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Tensiometer Soil Moisture Sensor

for Irrigation

User Manual

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1. Product Overview

Plant growth requires adequate soil moisture, and soil water content significantly impacts plant development. With the advancement of agriculture, demands for crop yield and quality continue to rise, necessitating precise irrigation cycles to determine optimal watering intervals. Soil tension sensors provide this critical irrigation timing. They clearly indicate to growers whether plants are water-deficient, how soon they will become deficient, and the frequency of irrigation. This enhances both crop yield and quality.

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In modern agriculture, soil tension sensors play a highly significant role. After collecting dynamic soil moisture content data from cultivated crops, these sensors enable more precise irrigation measures based on crop growth patterns. They not only record soil tension changes but also help growers continuously update soil environment data for specific crop varieties. This is crucial for improving crop varieties and enhancing both quality and yield. The product employs standard ModBus-RTU485 communication with a maximum transmission distance of 2000 meters. Constructed with transparent PVC plastic tubing, the device allows clear visibility of remaining water levels for convenient refilling. Suitable for locations requiring soil moisture and drought condition monitoring, it is widely used in agricultural crop cultivation to detect water deficiency and optimize irrigation practices.

1.1 Product Features

● The transparent PVC plastic tube housing allows direct observation of water levels, ensuring fast response times and effective sensing of soil conditions.

● Features a premium clay head for rapid water permeability, air impermeability, and high sensitivity.

● Unaffected by soil salt ions; agricultural activities like fertilizer application, pesticide use, and irrigation do not impact measurement accuracy.

● Utilizes standard ModBus-RTU485 communication protocol with a maximum transmission range of 2000 meters.

● Supports 10-24V wide-range voltage charging.

1.2 Technical Specifications

Power Supply Method	10-24V wide DC power supply
Transmitter Component Temperature Resistance	0 to ~+80° C
Measurement Range	-100 kPa to 0
Measurement Accuracy	±0.5 kPa (at 25° C)
Resolution	0.1 kPa
Housing Material	Transparent PVC plastic tubing
Protection Rating	IP67
Output Signal	RS485 (Modbus protocol)
Power Consumption	0.8W (at 24V DC supply)
Response Time	200ms

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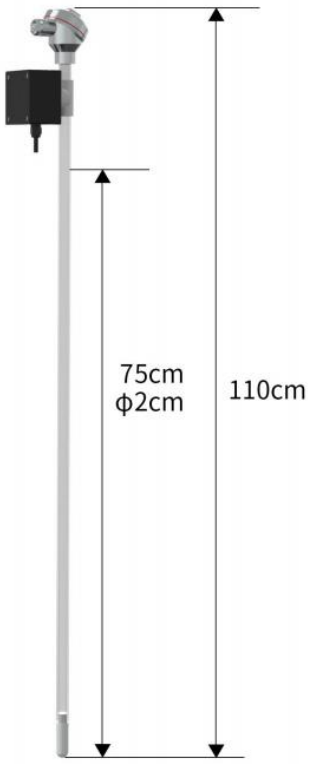
2. Equipment Installation Instructions

2.1 Equipment Dimensions and Monitoring Depth

The product employs a bottom-mounted monitoring structure. Insert the bottom of the device into the soil to the desired monitoring depth to measure soil tension at that depth (e.g., monitoring at 75 cm). As shown below:



2.2 Pre-Installation Equipment Inspection

2.2.1 Equipment List

Soil tension sensor: 1 unit
Certificate of conformity, warranty card, etc.: 1 set
USB to RS-485 converter: 1 unit (optional)
Soil drill: 1 unit (optional)
Self-prepared items list
Water, bucket, gloves, soil drill (select based on individual needs)

2.2.2 Equipment Usage Instructions

1. Prepare cool boiled water (air-free). Boil tap water for 20 minutes, then let cool for later use.
2. De-air the clay head: Unscrew the top cap, remove the silicone plug, fill with cool water to the brim, Stand the device upright for 10-40 minutes (without the cap) until water drips from the clay head surface. Replace the silicone plug, wrap the clay head with paper towels to absorb water, achieving soil tension around -40kPa. Observe rising bubbles; gently shake the device to expel air.

Repeat this process 2-3 times.

3. Submerge the clay head in water until soil tension recovers to within -10 kPa. Refill with water, reseal with the silicone plug, screw on the top end cap, and store for future use.

Additional Precautions:

1) Avoid oil contamination on the clay head to prevent micro-pore blockage and instrument failure.

2) The instrument's measurement range is -100kPa to 0kPa. Exceeding this limit may cause air leakage due to rupture of the clay head's tube wall, rendering the instrument inoperable.

3) Conduct regular inspections and refill the sensor with cool boiled water approximately every two weeks to one month (or when the water level drops to the point above the gas collection tube). Do not loosen the sensor during refilling.

4) Before temperatures drop below 0° C, bring outdoor instruments indoors to prevent freezing and cracking.

2.2.3 Installation Site Selection

● Install equipment after crop sowing;

● Select a flat terrain for installation;

● Under full irrigation conditions, prioritize areas receiving less water as monitoring locations; under partial irrigation conditions, choose locations within moist zones;

● Select sites where crop growth is balanced and representative of the majority of crop development;

● Understand the root distribution of the monitored crop; generally select locations near the crop's water-absorbing roots.

Note: Install equipment at relatively elevated terrain to prevent rainwater backflow into the device, which may cause short circuits or wiring failures.

2.3 Installation Method

Step 1: Drill holes at suitable locations using a soil auger

1. Position the 20mm diameter soil auger vertically on the ground. Grip the handle firmly with both hands and apply downward pressure while rotating clockwise slowly. (Caution: Avoid excessive force. Ensure slow, multiple rotations to prevent the drill bit from deviating and creating a crooked hole.)

2. Remove the auger from the hole and place it into a bucket. Collect the soil from the auger into the bucket for use in the next step to create slurry.

3. Repeat the drilling and soil collection process. During this, gently test-fit the sensor into the hole (do not force the device to bottom out) to verify the hole depth is adequate. If resistance occurs, adjust the hole with the auger to ensure smooth insertion and removal of the sensor. Continue until the hole depth aligns with the sensor's marked installation level, completing the drilling.

Step 2: Preparing the Slurry

1. Remove impurities from the soil, such as stones, grass roots, and hard-to-dissolve clumps. Rub the soil finely to facilitate mixing with the slurry.

2. Add an appropriate amount of water and stir thoroughly until a viscous consistency is achieved; loam slurry should generally not be thicker than sesame paste. Slurry preparation is complete.

Step 3: Grouting Installation

1. Slowly pour the slurry into the hole, filling it approximately halfway. Adjust the amount as needed based on actual conditions.
2. Carefully lower the sensor into the hole, rotating it slowly in one direction while applying downward pressure. Moving too quickly may prevent air bubbles from being fully expelled. (Note: Do not pull the sensor upward during rotation and pressing to prevent air from being sucked back into the hole.)
3. Once the sensor reaches the correct depth (zero calibration line flush with ground level), excess grout will overflow around the device, indicating completion. (Note: Remove any excess grout beyond 3 cm around the sensor to prevent clumping that could impede water infiltration.)

Step 4: Installation Complete

After connecting the device to the power supply and 485 communication cable, power it on for 24 hours before initiating data collection.

1. Sand Soil Installation Guidelines

Sand soil installation follows the same standard procedure as loam soil, with the key requirement of preparing sufficient water. Before grouting, pour water into the borehole to saturate the entire borehole wall until excess water appears at the bottom. Then, following the steps, slowly pour the slurry into the borehole until it reaches approximately half the borehole depth. The remaining installation steps are identical to those for loam soil.

2. Installation Key Points for Clay Soil

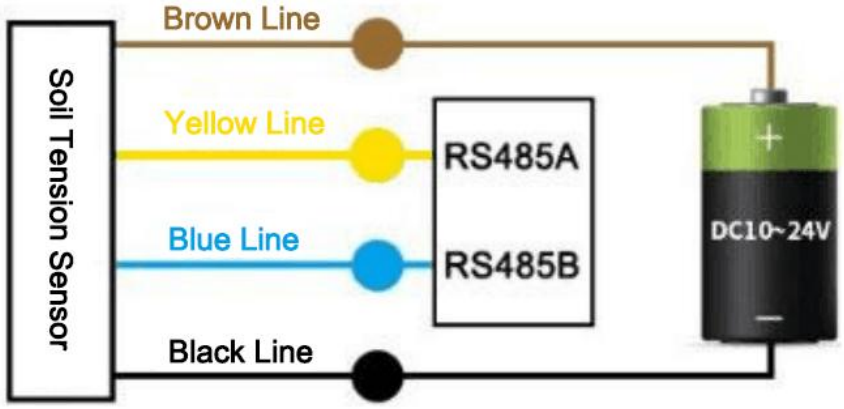
After drilling and collecting soil from clay soil, clean out impurities. Soak the clay in water for over 4 hours to soften it, facilitating the formation of a relatively uniform slurry. After soaking, stir it into a viscous consistency and proceed with grouting. The remaining installation steps follow the procedure for loamy soil.

2.4 Product Wiring Instructions

Power Supply and 485 Signal

Wide voltage power supply input supports 10~24V. When connecting the 485 signal lines, ensure the A and B lines are not reversed. Addresses must not conflict between multiple devices on the bus.

Category	Wire Color	Description
Power Supply	Brown	Power Positive (10－24V DC)
	Black	Power Negative
Communication	Yellow (Green)	RS485-A
	Blue	RS485-B



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3. Communication Protocol

3.1 Basic Communication Parameters

Encoding	8-bit binary
Data bits	8-bit
Parity bit	None
Stop bit	1-bit
Error checking	CRC (Cyclic Redundancy Check)
Baud rate	Configurable at 2400 bit/s, 4800 bit/s, 9600 bit/s; factory default is 4800 bit/s

3.2 Data Frame Format Definition

Using the ModBus-RTU communication protocol, the format is as follows:

Initial structure ≥4 bytes of time

Address code = 1 byte

Function code = 1 byte

Data area = N bytes

Error check = 16-bit CRC code

End structure ≥4 bytes of time

Address Code: Represents the transmitter's address, unique within the communication network (factory default 0x01).

Function Code: Indicates the command function issued by the host. This transmitter uses function codes 0x03 (read register data) and 0x06 (write register data).

Data Field: Contains the actual communication data. Note: For 16-bit data, the high byte precedes the low byte!

CRC Code: A two-byte error detection code.

Host Inquiry Frame Structure:

Address Code	1 byte
Function Code	1 byte
Register Start Address	2 bytes
Register Length	2 bytes
Low-Order Parity Bit	1 byte
High-Order Parity Bit	1 byte

From-machine response frame structure:

Address Code	1 byte
Function Code	1 byte
Number of Valid Bytes	1 byte
Data Area 1	2 bytes
Data Area 2	2 bytes
Data Area N	2 bytes
Checksum	2 bytes

3.3 Register Address

Register Address	0000 H	0001 H
PLC or Configuration Address	40001	40002
Content	Soil Tension Value (16-bit signed number, actual value multiplied by 10)	Soil Tension Value (16-bit signed number, actual value multiplied by 10)
Function Code (Hexadecimal)	03/04	03/04

3.4 Communication Protocol Examples and Explanations

Example: Reading the soil tension value from device address 0x01

Interrogation Frame (Hexadecimal):

Address Code	0x01
Function Code	0x03
Start Address	0x00 0x00
Data Length	0x00 0x01
Low-Order Parity Bit	0x84
High-Order Parity Bit	0x0A

Response Frame (Hexadecimal): (e.g., reading a tension value of -10.1 kPa)

Address Code	0x01
Function Code	0x03
Number of Valid Bytes Returned	0x02
Tension Value	0xFF 0x9B
Low-Order Parity Bit	0xB8
High-Order Parity Bit	0x1F

Tension Calculation:

Tension data is uploaded in two's complement format.

FF9B is hexadecimal, converted to decimal as -101. Tension value = Reading value * 0.1 = -101 * 0.1 = -10.1 kPa

Tension value: FF9B (hexadecimal) = -101 => Tension value = -10.1 kPa

4. Common Issues and Solutions

Device cannot connect to PLC or computer

Possible causes:

1) Computer has multiple COM ports; incorrect port selected

2) Incorrect device address, or duplicate addresses among devices (factory default is all set to 1) 3) Incorrect baud rate, parity mode, data bits, or stop bits. 4) Disconnected 485 bus or reversed A/B

wires.

5) Excessive device count or cable length. Use local power supply, add 485 repeater, and install 120Ω terminating resistor.

6) Missing or corrupted USB-to-485 driver.

7) Device malfunction.

5. Precautions

WARNING: Risk of personal injury. This device must not be used as a safety device or emergency stop device, nor for any other purpose where device failure could cause personal injury.

Use Restriction: Use only for the intended and authorized purpose. Consult the technical manual before installation, operation, or maintenance. Failure to follow these instructions may result in death or serious injury.