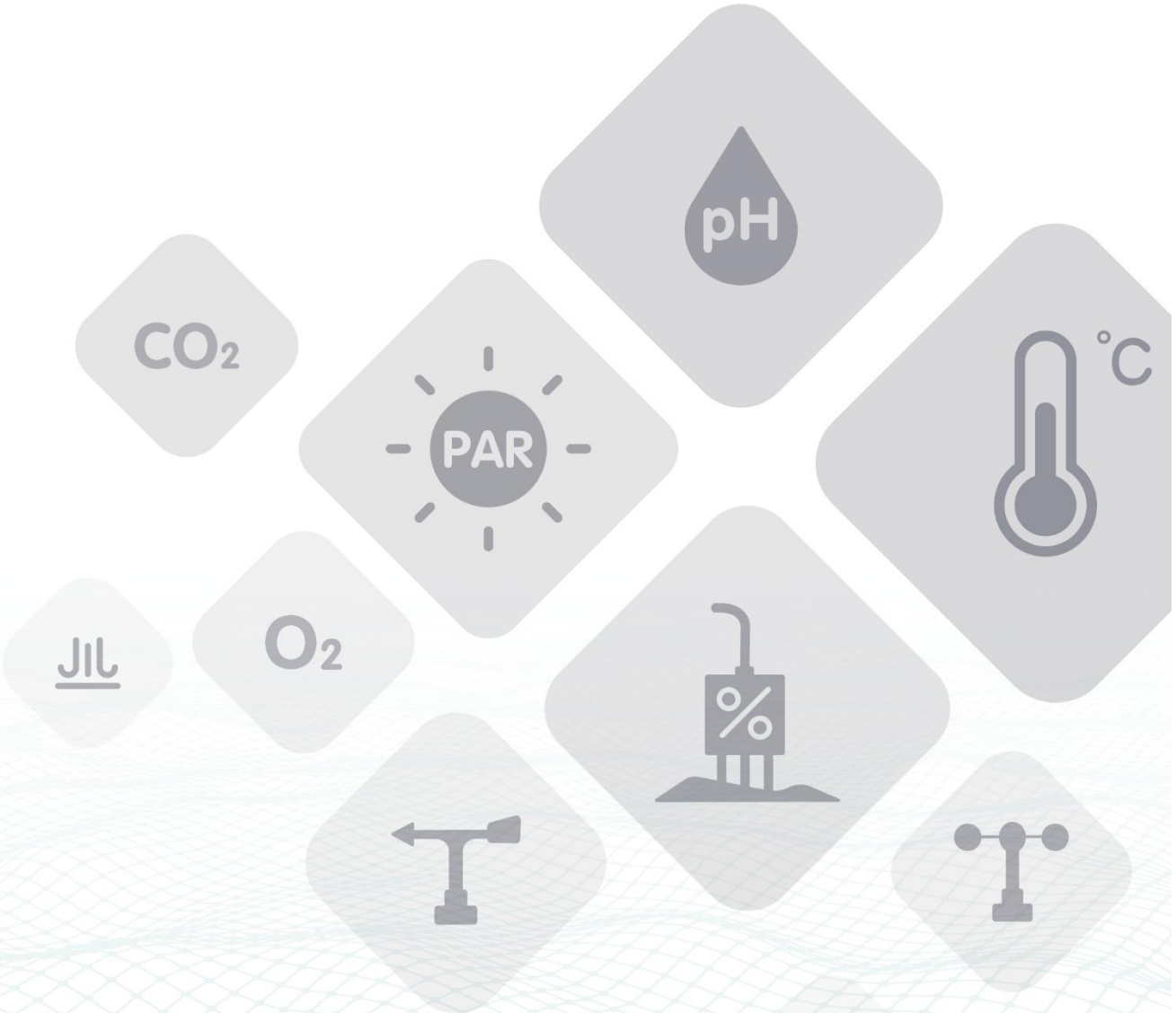
SENSECAP

Soil Moisture & Temperature Sensor User Manual

Product Model: S-Soil MT-02

Version: V2.1



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1 Introduction

The S-Soil MT-02 soil moisture & temperature sensor is provided with high accurate and high sensitive. By measuring the dielectric constant of the reaction of soil, soil direct stable real moisture content. This S-SOIL MT-02 soil moisture & temperature sensor can measure the volume of soil moisture. the soil moisture measurement method is in line with international standards at present. Apply to the soil moisture monitoring, scientific experiment, water-saving irrigation, greenhouse vegetables, flowers, grass, soil, plant cultivation, measured speed of sewage treatment, grain storage, greenhouse control, precision agriculture, at the same time in the measurement of water, weather and particulate matter content.

Features:

- High measuring accuracy, fast response, good interchangeability
- Good sealing performance, corrosion resistance, long buried in soil using
- The flame retardant epoxy resin curing, completely waterproof, can withstand the strong external shocks
- Needle using quality materials, can withstand long-term electrolysis, can withstand the corrosion of acid and alkali in the soil
- High measuring precision, reliable performance, the effects of soil salt content is small, suitable for all kinds of soil
- Having power reverse protection

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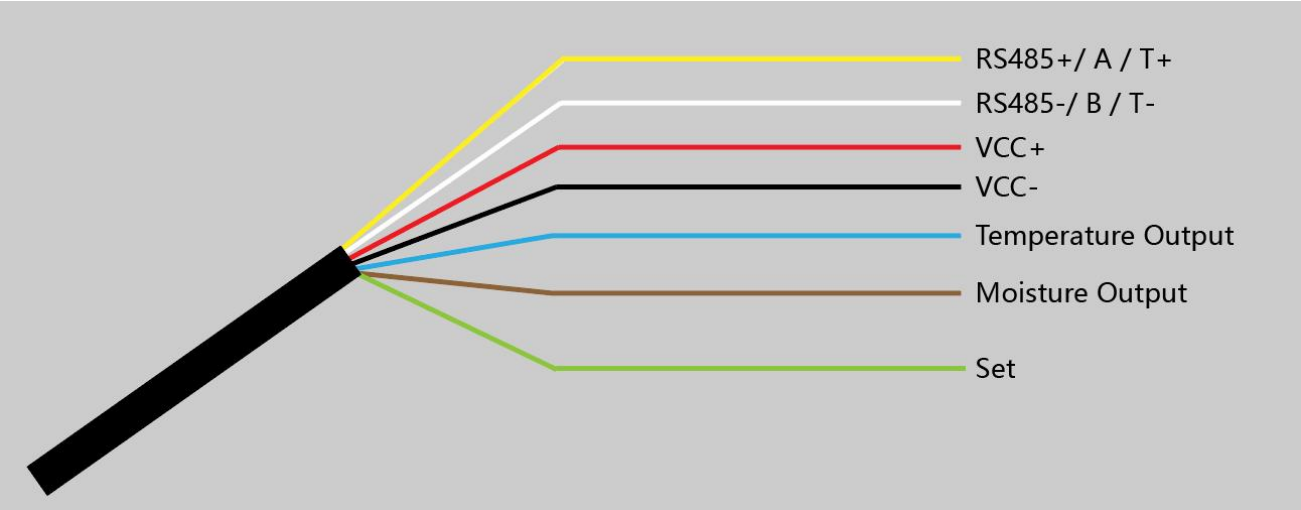
2 Specifications

Soil Temperature		
Range	-40 ℃ to +80 ℃	
Accuracy	± 0.5℃	
Resolution	0.1 ℃	
Soil Moisture		
Range	From completely dry to fully saturated (from 0% to 100% of saturation)	
Accuracy	± 3% (0~53%); ± 5% (53~100%)	
Resolution	1%	
General Parameters		
Product Model	S-Soil MT-02	
Interface	RS-485	0-2V voltage
Protocol	MODBUS-RTU RS485	-
Power Supply	3.6 ~ 30V DC	3.9 ~ 30V DC
Current Consumption	6mA @24V DC; Avg.current:<10mA @5V DC; Peak inrush current:<40mA@ 5V DC (≤5 ms)	
Measuring Area	A cylinder area (with the probe as the center, diameter: 7cm, height: 7cm)	
Response Time	Less than 1 second	
IP Rating	IP68	
Cable Length	5 meters	
Operating Temperature	-40 ~ 85℃	
Storage Temperature	-40 ~ 85℃	
The material of the probe	Food grade stainless steel	
Sealing material	The black flame retardant epoxy resin	
Installation	All buried or probe into all of the measured medium	
Device Weight	270g	

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3 Wiring



Yellow	RS485+/A/T+
White	RS485-/B/T-
Red	VCC+, power supply
Black	VCC-, power ground
Blue	Temperature Output
Brown	Moisture Output
Green	SET, V+ (power) when boot module into the "setting mode". Not connected or connected with the GND when boot into "mode of operation". Module configuration parameters such as Modbus address, baud rate, parity, communication protocol is composed of module inside the EEPROM (power down storage device stores). The specific configuration sometimes forget these parameters that cannot communicate with the module. In order to prevent this problem, the module has a special mode called "mode". When the module is based on the "mode" electric start, the module communicates with the following parameters: Fixed Modbus address 0 Communication configuration is 9600, N, 8,1 (9600bps, no parity bit, 8 data bits, a stop bit) Communication protocol for Modbus-RTU Configuration parameters in EEPROM will not because the module into the "mode" and "will change, when the module is in communication with in the EEPROM configuration parameter is still running mode".

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4 Installation

Rapid measurement method: the selected measurement locations, the right to avoid the rocks, to ensure that the needle will not touch the stones like hard object, according to the required depth of cut open the surface soil, maintain the tightness degree of the original soil below the sensor body, clenched vertically inserted into the soil, can not be inserted before and after shaking, ensure the close contact with the soil. A measuring point within a small range test should repeatedly averaging.

Buried in the underground measurement method: vertical drilling diameter greater than 20 cm depth of pit, according to the measurement needs, then the sensor wire inserted into the pit wall in a given level of depth, the pit landfill compaction, ensure the close contact with the soil. Stable after a period of time, can be last for days, months or even longer to measure and record.

If the surface measurement is hard, should first hole (diameter should be less than the diameter of the probe), and then inserted into the soil and the soil compaction and measurement; sensor should prevent violent vibration and impact, but not with a hard object percussion. Because the sensor for black package, in the strong sunlight will make the sensor to make sharp warming (up to over 50 DEG C), in order to prevent the temperature measurement of high temperature impact sensor, please pay attention to sun protection in the field or fields.

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5 Output

Model	The parameter range	conversion relation
Output voltage 0-2V	corresponding temperature of -40-80 °C	Temperature =60.0* voltage -40. If the measured voltage is 1.5V, the temperature of =60.0*1.5-40=50.00 °C.
	volumetric water content corresponding 0-100%	volumetric moisture content=0.5* voltage . If the measured voltage is 1.5V, the volumetric water content was =0.5*1.5=0.75=75.0%.
RS485 interface, Modbus protocol	corresponding temperature of -40-80℃	Temperature = temperature register value /100. If the read data is 2013, then the temperature = 2013/100=20.13 C.
	volumetric water content corresponding 0-100%	Volumetric water content = volumetric moisture content register value /10000. If the read data is 1568, then the temperature = 1568/10000=15.68%.
Custom		The output of models, please contact technical support.

Note: The unit of voltage formula for V (V)

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6 Modbus Communication Protocol

6.1 Serial communication parameters

Modbus is a serial communication protocol, Modicon programmable logic controller (PLC) for the use of published. It has become the industry standard communication protocols, and is now quite common connection between industrial electronic equipment. Modbus has extensive application in the industrial field. Modbus protocol is a master / slave framework agreement. A node is the master node, other nodes using the Modbus protocol in communication from node. Each slave device has a unique address.

Communication parameter default value: baud rate is 9600bps, a start bit, 8 data bits, no parity, one stop bit. Communication protocol for the Modbus RTU protocol. Communication parameters can be set by the program or the Modbus command to change.

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6.2 Modbus Register

Parameter	Register address (HEX) Channel 0	Parameter Type	Modbus Function Number	Range of Parameters and instructions	default
Temperature	0x0000	INT16,read only	3/4	-4000-8000 Divided by 100 to obtain the actual temperature value. No temperature measurement model the readout value is always 0.	no
Volumetric moisture content	0x0001	INT16,read only	3/4	0-10000 Water volume is divided by 10000 to obtain the actual rate.	no
Retain	0x0002	INT16,read only	3/4	Always 0	no
Retain	0x0003	INT16,read only	3/4	Always 0	no
Volumetric water content was the original AD value	0x0004	INT16,read only	3/4	Volumetric water content was the original AD value	no
Retain	0x0005	INT16,read only	3/4	Always 0	no
Retain	0x0006	INT16,read only	3/4	Always 0	no
Retain	0x0007	INT16,read only	3/4	Always 0	no
Soil Type	0x0020	UINT16,read only	3/6/16	0-3 0:Mineral soil (tillage) 1:Sand 2:Clay 3:Organic soil	0:Mineral soil (tillage)
Modbus Address	0x0200	UINT16,Read and write	3/6/16	0-255	1 or 17
baud rate	0x0201	UINT16,Read and write	3/6/16	0-7 0:1200bps 1:2400bps 2:4800bps 3:9600bps 4:19200bps 5:38400bps 6:57600bps 7:115200bps	3:9600bps
protocol	0x0202	UINT16,Read and write	3/6/16	0~1 0:Modbus RTU 1:Modbus ASCii 2:ADAM Advantech protocol 3:ADAM Advantech protocol (with parity)	0:Modbus RTU
parity	0x0203	UINT16,Read and write	3/6/16	0-2 0:No parity	0:No parity

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				1:Even parity 2:Odd parity	
data bits	0x0204	UINT16,Read and write	3/6/16	1 1:8 data bits	1:8 data bits
Stop bits	0x0205	UINT16,Read and write	3/6/16	0-1 0:1 stop bits 1:2 stop bits	0:1 stop bits
Response delay	0x0206	UINT16,Read and write	3/6/16	0-255 The host request command is received after a delay time and response. The delay time for the set value of *10 Ms. When set to 0 without delay.	0
active output interval	0x0207	UINT16,Read and write	3/6/16	0-255 Does not need the host request, to automatically send data fixed time interval. The time interval for the setting value * 1. Set to prohibit active output function 0.	0
Note: UINT16:16 bit unsigned integer register INT16:16 bit signed integer register UINT32:32 bit unsigned integer register UINT32:32 bit signed integer register BIT: bit register					

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6.3 Detail of Modbus Register

Soil Temperature		
parameter range	-4000-8000	Default: none
parameter storage	none	
Significance: the measured value of the temperature, negative for complement representation. Example: if the return value is 0702H (16 m, the original code), the first byte byte second byte 07H, low byte is 02H, then the temperature measurement value of (07H*256+02H) /100=17.94 C. If the return value is FF05H (16 m, complement), the first byte byte second byte FFH, low byte is 05H, then the temperature measurement value ((FFH*256+05H) -FFFFH-1H) /100 = (FF05H-FFFFH-1H) /100=-2.51 C.		

Soil Volumetric Water Content		
parameter range	0-10000	Default: none
parameter storage	none	
Significance: volumetric water content measurements. Example: if the return value is 071DH (16 m), the first byte byte second byte 07H, low byte is 1DH, then the volumetric water content was measured (07H*256+1DH) /100= (7*256+29) /100=18.21. representative volume water content is 18.21%.		

Volumetric Water Content Raw AD		
parameter range	Not fixed	Default: none
parameter storage	none	
Significance: volumetric water content was the original AD value. Example: if the return value is 071DH (16 m), the first byte byte second byte 07H, low byte is 1DH, then the volumetric water content was the original AD value was (07H*256+1DH) = (7*256+29) =1821.		

Soil Type		
parameter range	0-3	Default: none
parameter storage	Immediate memory	
Significance: soil type. 0: mineral soil (tillage soil) 1: sand 2: clay 3: organic soil Example: if the return value is 071DH (16 m), the first byte byte second byte 07H, low byte is 1DH, then the volumetric water content was the original AD value was (07H*256+1DH) = (7*256+29) =1821.		

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Modbus Address		
parameter range	0-255	Default:1 or 17
parameter storage	Immediate memory	
The Modbus address, can be set to 0-255. When the module external address code switch is set to address 0, use this register contents as the slave address. After setting the need to power on or use the RST command to restart module, make this address in force. Use this command to modify the module address does not need to open the cabinet can be set.		

Baud Rate		
parameter range	0-7 0:1200bps 1:2400bps 2:4800bps 3:9600bps 4:19200bps 5:38400bps 6:57600bps 7:115200bps	Default:3
parameter storage	Immediate memory	

Protocol		
parameter range	0~1 0:Modbus RTU 1:Modbus ASCII	Default:0
parameter storage	Immediate memory	

Parity		
parameter range	0-2 0:No parity 1:Even parity 2:Odd parity	Default:0
parameter storage	Immediate memory	

Data Bits		
parameter range	1 1:8 data bits	Default: 1, only supports 8 bits of data, the other is invalid
parameter storage	Immediate memory	
Stop bits		
parameter range	0-1 0:1 stop bits	Default:0

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	1:2 stop bits	
parameter storage	Immediate memory	
Response Delay		
parameter range	0-255	Default:0
parameter storage	Immediate memory	
Serial communication delay in response to a user in the following cases: when the host sends a request command module, delay (RESPONSEDELAY*10) ms, then the response data is returned to the host computer. For example, set the RESPONSEDELAY=5, then the module delay 5*10=50 ms after the response of host requests. When set to 0 for no delay immediate response. This command is mainly applied to the host from the sending State RS485 switch to slow the receiving state occasions.		

Active Output Interval		
parameter range	0-255	Default:0
parameter storage	Immediate memory	
Serial communication active output time interval used in the following cases: the host does not need to send a request command, module active output response data, output interval for ACTIVEOUTPUTINTERVAL seconds, such as setting the ACTIVEOUTPUTINTERVAL=5 module, then every 5 seconds according to the communication protocol of the output data set. When set to 0 active output invalid, need a host requests before response. This command is mainly used in GPRS wireless transmission, need to terminal nodes initiatively sends data occasions. Note: when set to the active output data, RS485 bus can connect a module, in order to avoid data conflict.		

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6.4 CRC16 Validation and Sample Code

For example: 0x0000H-0x0001H read registers, measuring temperature, volumetric water content values

Request: 01 03 00 00 00 02 C4 0B (8 bytes)

Device address	1 byte	0x01
Function number	2 bytes	0x03
starting register address	2 bytes	0x0000
number of registers	2 bytes	0x0002
Check	2 bytes	0xC40B

Request: 01 03 04 07 02 07 1D E1 7E (9 bytes)

Device address	1 byte	0x01
Function number	1 byte	0x03
effective number of bytes	1 byte	0x04
Data	4 bytes	0x07 (high temperature byte)
		0x02 (low temperature byte)
		0x07 (high volume water content byte)
		0x1D (low volume water content byte)
check	2 bytes	0xE17E

When the 9 bytes of data receiving equipment return, the following CRC computations, where num (parameter 2) = 9.

```
//------------------------------------------------------------------------

//CRC calculation of C51 language function is as follows

/ / input parameters of 1:snd, to check the byte array name

/ / input parameters of 2:num, the total number of bytes to be calibrated. (2 bytes including CRC check)

/ / function return value: return a value other than 0 check failed. Check back 0.
//------------------------------------------------------------------------
unsigned int calc_crc16 (unsigned char *snd, unsigned char num)
{
unsigned char i, j;
unsigned int c,crc=0xFFFF;
for(i = 0; i < num; i ++)
{
c = snd[i] & 0x00FF;
```

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```
crc ^= c;
for(j = 0;j < 8; j ++)
{
if (crc & 0x0001)
{
crc>>=1;
crc^=0xA001;
}
else
{
crc>>=1;
        }
}
}
return(crc);
}
```

To get results back to 0 then the verification is successful, if the validation fails to return to a non-zero value.

After the successful calibration, use the following formula to calculate the temperature and volumetric moisture content (negative to complement representation):

When the temperature = (07H*256+02H) /100=17.94

The volumetric moisture content = (07H*256+1DH) /10000= (7*256+29) /10000=18.21%

If the check fails, the error transfer process, should abandon the collected data, re collection.

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7 Document version

Version	Date	Description	Editor
V2.0		First Version	
V2.1	07/03/23	Modify Soil Volumetric Water Content	Yvonne.Meng

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