SISTEMES ELECTRÒNICS PROGRÉS

Manual

Teros 12 Soil water content, temperature and conductivity sensor

CODE 06140294

Sensor for reading soil water content (VWC), temperature and electrical conductivity of the soil using the three stainless steel spikes. Ideal for installing in substrates without soil.

TEROS 12 Sensors use an electromagnetic field to measure the apparent dielectric permittivity (εa) of the surrounding medium.

The sensor applies a 70 MHz wave to the sensor spikes, which are charged according to the material's dielectric constant. The charging time is proportional to the dielectric and the VWC of the substrate. The internal microprocessor of the TEROS 12 measures this charge field and converts it to a VWC value using a specific calibration equation for each substrate. This measurement is made between spike 1 and 2.

The TEROS 12 uses a thermistor to take temperature readings, located on spike 2. This is very important for measurements near the surface where temperature changes are faster. The temperature delivered by this sensor is represented in degrees Celsius. Although the sensor body is white, direct sunlight can raise the temperature measurement, so be careful when installing it and avoid direct exposure.

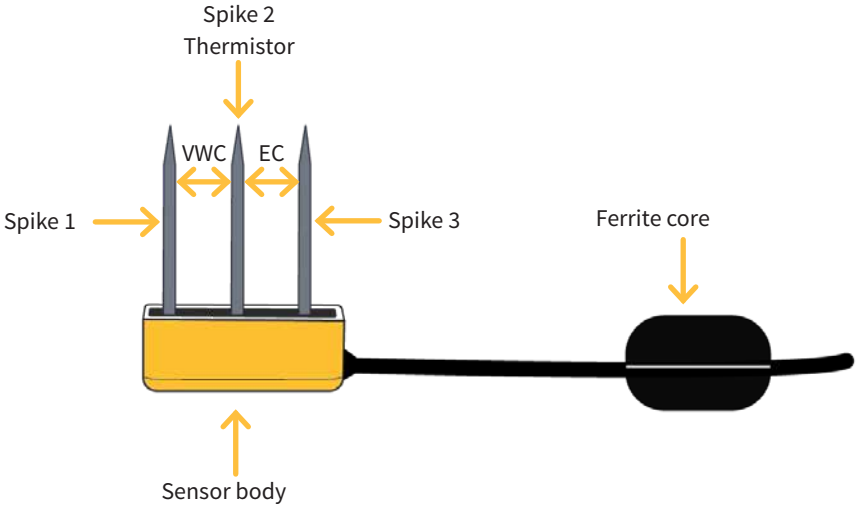
Electrical conductivity (EC) is the ability of a substance to conduct electricity and can be used to interfere with the number of ions in a solution. EC is measured by applying an alternating electrical current to two electrodes and thus measuring the resistance between them. The EC substrate is derived by multiplying the inverse of the resistance (conductance) by the cell constant (ratio of the distance between the electrodes to their area). EC measurements are normalised to 25°C and the reading is taken between spikes 2 and 3.

Technical specifications

Sensor details	
Dimensions	Length: 9.4 cm Width: 2.4 cm - Height: 7.5 cm
Cable length	5 metres
Soil type	Mineral - Peat
Output type	SDI-12 communication bus
VWC precision	± 0.03 m^3/m^3
Precision ºC	± 1ºC
Precision EC	± 5% of reading

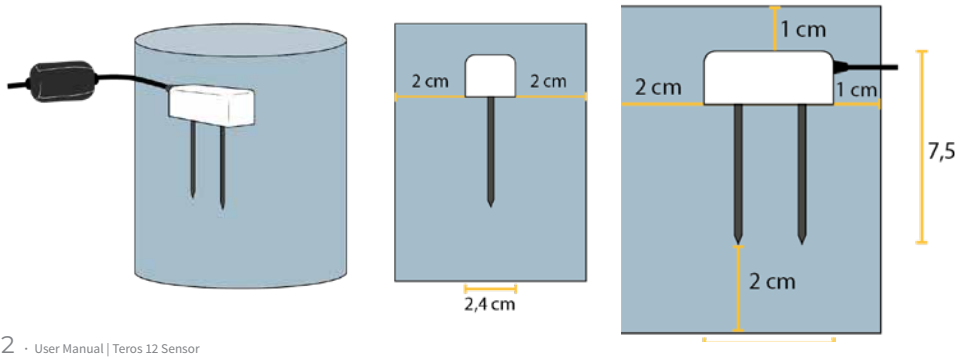
Reading range	
Soil water content (VWC)	0 to 100%
Temperature (ºC)	- 40 to 60ºC
Apparent dielectric permittivity (ε)	01 to 80
Conductivity (EC)	0 to 23 mS/cm

Sensor parts



The measurement sensitivity of the TEROS 12 VWC sensor is contained in a volume of approximately 1,010 ml.

It is shown below:



Installation

The ferrite core placed on the TEROS 12 sensor cable 7.6 cm from the sensor body is used to isolate the sensor from any interference in the system. This mitigates any potential system noise in the measured sensor data.

IMPORTANT

Do not connect anything to the cable section between the sensor head and the ferrite core, as this may influence the measurements.

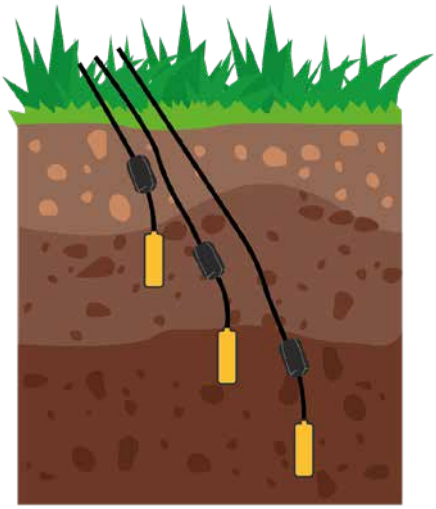
Recommendations to always take into account:

- Minimise soil disturbance at the measurement site.
- The correct thing to do is to install it in the native soil to get accurate soil moisture readings.
- Avoid air gaps around the sensor spikes as they can lead to low readings.
- When installing the sensors in rocky soil, be careful to avoid bending the sensor spikes.
- The TEROS 12 sensor can be placed in any direction (horizontally or vertically aligned spikes), however it is preferable that the sensor body is vertically aligned so that there is less restriction to the flow of water through the soil because water will flow through the soil directly to the spikes.

INSTALLATION WITH TRENCH

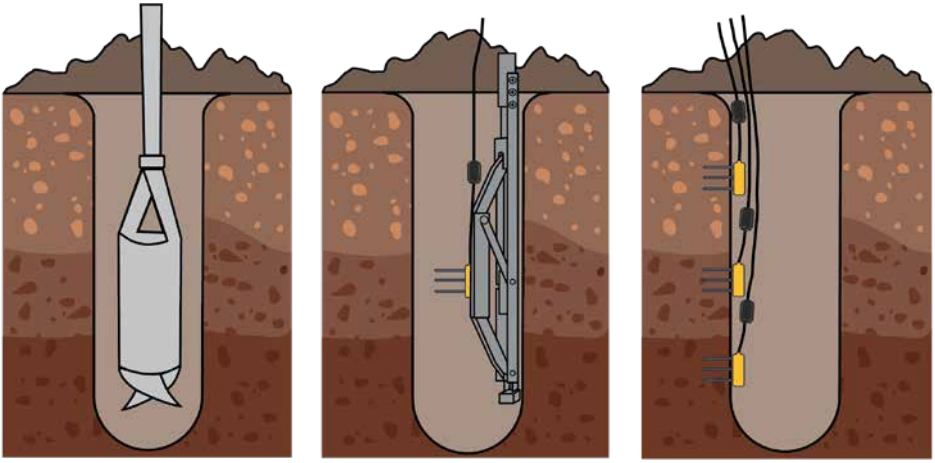
This method is best for shallow installations (less than 40 cm).

- Dig a trench or hole with a shovel, bulldozer, etc. The trench must be dug to the depth of the deepest sensor to be installed.
- Carefully install in the undisturbed soil on the side wall of the trench.
- Fill carefully, to preserve the apparent density of the soil and also to avoid dislodging the installed sensor, accidentally catching the ferrite core.



INSTALLATION WITH DRILL

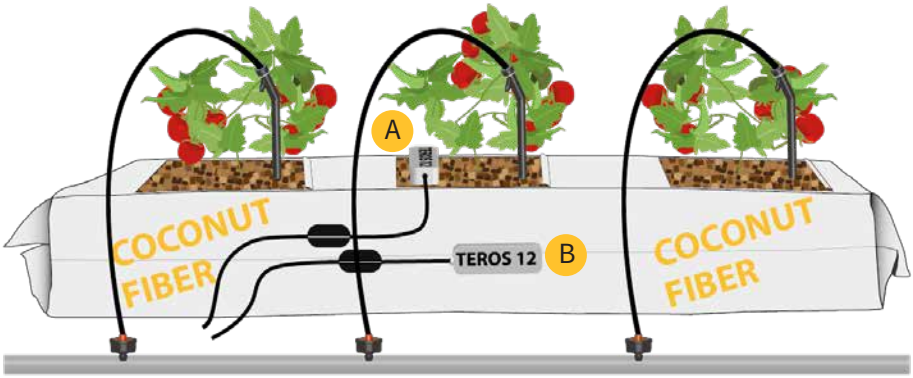
This system provides comfortable installation for sensors deeper than 50 cm.



1. Drill and make the hole to the desired depth and direction according to the installation method and the different sensors to be installed.
2. Adjust the tool to the desired depth where the sensor is to be installed.
3. Place the TEROS 12 sensor in the installation tool (product not supplied by Progrés).
4. Insert the tool with the sensor into the hole with the back against the back wall, as shown in the image.
5. Pull the lever of the tool to activate the mechanism to drive the sensor into the side wall.

Check the installation with a drill video by clicking on the image,
via the link https://youtu.be/JHk2W8xQ0T4

INSTALLATION ON SUBSTRATES WITHOUT SOIL



When the TEROS12 sensor is installed on substrates without soil (for example in coconut fibre bags) it can be done in two different ways, both of which are valid.

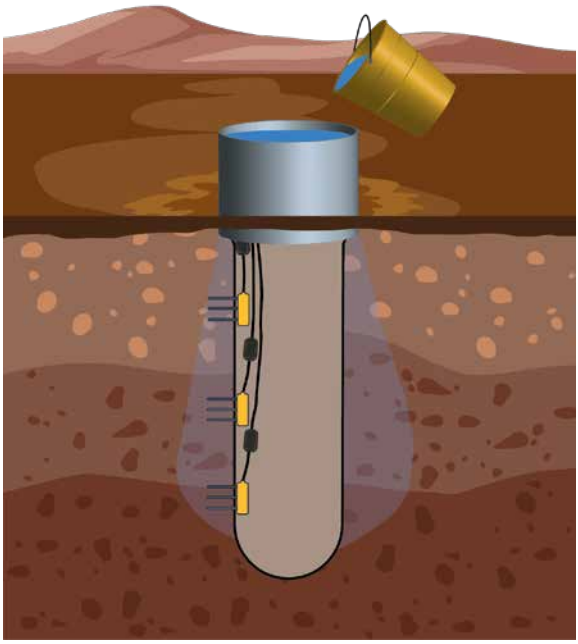
1. Installation on top of the substrate: The sensor must be installed at a maximum distance of 5 cm from the drip emitter. A
2. Installation on the side of the substrate: The sensor should be installed just below where the drip emitter is. B

SOIL INFILTRATION

Once the sensor is installed, it is recommended to infiltrate the soil to achieve saturation and thus be able to view the field capacity value from the programmer.

This infiltration varies with soil texture and will be faster in sandy soils and slower in clay soils.

A ring-shaped container with a diameter and a height of approximately 30 cm is needed. You will also need a bucket of about 50-litre capacity to pour water into the container.



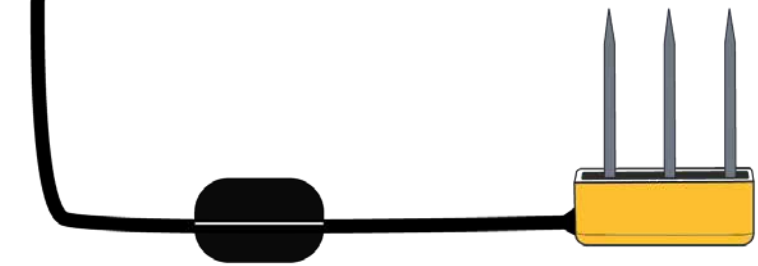
The steps to follow to infiltrate the soil are:

- Place the container in the centre where the Teros-12 probe is located and bury it about 10 cm.
- Pour 50 litres of water inside the ring in different doses and as the water infiltrates. This operation will take more or less time depending on the type of soil.
- Observe, through the programmer, the reading in % of water content in the soil of each of the sensors at different depths. The expected saturation values for each soil must be higher than the values marked as FC (Field Capacity) in the table shown on page 10.

Connections

The TEROS 12 sensor can be connected to the AgroBee-L SDI-12, AgroBee SDI-12 module, to the Agrónic 2500 or 5500 with SDI-12 option or to the SDI-12 transmitter. A cable hose is provided for each unit that enables the different connections to be made easily with no need to access the inside of the module. All of the units use the following colour legend:

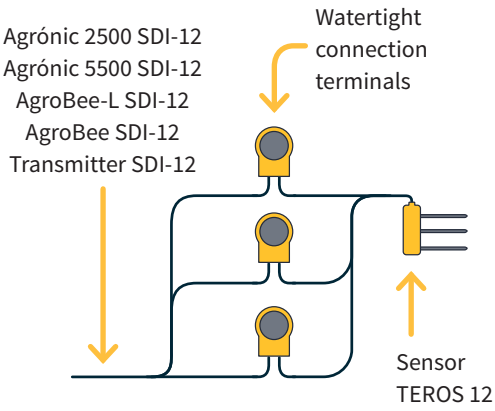
	8 sensors A2500/A5500 SDI-12	*4 sensors* AgroBee-L SDI-12	*4 sensors* AgroBee SDI-12	*1 sensor* Transmitter SDI-12
Brown **VA**	Blue	Green	Blue	Green
Mesh **0 V**	Brown	White	Yellow/green	Brown
Orange **A**	Yellow/green	Brown	Brown	White



NOTE It is recommended that the cables that remain loose are also connected with a spare 3M connector to avoid possible short circuits or getting wet. These connectors are supplied together with the sensor.

To ensure the water tightness of the module's hose wire connections, it is recommended to use waterproof terminals. The connection through these terminals must be made without stripping the cable wires.

As connection elements, those of the 3M Scotchlok series (www.3m.com) can be used; ES Caps from TYCO Electronics (www.tycoelectronics.com); or the Cellpack splicing and resin diversion kits (www.cellpackiberica.com).



Compatibility table

AGRÓNIC 2500	AGRÓNIC 4000	AGRÓNIC 5500	AGRÓNIC 7000	AGRÓNIC BIT
+ option SDI-12 or + Trans. SDI-12	+ Trans. SDI-12	+ option SDI-12 or + Trans. SDI-12	+ Trans. SDI-12	+ Trans. SDI-12
✓	✓	✓	✓	✓

AGROBEE-L	AGROBEE	A. MONOCABLE	AGRÓNIC RADIO
+ AgroBee-L SDI-12	+ AgroBee SDI-12	+ Trans. SDI-12 + 5 W panel + Bat. 7A + regulator	+ Trans. SDI-12 + 5 W panel + Bat. 7A + regulator
✓	✓	✓	✓

Sensor configuration

The sensor acts by delivering a current or a voltage proportional to what it measures. The format indicates the sensor units and the relationship between the voltage read by the input and the sensor reading values.

A format with at least two calibration points needs to be configured for the sensor calculation and is configured from the programmer menu as follows.

Go to:

Function | Settings | Analogue Sensors | Formats (Always validate with the Enter key)

Once in the "**Formats**" menu, configure the settings as shown in the table.

- For A-2500, A-5500 and A-Bit units, choose format numbers between 22 and 31.
- For the A-4000 unit, choose format numbers between 21 and 26.
- For the A-7000 unit, choose any function (see manual).
- For AgroBee / AgroBee-L SDI-12 models, the formats are auto-assigned when configuring the analogue sensor.

TEROS-12 sensor format

Setting	Format Value 1		Format Value 2	Format Value 3
	ε [ ]	VWC [%]	EC [mS/cm]	Temperature [°C]
No. of integers	2	3	2	2
No. of decimals	1	1	2	1
Sign	no	no	no	Yes
Units	-	%	mS/cm	ºC
Calibration Point 1				
Real value	800 mV	800 mV	800 mV	800 mV
Logical value	01.0	000.0%	00.00 mS/cm	-40.0ºC
Calibration Point 2				
Real value	4000 mV	4000 mV	4000 mV	4000 mV
Logical value	80.0	100.0%	23.00 mS/cm	+60.0ºC

Troubleshooting

THE SENSOR DOES NOT RESPOND

- Check the supply voltage that the device (AgroBee-L or AgroBee) supplies to the sensor.
  - If the voltage is **equal to or greater than 10 V**, it is correct.
  - If the voltage is **less than 10 V**, there is an over-consumption and the problem is possibly in the sensor or sensors.

To check this voltage in the same module, a Module Reader is needed (only in AgroBee-L) and it is carried out as follows:
ENT. QUERY DIG.-ANAL. | VDC SENSORS

- Check the current generated by the transmitter towards the programmer or module (4-20 mA) in the following cases:
  - If "**Minimum error**" is read in the Agrónic analogue input report.
  - If the "REPORT" menu of the Module Reader reads: **"COM. SDI-12: incorrect".**

This current can be verified with an ammeter in series on cable S1, S2 or S3 of the transmitter or using a Module Reader (QUERY menu). If the output current is **0 mA**, it indicates that the sensor is not connected or there is a problem with the sensor.

- Check that the connection is correct according to the table detailed in this manual (page 5).

SENSOR READING TOO HIGH

- Check that the soil is not too compacted during installation. Too high a density can cause the sensor reading to be higher.
- Make sure that the soil that has been configured is correctly selected on the device where it will be connected. Each soil needs a specific calibration equation.
- Some substrates have a very high dielectric permittivity constant (εa) (soil of volcanic origin or high titanium). If it is greater than 6, or the EC substrate is greater than 10 dS/m, the equations are not prepared, requiring custom equations that can only be provided by the manufacturer.

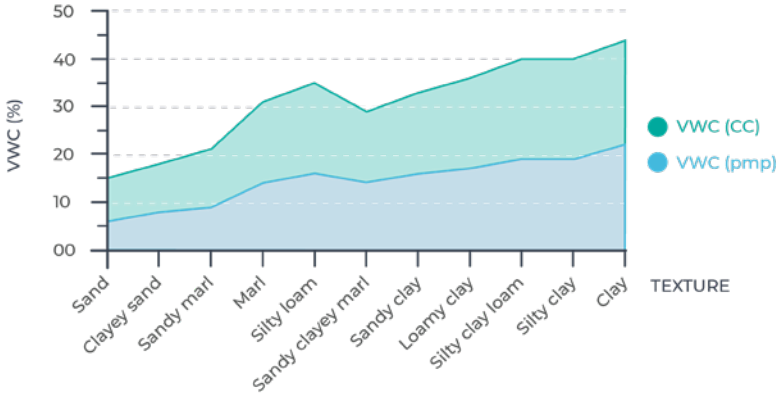
SENSOR READING TOO LOW

- Check that there are no air pockets around the spikes or the sensor body. These could occur below the surface of the substrate when the spike makes contact with an obstacle and pushes it out of the way or if the sensor is not inserted perfectly linearly.
- Make sure that the soil that has been configured is correctly selected on the device where it will be connected. Each soil needs a specific calibration equation.

Indicative values of the type of soil texture for:

TEXTURE	VWC (FC) % Field capacity	VWC (pmp) % Wilting point	CRAD % Available water retention capacity
Sand	15	6	9
Clayey sand	18	8	10
Sandy marl	21	9	12
Marl	31	14	17
Silty loam	35	16	19
Sandy clayey marl	29	14	15
Sandy clay	33	16	17
Loamy clay	36	17	19
Silty clay loam	40	19	21
Silty clay	40	19	21
Clay	44	22	22

Source: New Mexico State University Climate Centre



NOTE

In certain external circumstances, such as in areas with a high probability of electrical storms (lightning), the use of extension cords and the presence of more than one sensor, even if grounded, it is not possible to guarantee 100% that the sensor will not be damaged from the lightning.

Further information

For further information about the sensor, please see the manufacturer's generic video:

https://youtu.be/-7qezpt8_1s

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