Installation and use of the TerraSense soil sensor

The sensor TerraSense SMT2 manufactured by Netsens allows accurate measurement of soil moisture (**water volume content, WVC**) and temperature, and is a key sensor to know the actual water supply of the soil, and to implement better water management strategies for your crop.
The sensor is based on the **FDR** (Frequency Domain Reflectometry) measuring principle, and generates a radiofrequency signal (RF), which is altered by the soil properties, according to the different water volume content. The particular production technique and the compensation formulas implemented by Netsens allow to obtain a measurement substantially **insensitive of the soil texture**, of the environment characteristics and of the aging of the sensor, without the need for periodic calibrations.

Each sensor is factory calibrated at the time of testing, in order to ensure adequate accuracy of measurement, within the production specifications, by compensating the errors due to manufacturing tolerances.

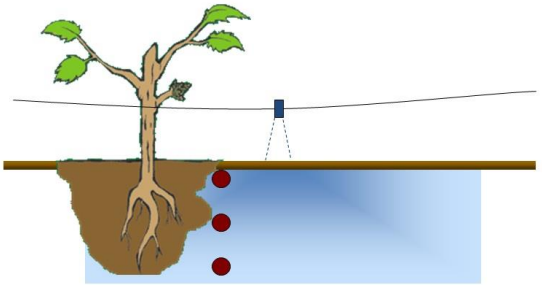
However, to ensure optimum results in terms of measurement accuracy and sensitivity, it is requested that the sensor shall be **properly placed in the ground**, as described below, considering that the measurement is performed around the electrodes positioned within the Vetronite (color green or red, depending on the model), and that it is requested to have the higher uniformity of soil in the area between and surrounding the electrodes.

The following instructions refer to standard soil crops; in the case of crops out of ground and / or in the presence of artificial substrates, the instructions may differ: contact Netsens Technical Support for more information.

Sensor placement

The depth at which the sensor(s) are positioned relays on agronomic considerations; hereinafter general guidelines are reported:

a) in the case of single sensor per measuring point, this may be placed at the average root level;
b) in the case of two sensors for the measuring point, the upper sensor can be installed at the upper limit of the roots, and the lower one below them;
c) in the case of three sensors, it will be possible to have the middle sensor at the average of the root level.



In general, the average depth can then be **between 10-15 cm** from the surface, as in the case of vegetable post- transplantation, **and 80-90 cm**, to analyze the drainage of arboreal crops.

The positioning of the sensors is also related to the type of irrigation system used; in particular, with **dripping** systems it is recommended to place the sensor at about 20-30 cm from the vertical fall of the drop, still being in the wet soil portion. Similarly, in the case of systems with sub-irrigation, the sensor shall be positioned within the irrigated portion of the soil. In other cases, the sensor response may be not consistent with the irrigation cycles and could provide only a rainfall effect indication.

Sensors identification

By convention, in the case of multiple sensors connected to the same apparatus, the sensors are identified in the following way:

SENSOR ID 27: single sensor, or upper sensor
SENSOR ID 28: lower sensor
SENSOR ID 29: intermediate Sensor

The identifier is factory- associated to each sensor and can not be modified in the field.

Installation procedure

A correct installation is essential to get reliable and accurate measurements. Therefore Netsens recommends to follow these guidelines. In the event that these, for whatever reason, can not be followed, our technical support is available to evaluate the effects and identify possible alternative solutions.

1) Drill a hole in the ground, taking care to leave the **sides of the hole with compact soil**. The hole should be as deep as the positioning of the lower level sensor (in the case of multiple sensors).

2) Insert the sensor in the still compact hole side, if necessary by applying a light force, provided it is in the longitudinal direction of the electrodes, and taking care **not to exert any bending or twisting** of the same, and using only the plastic case to insert or remove the sensor, without exerting any action on the cable. If necessary you can soak into the ground to soften it and facilitate a smoother entry.

3) Cover the sensor compacting the soil previously extracted from the hole. It is important that the soil results **extremely compact** even at the end of this operation.

4) Repeat the operation in the case of additional sensors placed closer to the surface, and completely fill the hole with the removed part of the soil.

5) Take care to **protect the cables** coming out from the ground, especially when mechanized operations are practiced. In any case, operations such as milling, ripping etc. can irreparably damage the sensors. Contact Netsens Technical Support for more information.

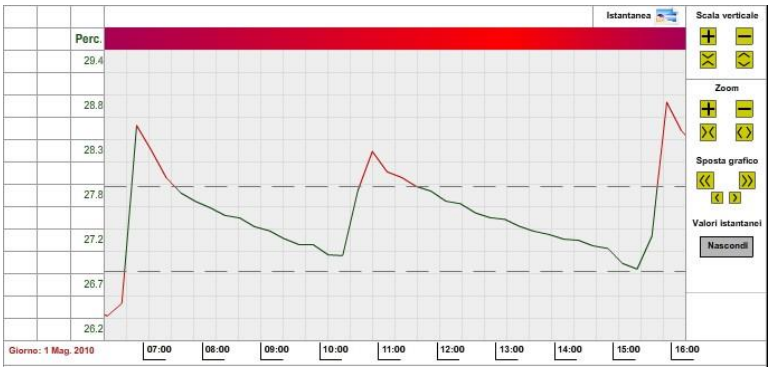
Data analysis

The TerraSense SMT2 sensor provides, in addition to the temperature of the soil, the volumetric content of water in the soil (WVC). The value is expressed in percentage, and the reading scale is **between 0%** ("air" measure) and a value related to the **field capacity** of the soil, that is, the maximum water content that can be retained by a given volume of soil.
Customary values of field capacity are reported in the following table:

- Sandy soil: about 15%
- Medium-textured soil: about 35%
- Clay soil: 45%

Therefore, for agronomic purposes, it is necessary to accurately know the value of field capacity of the soil in which the sensor is positioned, in order to understand the meaning of the instrument reading; in fact, a 10% value can be both indicator of "easy water" availability, in the case of sandy soils, but it is a value close to stress for clay soils.
An approximate method for assessing field capacity is to pour water in the soil, after you have successfully installed the sensors, making sure that this is completely absorbed, then get one or more readings. The value represents an approximation of the field capacity value or the measured soil.

In addition to the absolute value of measurement, it is particularly important to understand **the response of the sensor(s) to the irrigation** interventions: the responds time to irrigation (or to a significant rain event) is indicative of a correct installation of the sensor and of a good drainage of the soil.
In general, the upper sensors have a faster response than those in depth, whose response is an indication that the irrigation water has reached the root level (and thus can be used to determine when to end the irrigation).
Furthermore, the falling time of the reading at the end of irrigation is also an important parameter for water management: the surface sensors have a faster response, more closely linked to the environmental conditions (evaporation), while the lower sensors will have a slower response.
Generally speaking, a proper water management is that which involves the **least variation of the water content** in the soil, within the optimum values for the crop itself.



LiveData® data browsing

The LiveData software interface allows various steps of soil moisture analysis, hereinafter reported:

Main station
On the station's main sensor panel, you can view the histogram of soil sensors that are present. In the case of presence of leaf wetness sensor, the soil moisture sensor shall be selected in the same display frame of leaf wetness sensor. By clicking on the histogram you access the graphic presentation of the sensor, on a user's selectable time interval.

Wireless units
On the wireless unit panel the histogram of soil moisture sensors (max 2) is displayed. By clicking on the histogram you access the graphic presentation of the sensor, on a user's selectable time interval.

Graphic tool
The display of the value of moisture and / or temperature of the soil is representable on the "graphic" tool, and can be easily compared with other sensors (of same type or not). Refer to LiveData user manual for more information and details.

Reports
Using the "advanced" report tool, you can have a daily summary (any time interval) of the humidity and temperature of the soil. The report, easily exportable to spreadsheet (e.g. Microsoft Excel) in CSV format, shows the average values, minimum and maximum daily or hourly, on the selected interval.

Getting closer to our customers
Netsens assists customers in making cost effective and correct use of the products. Please contact us for further information.