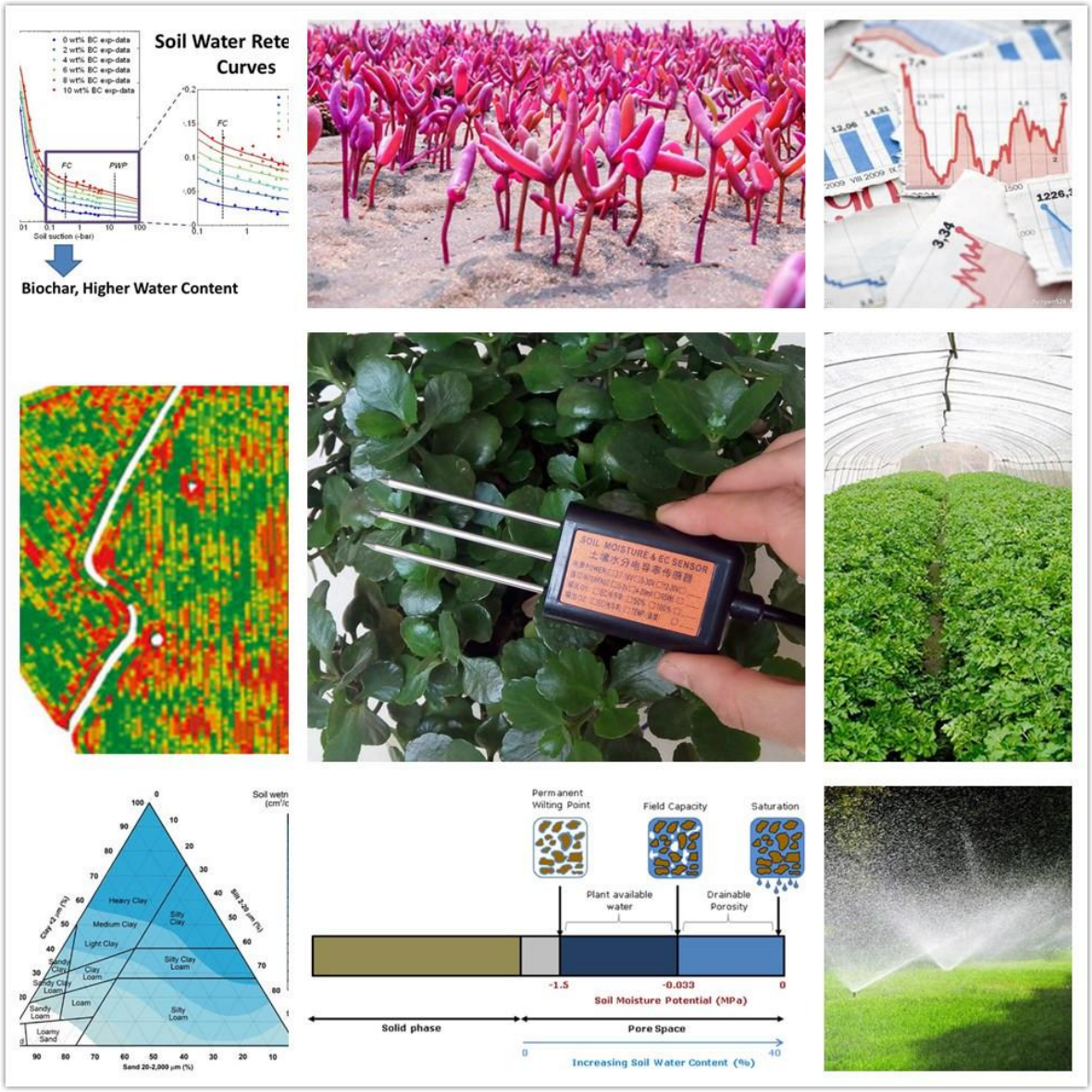
MEC10 Soil Moisture & Temperature & EC Sensor User’s Manual



Catalog

1 Technical support

Thank you for choosing and using the MEC-10 soil moisture & temperature & EC sensor of Dalian Endeavour Technology Co., Ltd., this user's manual to help you understand and use the sensor correctly. If you need to order products, technical supports, and product information feedback, please contact us by the following ways. Please note the time of purchase, purchase way, contact information, address, telephone and other related information, so that we can serve you.

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2 Introduction and background knowledge

2.1 Background knowledge

2.1.1 Effects of soil electrical conductivity (salinity) on plants

The effects of soil salinity on plant growth are various, mainly in the following aspects：

(1) Physiological drought. Too much soluble salt in the soil, The soil water potential was decreased with the increase of osmotic potential. Based on the principle that water flows from high water potential to low water potential, the water potential of the root cell must be lower than the water potential of the surrounding medium, so the soil salinity is higher, the root water absorption is more difficult. The body of water is dangerous and even extravasations. Thus, the general expression of salt damage is actually a drought disaster, especially in the case of low relative humidity of the atmosphere. As evaporation strengthened, salt damage is more serious, the abnormal growth of plants, Plant short stature, leaf small dark green, like drought.

（2） Toxic effect of ions.Plants have been excluded from the absorption of other nutrients because of absorbing excessive certain salts.

（3） Destruction of normal metabolism. Too much salt can inhibit the synthesis of chlorophyll and the occurrence of various enzymes in the photosynthetic apparatus, especially effects the formation of chloroplast in. Crops grown in soils with too much salt,The average net photosynthetic rate is lower than that of the plant. Chloroplast is the main site of photosynthesis in plants. The content of chlorophyll is a physiological index reflecting the intensity of photosynthesis in plants. Under the salt stress, the effect of plant photosynthesis is mainly on Chloroplast. Plants cannot absorb enough water and mineral nutrients, resulting in poor nutrition, and low chlorophyll content, affecting photosynthesis. In addition, the enzyme activity decreased and the chloroplast tended to break down, and the chlorophyll was destroyed. The biosynthesis of chlorophyll and carotenoid was blocked, stomata closure, so that the photosynthetic rate decreased, affecting crop yield.

（4） Effect on membrane structure of plant cells. Salt stress directly affects the membrane lipid and membrane protein, the membrane permeability increased and membrane lipid per oxidation, Thereby affecting the normal physiological function of the membrane. Normal condition, cell wall and plasma membrane are exposed to each other; contraction of plasma membrane during loss of water, because of the plasma membrane is different from the cell wall, "Tear" deformation of wall, the intracellular free calcium concentration was increased, plant active oxygen burst. Salt stress causes cell loss of water, the cell swelling and osmotic pressure changes.

（5） Protein synthesis of crops. The effect of excessive salt on protein metabolism is obvious. Inhibition of synthesis promoting decomposition, the direct reason for the inhibition of protein synthesis may be due to the destruction of the synthesis of amino acids, Such as beans under salt stress in leaves of cytokine and methionine synthesis decreased, so as to reduce the protein content, to produce toxic substances, salt threatens to force the plant to accumulate toxic metabolites, the accumulation of free amino acids, amines, amino acids, such as the product of protein decomposition, these substances are toxic to plants, resulting in poor growth of plant leaves, inhibited root growth, tissue necrosis and so on.

2.1.2 Significance of measurement of soil conductivity (salinity)

The soil total salt is said the total content of salt in the soil. Due to the various salts in soil leachate generally exists in the form of ions, So the total salt can also be expressed as the amount of soil leaching liquid of all kinds of cationic and anion. In recent years, The soil total salt increases year by year, So make the soil acidification and secondary salinization, This is mainly due to the perennial cover or seasonal soil cover changed the water under the natural state of thermal equilibrium（High temperature, lack of strong rainwater leaching, evaporation）,soil is not fully washed out of the rain, salt gathering on the soil surface ,also caused by fertilization. In the analysis of soil,salt is an important comprehensive index,and determination of conductivity can directly reflect the soil salinity in the soil. Therefore, to monitor the soil electrical conductivity able to grasp its pollution situation is very necessary.

The soil electrical conductivity is the indispensable parameter in the precision agriculture; it contains the soil quality and the physical properties of information. For example: salt, moisture, temperature, organic matter content in the soil and texture structure is different degree affects the soil electrical conductivity. Effective access to the soil electrical conductivity,to determine the various parameters of time and space distribution in field is significant,thus for the popularity of modern precision agriculture based on the information and knowledge promotion to lay the foundation.

（1）Understanding of water and salt dynamics and its harm to crops, provide reference for the prediction of soil salt, the forecast, in order to take effective measures to ensure normal crop growth.

（2）Understand the comprehensive control measures the effect of saline soil.

（3）According to the soil salt content and its composition, saline soil classification, and make reasonable planning, in order to achieve reasonable planting, the purpose of reasonable irrigation and drainage.

（4）For irrigation water quality appraisal, determination of the salt content in irrigation water, so that the rational utilization of water resources, land reclamation, prevent soil salinization.

2.1.3 Plants were judged by salt stress

The higher soil electrical conductivity of the EC value, show that the greater the concentration of soluble salt ions in the soil, thus it is possible to form a reverse osmosis pressure, the plant roots in the water replacement, so that the root tip is damaged, and then lose the ability to absorb water and nutrients, which is excessive fertilization will cause the burning of the cause of the seedlings.

（1）Aboveground symptoms: Wilting, chlorosis, necrosis or dwarf symptoms.

（2）Root symptoms: Root browning, mild dry root, no hair, serious when the root rots necrosis. High EC value of the soil will also increase the incidence of root rot (cotton rot pathogen). When the plants grow slow or stop the growth, avoid blindness in fertilizer nutrition. First of all, we should observe the situation in roots, combined with the characteristics of matrix and the situation of water and fertilizer management judgment, the soil electrical conductivity (salinity) test of soil EC Value. When the absorption capacity of plant roots decreased, the unreasonable fertilization

would lead to the accumulation of soil salinity and accelerate the death of the plant； Secondly, use the lower of EC value irrigation to flush the soil, in order to achieve the purpose of reducing the concentration of soil salt; Third, it can be appropriate to use the rooting agent, to promote the growth of plant roots, to accelerate the plant to return to normal.

2.1.4 Conductance and salinity measurement

Usually electrical conductivity EC (Conductivity Electrical) is used to measure the concentration of soluble salts in the solution of the indicators, units per meter for the SIEMENS S/m (1S/m=10mS/cm = 10000uS/cm = 10dS/m).The conductivity and temperature of the soil can be determined by measuring the conductivity and temperature of the soil substrate or nutrient solution depending on the nature of the temperature and salinity. The EC value of the measurement temperature is usually 25 degrees Celsius, the same solution, the lower temperature of the measurement EC value is lower.Under normal temperature condition,, The variation of electrical conductivity of each phase is about 2% .

The conductivity and salinity are approximately linear, its proportion is based on temperature 25 ℃, the proportion is:1 S/cm=0.55 ~ 0.75mg/l salt content. At other temperatures, it is necessary to be adjusted, that is, the temperature of each change 1℃, the salinity of about 1.5-2%.

The temperature is higher than 25 ℃ with negative, temperature lower than 25℃ with positive. So the salt can be estimated according to the electrical conductivity.

2.1.5 Effect of soil moisture on plant

Moderate moisture is an important condition for plant growth, too much water or lack of water will be affected by the following aspects.

（1）Effects on plant morphology

Plant photosynthesis and dry matter accumulation by water supply, the amount of accumulation is directly reflected in the plant height, stem diameter, leaf area and yield formation. Individual plants suffered from water stress after the low photosynthetic leaf area decreased, yield

decreased.

（2）Effect on leaf change

Leaves are the main places for photosynthesis and transpiration. The mesophyll cell expansion and leaf growth is very sensitive to water conditions. Leaves to stay standing state, both rely on the cellulose support, but also to rely on the support organization in higher turgor, wilting phenomenon of water when the plant is the turgor pressure decreased performance.

（3）Effect on Yield Formation

Crop yield is the accumulation of solar energy into chemical energy on the crop. Soil moisture content affected the plant root water uptake and transpiration, which affected the accumulation of dry matter, and ultimately affected the yield of crops.

（4）The influence of moisture on root development

Plant root is the main organ of water absorption, its development is affected by many aspects, but the main function are soil moisture condition and ventilation condition. The vertical distribution of soil water status of root, when the soil moisture content is higher, Root diffusion is affected by soil resistance, it helps the new root formation, root developed. Soils usually contain some usable water, so the root itself not prone to water deficit. When the soil is dry or the water supply is insufficient, the root system absorbs the limited water. First, it meets the needs of its own, and to the ground part of the transmission is very little. Therefore, the impact of soil moisture on the ground is greater than the impact of the underground. Root cap ratio increases. On the contrary, if too much soil moisture, poor soil aeration condition, the impact on the underground section is greater than that of the ground. Root ratio decreased. Moderate and slow water deficit can increase the absolute root weight, inhibition of aerial part growth, reduce the aboveground dry matter accumulation, yield decreased, but is conducive to planting, so as to improve the total yield. Research has shown that a certain period of water deficit is helpful to improve the yield and quality. Late prophase drought can enhance ability of drought resistance in seedling of mild drought could promote root growth of "compensation", Enhancing drought resistance of plants.

（5）influence on photosynthesis

Photosynthesis is the main source of energy for green plants. The size of photosynthetic rate is closely related to the water status of plants. Experiments show that when the plant tissue water approaches saturation, the strongest photosynthetic; too much water, saturated water content, stomatal passive off, photosynthesis was inhibited. Lack of water, photosynthesis decreasing; serious water shortage to leaf wilting, photosynthetic decline sharply, or even stop. Soil water status also affected the photosynthesis of plants. The soil water content decreased, the water potential was decreased, the stomatal resistance increased, and the diffusion resistance of the leaves increased, the CO2 diffusion was blocked, and the photosynthetic rate decreased.

（6）Effect of organic matter transport

As the water supply decreased, the leaf water potential decreased, and the assimilation of material from the source to the phloem decreased. One reason is the decrease in leaf water potential, photosynthetic rate decreased, mesophyll cells can be transported out of the sucrose concentration becomes lower. On the other hand is due to the decrease in the velocity of longitudinal movement of the sieve tube collector. Water is the medium in which the material is transported, and it is also directly involved in some of the biochemical reactions. Usually crop fruit expanding stage and grain filling period of water shortage, due to obstruction of photosynthesis and transport, fruits and seeds can not accumulate sufficient organic matter and become thin withered. Therefore, irrigation can accelerate the transport of organic matter under drought conditions. However, too much water is not conducive to the transport of organic matter, which is mainly caused by excessive water and soil aeration, affecting the respiration and other metabolic processes.

（7）Effect of mineral elements on absorption and transport

Mineral elements must be dissolved in water to be absorbed by plants. But the amount of water absorbed by plants and the amount of mineral salts are disproportionate, and the two types of absorption due to changes in the environment are very different. The plant's absorption of water and minerals is both relevant and irrelevant. Relevant side is the salt must be dissolved in the water to be absorbed by the plant roots, and with the water into the root of the plant; Irrelevant side is the absorption mechanism of the two is different. Water absorption is mainly caused by the passive

absorption of transpiration, and mineral absorption is mainly consumed by the active absorption of energy metabolism.

（8）Effect on Seed Germination

Water absorption is the main condition of seed germination. Only after absorbing enough water, the physiological and biochemical action related to germination can be started. This is because water can make the seed coat of swelling and softening, breathing oxygen easily penetrate and enhanced embryo. At the same time, the embryo is easy to break through the seed coat; moisture can enable protoplasts from gel state change into sol state, enhance the metabolism and in the role of a series of enzymes, endosperm storage substances gradually transformed to soluble materials, for the growth of embryo differentiation; water is available to facilitate transport of soluble material to the growing buds, roots, supply needs to breathe and the new cellular structure of the form.

2.2 Product Introduction

This MEC10 soil moisture & EC & temperature sensor is provided with high accurate and high sensitive. It is an important tool to observe and study the occurrence, evolution, improvement and the dynamics water of saline soil. By measuring the dielectric constant of the reaction of soil, soil direct stable real moisture content. This MEC10 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. The sensor has the following characteristics:

Soil moisture content, electrical conductivity and temperature three parameters.

One solution can also be used for fertilizer, and other nutrient solution conductivity matrix.

（3）Electrode using special treatment of the alloy material, can withstand a strong external impact, not easy to damage.

（4）Completely sealed, acid and alkali corrosion, can be buried in the soil or directly into the water for long-term dynamic testing.

（5）High precision, fast response, good compatibility, the probe insert design to ensure accurate measurement, reliable performance.

（6）Perfect protection circuit and a variety of signal output interface.

Technical parameter			
signal output type	Voltage output 0-2V （output impedance 0 ohm）	Current output 4-20mA (load resistance <500ohm）	RS485 interface Modbus Protocol
Power supply	3.6-30V/DC	12-30V/DC	3.6-30V/DC
Quiescent dissipation	6mA@24V DC	50mA@24V DC (2 output channels all 20mA)	6mA@24V DC
Soil moisture measurement range	0-50% volumetric moisture content 0-100% volumetric moisture content Resolution: 0-50%, 0.03%, 1% within 50-100% Accuracy: 0-2%, inside 50% 3% within 50-100%		
Conductivity range	optional range: 0-5000 us/cm, 10000 us/cm, 20000 us/cm Resolution: 10 us/cm within 0-10000 us/cm, 50 us/cm within 10000-20000 us /cm Precision of 0-10000 us/cm range is ±3%; 10000-20000 us/cm range is ±5%		
Electrical conductivity temperature compensation	Built in temperature compensation sensor, compensation range 0-50℃		
Soil temperature measuring range	Range: - 40 ~ 80 ℃, resolution: 0.1 ℃, precision: ± 0.5 ℃		
Measuring principle and measuring method	The FDR method of soil moisture, soil electrical conductivity of alternating current bridge method to soil in situ insertion or immersion into the culture medium and fertilizer whole nutrition liquid in direct test		
Protection grade	IP68 submerged in water can be used for a long time		
Operating environment	-40~85℃		

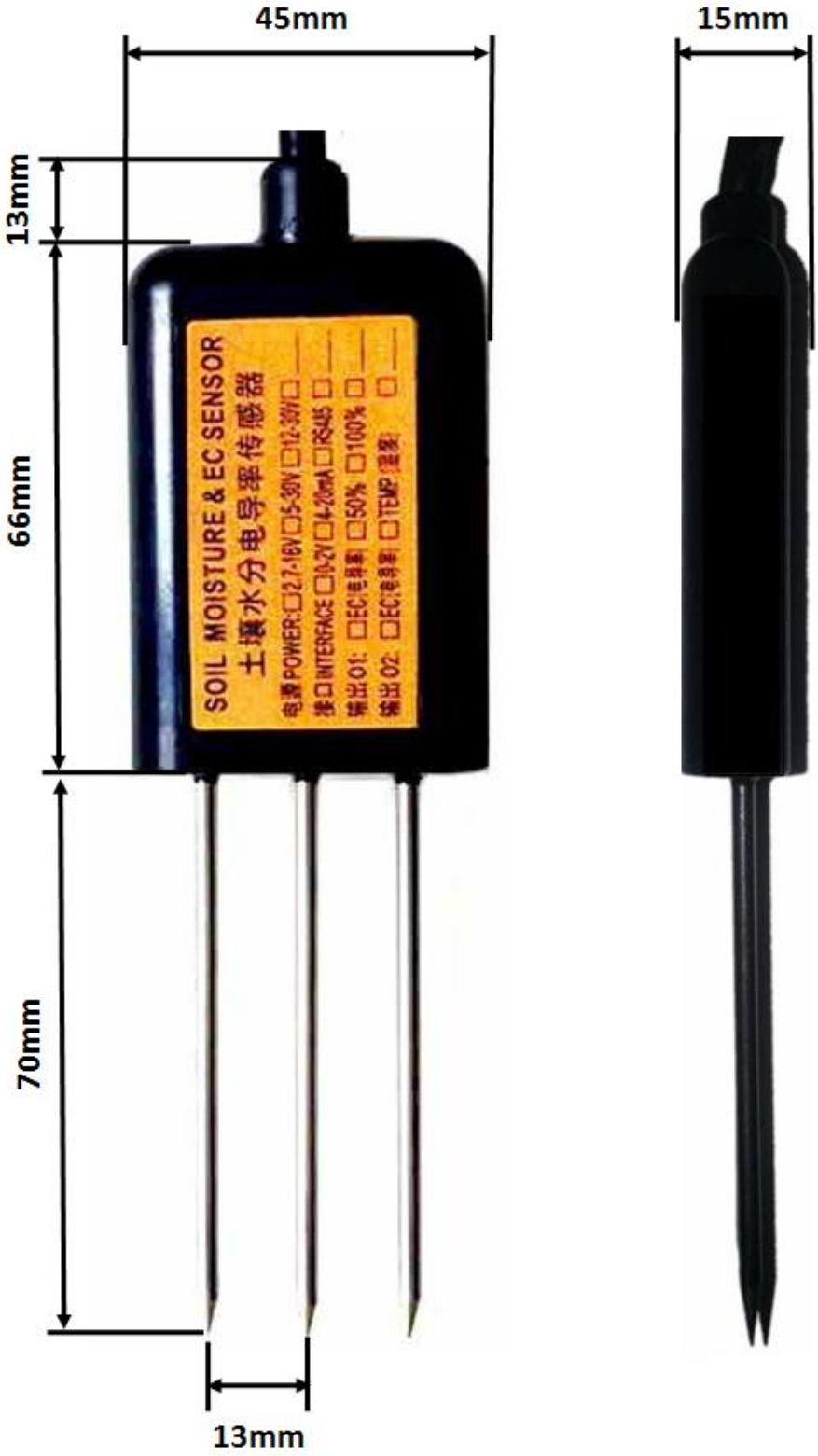
The material of the probe	Anti-corrosion special electrode
Sealing material	Black flame retardant epoxy resin
Installation	All embedded or probe inserted into the measured medium
Default cable length	2 meters, the cable length can be customized according to requirements
attended mode	Pre installed cold pressed terminal
outline dimension	45*15*145mm
Electrode length	70mm

3 Connection Guide

Model	Wiring diagram
Voltage output type	Red (V+): Power Supply Black (G): power ground Blue (O1): the output signal (moisture,conductivity ,temperature) Brown (O2): the output signal (moisture, conductivity ,temperature)
Current output type	Red (V+): Power Supply Black (G): power ground Blue (O1): the output signal (moisture, conductivity ,temperature) Brown (O2): the output signal (moisture, conductivity ,temperature)
RS485 interface type The Modbus protocol	Red (V+): Power Supply. Black (G): power ground Yellow (T+): RS485+/A/T+ White (T-): RS485-/B/T- Green (SET): V+ (power) when boot module into the "setting mode". Not connected or connected with the G (power) 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".

4 Exterior size, type selection

4.1 Exterior size



4.2 Type selection

Code number	Code	Code info.
Code1：product line	MEC10	MEC10 Soil moisture, soil electrical conductivity (EC) and temperature, three parameter measuring sensor
Code2：Measurement parameters	A B C	Soil moisture, soil electrical conductivity (EC) Soil temperature, soil electrical conductivity (EC) Three parameter measurement（RS485 ONLY）
Code3：Soil moisture range	A B	0-50% 0-100%
Code4：Electrical conductivity range	A B C D	0-5000us/cm 0-10000us/cm 0-20000us/cm Customer customization
Code5：power supply	A B C	3.6-30V/DC 1.3-5.6V/DC 12-30V/DC （output：4-20mA Only）
Code6：Output	A B C D E	Voltage output 0-2V Current output 4-20mA RS485 interface Modbus protocol RS485 interface, Modbus Protocol & voltage 0-2V output RS485 interface, Modbus Protocol & current 4-20mA output
Code 7：Line length	002 XXX	2 meters Custom, XXX is an arbitrary length (unit: m)
Model example： MEC10 Sensor, soil moisture range is 0-100%,Soil electrical conductivity measurement range 0-10000us/cm,3.6-30V/DC,RS485 interface, Modbus protocol, 5 wire length. Type selection code：MEC10 - A B B A C 005		

5 Installation and measurement

Because of the direct determination of the soluble salt ions in the soil, the water content of the soil can be higher than about 20%, and the soluble ions in the soil can correctly reflect the electrical conductivity of the soil. In the long-term observation, after irrigation or rainfall measured values are close to the true level. If the velocity measurement, first in the tested soil watering, to be full of water permeability were measured.

（1）Rapid measurement method: selected measurement locations, 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.

（2）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 ℃), in order to prevent the temperature measurement of high temperature impact sensor, please pay attention to sun protection in the field or fields.

6 Conversion of soil electrical conductivity, temperature and output

Model	Parameter range	Conversion relationship
Voltage output 0-2V	corresponding temperature -40-80℃	Temperature=60.0*Voltage output-40.Such as the measurement of the voltage is 1.0V, the temperature is =60.0*1.0-40=20.00.
	Corresponding water content 0-50%	The water content =25* voltage, such as the measurement of the voltage is 0.3V, the water content =25*0.3=7.5%
	Corresponding water content 0-100%	The water content =50* voltage, such as the measurement of the voltage is 0.3V, the water content =50*0.3=15%
	Corresponding electrical conductivity 0-5000us/cm	Electrical conductivity =2500* voltage, such as measured to the voltage of 0.3V, the conductivity =2500*0.3=750us/cm.
	Corresponding electrical conductivity 0-10000us/cm	Electrical conductivity =5000* voltage, such as measured to the voltage of 0.3V, the conductivity =5000*0.3=1500us/cm.
	Corresponding electrical conductivity 0-20000us/cm	Electrical conductivity =10000* voltage, such as measured to the voltage of 0.3V, the conductivity =10000*0.3=3000us/cm.
Current output 4-20mA	corresponding temperature -40-80℃	温度=7.5*电流-70.如测量到电流为 10mA,则温度=7.5*10-70=5.00℃. Temperature =7.5* current -70. Such as measured to the current is 10mA, the temperature is =7.5*10-70=5.00℃
	Corresponding water content 0-50%	Moisture content = 3.125 * (current -4). Such as the measured current is 6.4mA, the water content

		is =3.125*(6.4-4) =7.50%
	Corresponding water content 0-100%	Moisture content = 6.25 * (current -4). Such as the measured current is 6.4mA, the water content is =6.25*(6.4-4) =15%
	Corresponding electrical conductivity 0-5000us/cm	Conductivity = 312.50 * (current -4). Such as the current is measured to 6.4mA, then the electrical conductivity = 312.50* (6.4-4) =750us/cm
	Corresponding electrical conductivity 0-10000us/cm	Conductivity = 625 * (current -4). Such as the current is measured to 6.4mA, then the electrical conductivity = 625* (6.4-4) =1500us/cm
	Corresponding electrical conductivity 0-20000us/cm	Conductivity = 1250 * (current -4). Such as the current is measured to 6.4mA, then the electrical conductivity = 1250* (6.4-4) =3000us/cm
RS485 interface Modbus protocol	Corresponding water content 0-100%	The moisture content = the moisture content of the memory value /100. Such as the read data is 2013, then the moisture = 2013/100=20.13%
	corresponding temperature -40-80℃	Temperature = temperature register value /100. such as read the data is 2013, the temperature = 2013/100=20.13℃
	Corresponding electrical conductivity	Conductivity = electrical conductivity register value. Such as the read data is 1568, then the conductivity = 1568us/cm.
Customer order	Custom type output please contact technical support.	

Note: in the formula, the voltage unit is V, and the current unit is mA.

7 RS485 communication and protocol

7.1 Modbus communication protocol

Modbus is a serial communication protocol, a variety of instruments and intelligent sensors in the communication interface standards, in the smart sensor has a wide range of applications. Modbus is a master slave architecture of the protocol. There is a master node, and the other uses the Modbus protocol to participate in the communication of the nodes that are from the node. Each one has a unique device address from the device.

EC10 conductivity sensor with RS485 interface, support Modbus protocol. The communication parameters to factory default values for: baud rate 9600 BPS, one start bit, 8 data bits, no parity, one stop bit. Communication protocol is Modbus RTU protocol. Communication parameters can be changed by the setup program or MODBUS command, after the communication parameters are changed, the sensor is required to re - enter the sensor to be effective.

7.2 Modbus register

Parameter name	Register address (16 system /10 system)	Parameter type	Modbus function number	Parameter range and description	default
TEMPRATURE	0x0000 /0	INT16 read	3/4	-4000-8000 corresponds to -40.00~80.00℃.	N/A
VWC	0x0001 /1	UINT16 read	3/4	0-10000 corresponds to 0-100%	N/A
EC	0x0002 /2	UINT16 read	3/4	0-20000 corresponds to 0-20000us/cm	N/A
SALINITY	0x0003 /3	UINT16 read	3/4	0-20000 corresponds to 0-20000mg/L	N/A
TDS	0x0004 /4	UINT16	3/4	0-20000 corresponds	N/A

		read		to 0-20000mg/L	
EPSILON	0x0005 /5	UINT16 read	3/4	0-8200 corresponds to 0.00~82.00	N/A
SOIL TYPE	0x0020 /32	UINT16 read-write	3/6/16	0-3 0: Mineral soil 1: sandy soil 2: clay 3: organic soil	0: Mineral soil
TEMP UNIT	0x0021 /33	UINT16 read-write	3/6/16	0:℃ 1:℉	0
EC&TEMP COFF	0x0022 /34	UINT16 read-write	3/6/16	0-100 corresponds to 0.0%-10.0%	20（2%）
SALINITY COFF	0x0023 /35	UINT16 read-write	3/6/16	0-100 corresponds to 0.00-1.00	55（0.55）
TDS COFF	0x0024 /36	UINT16 read-write	3/6/16	0-100 corresponds to 0.00-1.00	50（0.5）
Modbus ADDRESS	0x0200 /512	UINT16 read-write	3/6/16	0-255	1
BAUDRATE	0x0201 /513	UINT16 read-write	3/6/16	0-6 0:1200bps 1:2400bps 2:4800bps 3:9600bps 4:19200bps 5:38400bps	3:9600bps
PROTOCOL	0x0202 /514	UINT16 read-write	3/6/16	0~1 0:Modbus RTU 1:Modbus ASCII	0:Modbus RTU

PARITY	0x0203 /515	UINT16 read-write	3/6/16	0-2 0: No parity bit 1: even parity check 2: Odd Parity bit	0: No parity bit
DATABITS	0x0204 /516	UINT16 read-write	3/6/16	1 1:8 data bits	1:8 data bits
STOPBITS	0x0205 /517	UINT16 read-write	3/6/16	0-1 0:1 Stop bit 1:2 Stop bit	0:1 Stop bit
RESPONSE DELAY	0x0206 /518	UINT16 read-write	3/6/16	0-255 corresponds to the 0-2550 milliseconds sensor to receive the host request for a period of time and then the delay response. The time delay for setting the value of *10 milliseconds. Set to 0 when no delay.	0
ACTIVE OUTPUT INTERVAL	0x0207 /519	UINT16 read-write	3/6/16	0-255 corresponds to 0-255 seconds does not require the host to request, the sensor to send data at a fixed time interval. The time interval is set value * 1 second. Set	0

				to 0 when the active output function is prohibited.	

UINT16: 16 bit unsigned integer register

7.3 Modbus register parameter description

TEMPERATURE		
Parameter range	-4000-8000 corresponds to -40.00~80.00℃	Default: none
Parameter storage	none	

Meaning: the measured value of the temperature, negative for complement representation.

For example: if the return value is 0702H (of 16 hexadecimal, source code), the first byte is 07, the second byte and the low byte is 02h, then the temperature for the measured value (07H*256 02h) /100=17.94℃.

If the return value is FF05H (16 - band, the complement), the first byte is FFH, low second byte is 05H, then temperature measurement value ((FFH*256 05H) -FFFFH-1H) / 100 = FF05H-FFFFH-1H Celsius /100=-2.5℃.

VWC --- volumetric water content		
Parameter range	0-10000 corresponds to 0-100%	Default: none
Parameter storage	None	

Significance: volumetric water content measurements.

For example: if the return value is 071DH (16 Decimal), the first byte of the high byte is 07H, second bytes of low byte is 1DH, then the measured value is (1DH 07H*256) /10000= (7*256 29) =1821. representative volume water content is 18.21%.

EC --- electrical conductivity		
Parameter range	0-20000 corresponds to 0-20000us/cm	Default: none
Parameter storage	None	

Significance: electrical conductivity measurement.

For example: if the return value is 071DH (in hexadecimal), the first byte is 07, the second byte and the low byte is 1dh, then conductivity measurement value (07H*256 1dh) / 10000 = (7*256 29) on behalf of the =1821. soil conductivity 1821us/cm

SALINITY		
Parameter range	0-20000 corresponds to 0-20000mg/L	Default: none
Parameter storage	None	

Significance: Salinity Measurement.

For example: if the value returned is 071DH (16 Decimal), the first byte of the high byte is 07H, the second byte low byte is 1DH, then the salinity measurement value (1DH 07H*256) /10000= (7*256 29) =1821. on behalf of the soil salinity is 1821mg/L.

TDS--- total dissolved solids		
Parameter range	0-20000 corresponds to 0-20000mg/L	Default: none
Parameter storage	None	

Significance: TDS measurement value.

For example: if the value returned is 071DH (16 Decimal), the first byte of the high byte is 07H, second bytes of low byte is 1DH, then the TDS measurement value (1DH 07H*256) /10000= (7*256 29) =1821. on behalf of TDS 1821mg/L.

EPSILON--- dielectric constant		
Parameter range	0-8200 corresponds to 0.00-82.00	Default: none
Parameter storage	None	

Meaning: dielectric constant.

For e xample: if the value returned is 071DH (16 Decimal), the first byte is 07H, the second byte low byte is 1DH, then the measured value is (1DH 07H*256) /10000= (7*256 29) =1821. to represent the dielectric constant of 18.21.

TEMP UNIT--- degree unit

Parameter range	0：℃ 1：℉	Default: 0
Parameter storage	None	

Significance: unit of temperature.

EC TEMP COFF		
Parameter range	0-100 corresponds to 0.0%-10.0%	Default: 20（2%）
Parameter storage	None	

Significance: the temperature compensation coefficient of electrical conductivity

SALINITY COFF		
Parameter range	0-100 corresponds to 0.00-1.00	Default: 55（0.55）
Parameter storage	None	

Significance: Salinity / conductivity compensation coefficient

TDS COFF		
Parameter range	0-100 corresponds to 0.00-1.00	Default: 50（0.50）
Parameter storage	None	

Significance: TDS/ conductivity compensation coefficient

SLAVE ADDR --- Modbus address		
Parameter range	0-255	Default:1
Parameter storage	Immediate storage	

Modbus address can be set to 0-255. When outside of the module address the dip switch setting to address 0, using the contents of the register as a slave address. After setting need to re power or use the rst command restart module, the entry into force of this address. The use of the command to change the module address does not need to open the cabinet can be arranged.

BAUDRATE		
Parameter range	0-5 0:1200bps 1:2400bps 2:4800bps	Default:3

	3:9600bps 4:19200bps 5:38400bps	
Parameter storage	Immediate storage	

PROTOCOL --- **Serial communication Protocol**		
Parameter range	0~1 0:Modbus RTU 1:Modbus ASCII	Default:0
Parameter storage	Immediate storage	
PARITY --- **Serial communication Check bit**		
Parameter range	0-2 0:none 1: even parity check 2: Odd parity check	Default:0
Parameter storage	Immediate storage	

DATA BITS		
Parameter range	1 1:8 data bits	Default:1,Only supports 8 data bits, the other is invalid
Parameter storage	Immediate storage	

STOP BITS		
Parameter range	0-1 0:1 stop bit 1:2 stop bits	Default:0
Parameter storage	Immediate storage	

RESPONSE DELAY		
Parameter range	0-255	Default:0
Parameter storage	Immediate storage	

Serial communication delay response used in the following circumstances: when the host sends a request command, delay module (RESPONSEDELAY*10 milliseconds), then the response data is returned to the host. For example, to set up RESPONSEDELAY=5, so delay module 5*10=50 millisecond response requesting host. Set to 0 for no delay an immediate response. This command is mainly used to host from RS485 transmission switch state to the receiving state relatively slow speed of occasions.

ACTIVE OUTPUT INTERVAL		
Parameter range	0-255	Default:0
Parameter storage	Immediate storage	

Serial communication active output time interval used in the following circumstances: hosts that do not need to send a request command module active output response data and output interval for ACTIVEOUTPUTINTERVAL second, such as setting ACTIVEOUTPUTINTERVAL=5. So module every 5 seconds according to set up the communication protocol of a debate output data. Set to 0 when the active output is invalid, the main request before response. This command is mainly used in GPRS wireless transmission, terminal active node data transmission occasions.

Note: when the active output data is set, only one module can be connected on the RS485 bus.

7.4 Modbus protocol communication sample

In the following instructions, the data at the beginning of the 0x or the ending of the H is a 16 - band data. Modbus protocol with two common types of registers:

(1)To maintain the register, storage data is not lost, it is read and write. Usually with function number 3 (0x03) read, use function number 6 (0x06) or 16 (0x10) write.

(2)The input registers are used to store a number of read - only physical variables, such as temperature values, that are read - only and usually read with a function number 4 (0x04).

7.4.1 Function number 3 communication sample

Common request format：AA 03 RRRR NNNN CCCC

AA	1 byte	Address, 0-255
03	1byte	Function number 3
RRRR	2byte	Start register address, high byte in front
NNNN	2byte	read the number of registers N, high byte in the front
CCCC	2byte	CRC CHECK

Common request format：AA 03 MM VV0 VV1 VV2 VV3… CCCC

AA	1byte	Address, 0-255
03	1byte	Function number 3
MM	1byte	Returns the number of data byte in the register value
VV0,VV1	2byte	Returns the first register value
VV2,VV3	2byte	Returns the second register value
…	…	Returns the “N” register value（N=MM/2）
CCCC	2byte	CRC CHECK

For example: to read register 0x0200-0x0201, namely from the machine address and baud rate for example

Ask：01 03 0200 0002 C5B3

Address	1byte	0x01
Function number	1byte	0x03
Start register address	2byte	0x0200
Register number	2byte	0x0002
Check	2byte	0xC5B3

Respond：01 03 04 00 01 00 03 EB F2

Address	1byte	0x01
Function number	1byte	0x03
Effective byte number	1byte	0x04

Slave address register value	2byte	0x00（From machine address high byte）
		0x01（From machine address low byte）
The baud rate register value	2byte	0x00（High baud rate byte）
		0x03（low baud rate byte）
Check	2byte	0xEBF2

7.4.2 Function number 4 communication sample

Common request format：AA 04 RRRR NNNN CCCC

AA	1byte	Address, 0-255
04	1byte	Function number4
RRRR	2byte	Start register address, High byte in front
NNNN	2byte	o read the number N Register, high byte in the front
CCCC	2byte	CRC CHECK

Common request format：AA 04 MM VV0 VV1 VV2 VV3… CCCC

AA	1byte	Address, 0-255
04	1byte	Function number4
MM	1byte	Returns the number of data byte in the register value
VV0,VV1	2byte	Returns the first register value
VV2,VV3	2byte	Returns the second register value
…	…	Returns the “N” register value（N=MM/2）
CCCC	2byte	CRC CHECK

For example: to read the register 0x0000-0x0003, that reads the temperature, water content, electrical conductivity value

Ask：01 04 0000 0003 B00B

Address	1byte	0x01
Function number	1byte	0x04
Start register address	2byte	0x0000
Register number	2byte	0x0003

Check	2byte	0xB00B

Respond：01 04 06 08 90 0E 93 02 4E D2 57

Address	1byte	0x01
Function number	1byte	0x04
Effective byte number	1byte	0x06
Temperature register value	2byte	0x08
		0x90
Volume water content register value	2byte	0x0E
		0x93
Conductivity register value	2byte	0x02
		0x4E
Check	2byte	0xD257

7.4.3 Function number 6 communication sample

Common request format：AA 06 RRRR VVVV CCCC

AA	1byte	Address, 0-255
06	1byte	Function number6
RRRR	2byte	Register address, high byte in front
VVVV	2byte	To write the value of the register, the high byte is in the front
CCCC	2byte	CRC CHECK

Common request format：AA 06 RRRR VVVV CCCC

AA	1byte	Address, 0-255
06	1byte	Function number6
RRRR	2byte	Register address, high byte in front
VVVV	2byte	To write the value of the register, the high byte is in the front
CCCC	2byte	CRC CHECK

For example: to write register 0x0021, namely the temperature unit for Fahrenheit cases

Ask：01 06 0021 0001 1800

Address	1byte	0x01
Function number	1byte	0x06
Start register address	2byte	0x0021
Register number	2byte	0x0001
Check	2byte	0x1800

Respond：01 06 0021 0001 1800

Address	1byte	0x01
Function number	1byte	0x06
Start register address	2byte	0x0021
Register number	2byte	0x0001
Check	2byte	0x1800

7.4.4 Function number 16 communication sample

Common request format：AA 10 RRRR NNNN MM VVVV1 VVVV2 …CCCC

AA	1byte	Address, 0-255
10(16 binary system)	1byte	Function number16（10 binary system）
RRRR	2byte	Start register address, High byte in front
NNNN	2byte	To read the number N Register, high byte in the front
MM	1byte	The number of byte to write the value of the register
VVVV1	2byte	To write the value of the first register, the high byte is in the front.
VVVV2	2byte	To write the value of the second register, the high byte is in the front.
…	…	To write the value of the “N” register, the high byte is in the front. N=MM/2

CCCC	2byte	CRC CHECK

Common request format：AA 10 RRRR NNNN CCCC

AA	1byte	Address, 0-255
10(16进制)	1byte	Function number16（10 binary system）
RRRR	2byte	Start register address, High byte in front
NNNN	2byte	To read the number N Register, high byte in the front
CCCC	2byte	CRC CHECK

For example: to write register 0x0200-0x0201 is set from the machine address is 1, the baud rate is 19200bps as an example

Ask：01 10 0200 0002 04 0001 0004 BACC

0x01	1byte	Address
0x10(16进制)	1byte	Function number16（10 binary system）
0x0200	2byte	Start register address, High byte in front
0x0002	2byte	To read the numberN Register, high byte in the front
0x04	1byte	The number of byte to write the value of the register
0x0001	2byte	To write such as from the station address register value is 1
0x0004	2byte	To write such as from the station address register value is 4
0xBACC	2byte	CRC CHECK

Respond：01 10 0200 0002 4070

0x01	1byte	Address
0x10(16进制)	1byte	Function number16（10 binary system）
0x0200	2byte	Start register address, high byte in the front
0x0002	2byte	To read the numberN Register, high byte in the front
0x4070	2byte	CRC CHECK

7.4.5 CRC16 Check algorithm and routines

routine：

```
//-----------------------------------------------------------------------------
// CRC calculation of C51 language function is as follows
// Enter the parameter 1:snd, to be the name of the byte Check array
// Input parameters 2:num, the total number of Check to be byte
// Function return value: Check and
//-----------------------------------------------------------------------------
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;
crc ^= c;
for(j = 0;j < 8; j ++)
{
if (crc & 0x0001)
{
crc>>=1;
crc^=0xA001;
}
else
{
crc>>=1;
        }
}
}
return(crc);
}
```

For example: to read the register 0x0000-0x0002, that reads the temperature, water content, electrical conductivity value

Host Ask:01 0400000003 B00B (8 byte)

Address	1byte	0x01
Function number	1byte	0x04
Start register address	2byte	0x0000
Register number	2byte	0x0003
Check	2byte	0xB00B

When the host needs to send data to the sensor, it will need to send Check data stored in the snd array.（01 04 00 00 00 03 A total of 6 byte）, Among them num=6

Pseudo code as follows,：

unsigned char request[8]={01,04,00,00,00,03,00,00};// The last two 00,00 are CHECK CRC

unsigned char num=6;// Calculate the array of the first 6 CRC CHECK byte

unsigned int crc16=0;

crc16= calc_crc16 (request, num);

request[6]= crc16%256;// Store check CRC in an array to be sent

request[7]= crc16/256;

CommPort.Send(request, 8);// Send data through serial port

Sensor Respond：01 04 06 08 90 0E 93 02 4E D2 57 （11 byte）

Address	1byte	0x01
Function number	1byte	0x04
Effective byte number	1byte	0x06
Temperature register value	2byte	0x08
		0x90
Volume water content register value	2byte	0x0E
		0x93
Conductivity register value	2byte	0x02
		0x4E
Check	2byte	0xD257

When the host receives the 11 byte data returned by the sensor, the following CRC calculation is performed, where num=11

Pseudo code as follows：

```
unsigned char response[11]={ 01 04 06 08 90 0E 93 02 4E D2 57};// The last two byte are the CHECK CRC that the sensor returns
unsigned char num=11;// Calculate the entire return of the 11 CRC CHECK byte
unsigned int crc16=0;
crc16= calc_crc16 (response, num);
if(crc16==0)
{
// Check CRC correctly, you can use the returned data
}
else
{
// Check CRC error, can not be used to return the data
}
```

To get results back to 0 so the success of Check, if Check fails to return to a nonzero value.If the Check does not succeed, it shows that the transmission process is wrong, should give up the collected data, re collection.

The success of the Check, use the following formula to calculate the temperature (negative to complement representation) and conductivity of H at the end of the 16 hexadecimal data：

Temperature=（08H*256+90H）/100=2192/100=21.92 ℃

volumetric water content =（0EH*256+93H）/100=3731/100=37.31%

conductivity =02H*256+4EH=2*256+78 =590 us/cm