OHTS1021 Tube Soil Moisture Monitoring Sensor

1 Product Overview

The OHTS1021 is a multi-layer soil parameter monitoring sensor based on the dielectric constant measurement principle. Utilizing a stratified measurement structure, it enables dynamic observation of soil moisture content, temperature, and electrical conductivity at different depths. The device is equipped with standard 3-layer to 5-layer soil parameter detection capability, with a measurement point spacing of 10cm. An optional integrated tri-axial tilt sensor is available for monitoring soil and equipment attitude changes.

The device features a PVC tubular housing structure that allows transmission of near 1GHz high-frequency detection waves, avoiding interference from soil salt ions, fertilizers, pesticides, and irrigation activities on measurement results. The circuit section employs potting processing, achieving IP68 protection rating for the below-ground portion. The communication interface adopts standard ModBus-RTU protocol with RS485 bus transmission, supporting a maximum communication distance of 2000m, and accepts 10-30V wide-range DC power supply.

2 Application Scenarios

- Agricultural irrigation automation control systems
- Soil moisture and drought monitoring networks
- Soil parameter acquisition for meteorological observation stations
- Hydrological and water resource monitoring projects
- Water conservancy engineering storage and diversion status monitoring
- Precision agriculture and environmental monitoring stations
- Geological disaster early warning soil parameter monitoring
- Long-term observation of soil physicochemical properties for scientific research

3 Product Features

- Utilizes dielectric constant method (TDR principle) to measure soil volumetric water content; measurement electrodes do not contact soil directly, avoiding electrochemical corrosion and polarization interference
- Multi-layer structural design supporting synchronous monitoring of 3 to 5 layers of soil parameters with 10cm inter-layer spacing
- Optional soil electrical conductivity (EC) monitoring function, range 0-20000μS/cm
- Optional tri-axial tilt sensor supporting static/dynamic angle monitoring for soil displacement and equipment attitude detection
- PVC tubular housing with excellent wave transmission performance and resistance to soil chemical corrosion
- Potting process treatment with IP68 protection rating for below-ground portions
- Standard ModBus-RTU communication protocol with RS485 interface, supporting multi-level bus networking
- 10-30V wide-range DC power supply with low power consumption design

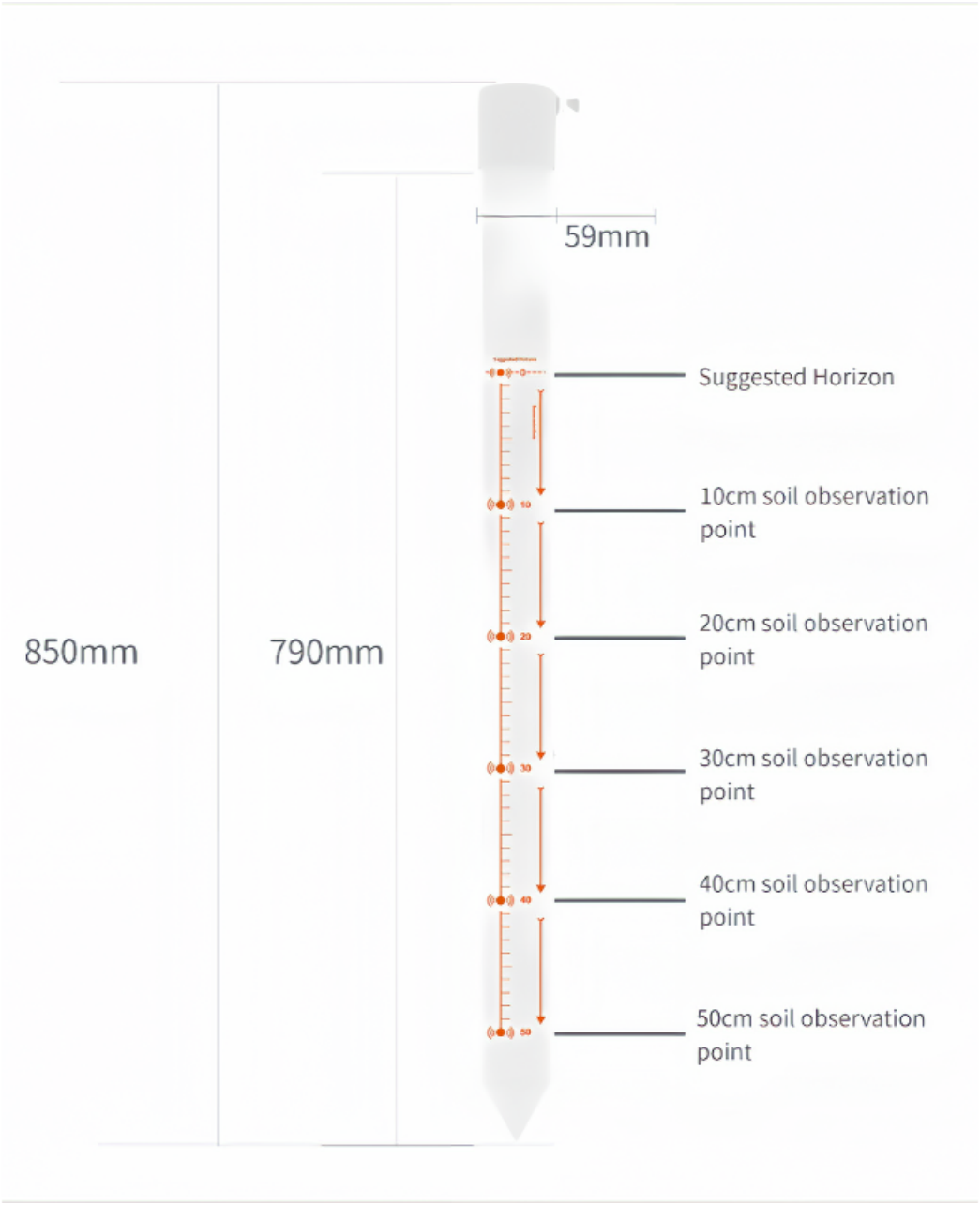
4 Technical Specifications

Parameter Category	Parameter Item	Specification
Environmental Adaptability	Operating Temperature	-40℃~80℃
Measurement Range	Soil Moisture	0~100%
	Soil Temperature	-15℃~35℃
	Soil Electrical Conductivity	0-20000μS/cm
	Tilt Angle	-90°~90°
Measurement Accuracy	Soil Moisture	±5% (@50%,25℃)
	Soil Temperature	±0.5℃ (25℃)
	Soil Electrical Conductivity	0-10000μS/cm range: ±3%FS; 10000-20000μS/cm range: ±5%FS (Brown soil,60%,25℃)
	Tilt Angle-X/Y Axis	Static accuracy: ±0.1°; Dynamic accuracy: ±0.5°
	Tilt Angle-Z Axis	Static accuracy: ±0.5° (dynamic has integration error)
Temperature Characteristics	Tilt Temperature Drift	±(0.5°~1°), (-40°C~+60°C)
Structural Parameters	Measurement Point Spacing	10cm
Electrical Parameters	Power Supply	10-30V DC
	Power Consumption (3-layer)	0.7W
	Power Consumption (5-layer)	0.96W
	Output Signal	RS485 (ModBus-RTU Protocol)
Performance Indicators	Response Time	≤60s
Material and Protection	Housing Material	PVC plastic tube
	Protection Rating	IP68 for below-ground portions

Note: When soil temperature is below 0℃, soil moisture and electrical conductivity readings are for reference only.

5 Physical Specifications

Parameter Item	Specification Description
Housing Material	PVC plastic tube
Protection Rating	IP68 for below-ground portions
Measurement Point Spacing	10cm
Layer Configuration	1 temperature observation point at ground level, 1 soil temperature and moisture measurement point every 10cm below ground



6 Installation Instructions

6.1 Pre-Installation Preparation

Equipment List:

- Tube Soil Moisture Monitoring Sensor main unit
- Certificate of conformity and warranty card
- USB-to-RS485 converter (optional)
- Solar charging panel (optional)
- Soil auger (optional)

Tools Required:

- Water, bucket, gloves (as required by site conditions)

Site Selection Requirements:

- Install after crop sowing, selecting flat terrain
- Under full irrigation conditions, select areas with less water access; under partial irrigation conditions, select moist areas

- Choose locations with balanced and representative crop growth
- Install away from positions close to crop water-absorbing root systems
- Installation site should be relatively elevated to prevent rainwater backflow

6.2 Installation Steps

Step 1: Drilling

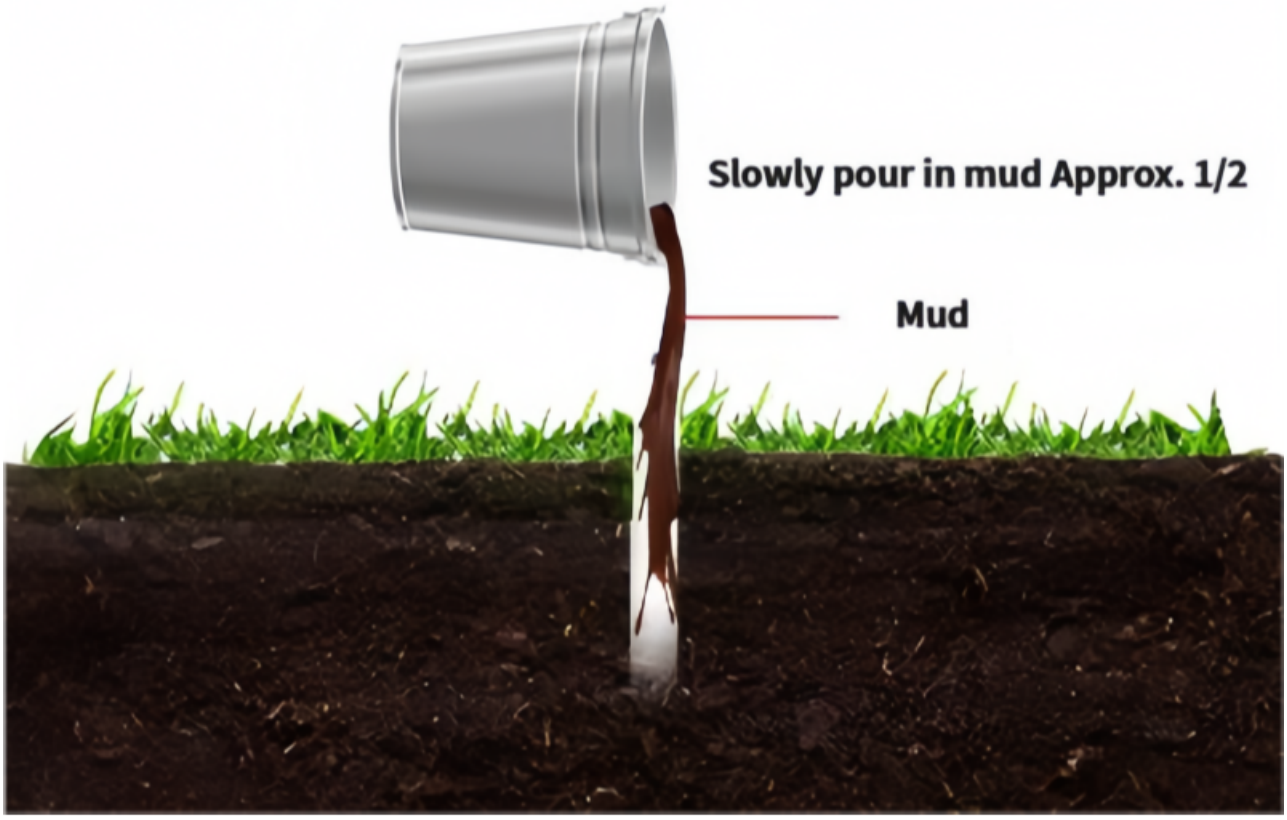
Use a soil auger to drill vertically at the selected location. Hold the handle firmly with both hands, press down clockwise, and rotate slowly. The first soil extraction contains too many impurities and should not be collected; subsequent extractions should be collected in a bucket for later use. During drilling, repeatedly test by gently inserting the sensor into the hole to ensure the hole depth aligns with the sensor's marked installation position without obstruction.

Step 2: Preparing Slurry

Remove stones, grass roots, and insoluble soil clumps from the soil, and crumble the soil finely. Pour in appropriate amount of water and stir thoroughly until viscous; the consistency of loam slurry should not exceed that of sesame paste.

Step 3: Grouting Installation

Slowly pour slurry into the hole to approximately 1/2 depth. Slowly insert the sensor into the hole, rotating in one direction while pressing down; the speed should not be too fast to ensure complete air bubble expulsion. Do not pull the sensor upward during this process. When installed to the correct depth, slurry should overflow around the device, with the sensor installation depth flush with the hole opening. Remove excess slurry beyond 3cm around the sensor to prevent caking that affects water infiltration.



Step 4: Power-on Debugging

Connect the power cable and RS485 communication cable. After powering on, the device will emit a prompt tone indicating successful startup. It is recommended to begin formal data collection after the slurry returns to normal condition.

6.3 Special Soil Installation Points

Sandy Soil Installation: Prepare no less than 5L of water. Before grouting, pour water into the hole to moisten the entire wall until water accumulates at the bottom, then proceed with standard grouting steps.

Clay Soil Installation: After extracting soil, remove impurities, soak the clay in water for more than 4 hours to soften, stir into viscous state, then grout.

7 Wiring Definition

Function Category	Wire Color	Definition
Power	Brown	Positive (10~30V DC)
	Black	Negative
Communication	Yellow (Green)	RS485-A
	Blue	RS485-B

Wiring Notes:

- RS485 bus communication distance up to 2000m maximum
- Device addresses on the same bus must not conflict
- A/B signal wires must not be reversed

8 Communication Protocol and Data Conversion

8.1 Communication Parameters

Parameter	Configuration
Coding Format	8-bit binary
Data Bits	8 bits
Parity	None
Stop Bits	1 bit
Error Check	CRC-16 (Cyclic Redundancy Check)
Baud Rate	2400/4800/9600 bit/s configurable, factory default 4800 bit/s

8.2 Data Frame Format

Utilizes ModBus-RTU communication protocol:

Master Inquiry Frame:

Address Code	Function Code	Register Start Address	Register Length	Checksum Low	Checksum High
1 byte	1 byte	2 bytes	2 bytes	1 byte	1 byte

Slave Response Frame:

Address Code	Function Code	Valid Byte Count	Data Area 1	Data Area 2	...	Data Area N	Checksum
1 byte	1 byte	1 byte	2 bytes	2 bytes	...	2 bytes	2 bytes

Function Code Description:

- `0x03`: Read register data
- `0x06`: Write register data

8.3 Register Address Table

Register Address	PLC/SCADA Address	Content Description	Function Code
0000H	40001	Layer 1 Soil Moisture (actual value × 10)	03/04
0001H	40002	Layer 1 Soil Temperature (actual value × 10)	03/04
0002H	40003	Layer 2 Soil Moisture (actual value × 10)	03/04
0003H	40004	Layer 2 Soil Temperature (actual value × 10)	03/04
0004H	40005	Layer 3 Soil Moisture (actual value × 10)	03/04
0005H	40006	Layer 3 Soil Temperature (actual value × 10)	03/04
0006H	40007	Layer 4 Soil Moisture (actual value × 10)	03/04
0007H	40008	Layer 4 Soil Temperature (actual value × 10)	03/04
0008H	40009	Layer 5 Soil Moisture (actual value × 10)	03/04
0009H	40010	Layer 5 Soil Temperature (actual value × 10)	03/04
003CH	40061	Angle (actual value × 100) or EC raw value	03/04
003DH-003EH	40062-40063	X-axis angle component (IEEE 754 floating point)	03/04
003FH-0040H	40064-40065	Y-axis angle component (IEEE 754 floating point)	03/04
0041H-0042H	40066-40067	Z-axis angle component (IEEE 754 floating point)	03/04
0043H-0044H	40068-40069	X-axis acceleration component (IEEE 754 floating point)	03/04
0045H-0046H	40070-40071	Y-axis acceleration component (IEEE 754 floating point)	03/04
0047H-0048H	40072-40073	Z-axis acceleration component (IEEE 754 floating point)	03/04
07D0H	42001	Device Address (1-247)	03/06
07D1H	42002	Baud Rate (0=2400, 1=4800, 2=9600 bit/s)	03/06

8.4 Data Conversion Formulas

Soil Moisture Conversion:

$$\text{Moisture}(\%) = \frac{\text{Register Value}}{10}$$

Soil Temperature Conversion:
When temperature $\geq 0^\circ\text{C}$:

$$\text{Temperature}(^\circ\text{C}) = \frac{\text{Register Value}}{10}$$

When temperature $< 0^\circ\text{C}$ (two's complement form):

$$\text{Temperature}(^\circ\text{C}) = \frac{\text{Register Value} - 65536}{10}$$

Tilt Angle Conversion (single-precision integer format):

$$\text{Angle}(^\circ) = \frac{\text{Register Value}}{100}$$

Soil Electrical Conductivity:
Register outputs raw ADC values; conversion requires calibration coefficients.

Floating Point Data Conversion (IEEE 754 standard):
For X/Y/Z axis angle and acceleration components, registers store 32-bit IEEE 754 floating point numbers in high-16-bit first, low-16-bit second format.

Conversion example:
If reading X-axis angle component registers 003DH-003EH yields `0x42B40000` (hexadecimal):

$$\text{Angle} = 90.0^\circ$$

9 Precautions

- This device is strictly prohibited from use as a safety device or emergency stop device, nor shall it be used for other applications where equipment failure may cause personal injury
- Use only for intended authorized purposes; technical manuals must be consulted prior to installation, operation, or maintenance
- Installation site should be relatively elevated to prevent rainwater backflow into the device causing short circuits or line failures
- During installation, ensure tight contact between sensor and soil, avoiding air bubbles that affect measurement accuracy
- When soil temperature is below 0℃, soil moisture and electrical conductivity readings are for reference only
- When using configuration software to modify address and baud rate, only one device may be connected to the bus
- Failure to use according to instructions or unauthorized removal, disassembly, or replacement of internal components will void the warranty

10 After-Sales Support

Warranty Period: 12 months from date of purchase (subject to valid purchase documentation).

Warranty Coverage: During the warranty period, if equipment itself has material or workmanship defects under normal use and maintenance conditions, free repair and parts replacement services will be provided after verification.

Lifetime Service: After the warranty period expires, lifetime paid repair services are available.

Non-Warranty Coverage:

1. Equipment damage caused by incorrect installation, use, or operation
2. Disassembly, repair, modification, alteration, or parts replacement by non-authorized technical personnel
3. Damage caused by negligent use or water/substance infiltration
4. Failures or damage caused by accidents or natural disasters
5. Failures caused by use beyond product operating parameters

11 Manufacturer Information

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12 Revision History

Version	Date	Description
V1.0	-	Initial release