °F	Default: 0
Parameter Storage	YES	

MEASURE_METHOD--- Measure Method, INT16 Format		
Data Range	0: Measure continuously (Perform measurement every 500ms) 1: Measure on register reading command received (Perform a measurement when the user sends a data reading command)	Default: 0
Parameter Storage	YES	

FLOATBYTEORDER: Floating Point Register Byte Order, INT16		
Range	0: Big-endian [ABCD] 1: Little-endian[DCBA] 2: Big-endian byte swap [BADC] 3: Little-endian byte swap[CDAB]	Default: 3

Parameter Save	YES	
----------------	-----	--

Note: Configure floating point register byte order.

Example: The 123456.00 in IEC754 is 0x47F12000 (A=47, B=F1, C=20, D=00), then

0: Big-endian [ABCD]

1: Little-endian[DCBA]

2: Big-endian byte swap [BADC]

3: Little-endian byte swap[CDAB]

SLAVEADDRESS - Modbus Slave Address (16-bit unsigned int)		
Data Range	1-255	Default: 1
Parameter Storage	YES	

Note: After changing the settings, please power cycle the sensor for the changes to take effect.

BAUDRATE - Serial Comm Baudrate (16-bit unsigned int)		
Data Range	0-5 0:1200bps 1:2400bps 2:4800bps 3:9600bps 4:19200bps 5:38400bps	Default: 3
Parameter Storage	YES	

Note: After changing the settings, please power cycle the sensor for the changes to take effect.

PROTOCOL - Serial Comm Protocol (16-bit unsigned int)		
Data Range	0 0:Modbus RTU	Default: 0
Parameter Storage	YES	

Note: After changing the settings, please power cycle the sensor for the changes to take effect.

PARITY - Serial Comm Parity (16-bit unsigned int)		
Data Range	0-2 0:NONE 1:EVEN	Default: 0

	2:ODD	
Parameter Storage	YES	

Note: After changing the settings, please power cycle the sensor for the changes to take effect.

DATABITS - Serial Comm Databits (16 bit unsigned int)		
Data Range	1 1:8 databits	Default: 1
Parameter Storage	YES	

Note: After changing the settings, please power cycle the sensor for the changes to take effect.

STOPBITS - Serial Comm Stopbits (16 bit unsigned int)		
Data Range	0-1 0:1 stopbit 1:2 stopbits	Default: 0
Parameter Storage	YES	

Note: After changing the settings, please power cycle the sensor for the changes to take effect.

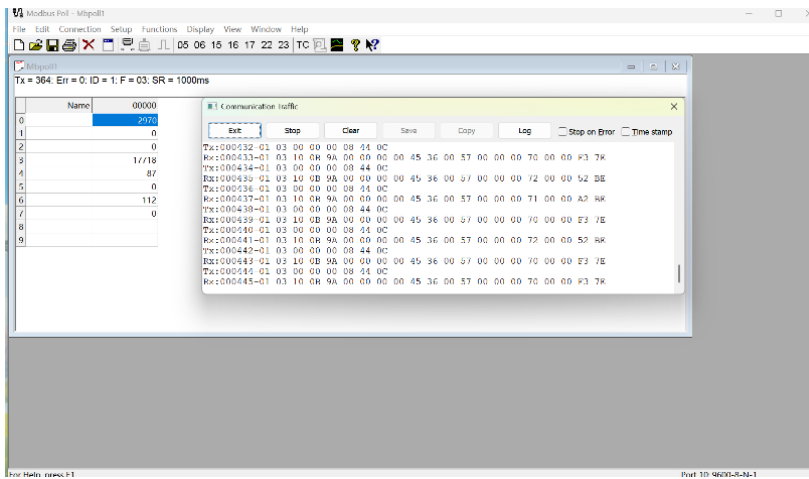
USER_SN--- User Serial Number		
Data Range	0x0000000000000000-0xFFFFFFFFFFFFFFFF User Serial Number. These four registers should be read and written together from the start address 0x0220 with quantity 4.	Default: N/A
Parameter Storage	YES	

5.4 Software Configuration Utility

Software: Modbus Poll

You can use the software listed below to try reading/ writing the register of the sensor.

[Download](#)



5.5 Command example

5.5.1 Modify the slave address

Default Registers	1
Change Slave Address	05
Address	0x0200 (512)
Number of Registers	1
Function Code	0x06
Default Sensor Address	01

To change the Modbus device address of the sensor from 01 to 05, use the following command:

Example:

Send Command	01 06 02 00 00 05 48 71
Response	01 06 02 00 00 05 48 71

Note: The address is changed to 05 and saved after power-off

5.5.2 Modify the baud rate

Address	0x0201 (513)
Number of Registers	1
Function Code	0x06
Default Value	3 (9600bps)
Supported Values	0-5 (1200-38400bps)

The baud rate can be set via the upper computer and takes effect after re-powering the sensor. The baud rate is saved after power-off.

The integer values map to baud rates as follows:

Integer value	Baud Rate
0	1200bps
1	2400bps
2	4800bps
3	9600bps
4	19200bps
5	38400bps

Example:

Send Command	05 06 02 01 00 02 59 F7
Response	05 06 02 01 00 02 59 F7

Note: The baud rate is changed to 4800bps and saved after power-off

5.5.3 Read measurement data

This reading includes ten values.

Address	0x0000 (0)
Number of Registers	3
Function Code	0x03

Example:

Send Command	05 03 06 09 1A 00 00 00 00 4A EE
Response	05 03 00 00 00 03 04 4F

6 Safety, Care and Installation

6.1 Care and Safety

- The rods of the sensor are sharp for ease of insertion. Care must be taken and handling precautions followed.
- Avoid touching the rods or exposing them to other sources of static damage, particularly when powered up.
- Do not pull the sensor out of the substrate by its cable.
- If you feel any resistance when inserting the sensor into the substrate, stop pushing and re-insert at a new location.

6.2 Installation

- Clear away any stones. Pre-form holes in very hard soil or substrate before insertion.
- Push the sensor into the substrate until the rods are fully inserted. Ensure good substrate contact.
- If you feel strong resistance when inserting the sensor, you have probably hit a stone. Stop and re-insert at a new location.

7 Document version

Version	Date	Description	Editor
V1.0		First Version	Zhai Chenyang