

# Soil Sensor WET150 Instructions



The Aranet Soil Sensor WET150 is a versatile, multi-parameter instrument designed to monitor soil and substrate moisture conditions in both controlled environments and open fields. It provides growers and researchers with accurate data on volumetric water content (VWC), temperature, and electrical conductivity (EC) — key parameters for optimizing irrigation, nutrient management, and overall root-zone health.

## Contents

<b>Introduction</b>	<b>2</b>
<b>Setting Up the Sensor</b>	<b>3</b>
General Guidelines for Sensor Placement . . . . .	4
Choosing the Installation Location . . . . .	4
Key Positioning Principles . . . . .	4
Recommended Installation Location in Slabs . . . . .	5
Recommended Installation Location in Containers and Pots . . . . .	7
Installing the Sensor . . . . .	7
Inserting Prongs into the Substrate . . . . .	7
Interaction Between Multiple Sensors . . . . .	8
Outdoor Installation in Soil . . . . .	9
Positioning the Transmitter . . . . .	9
Taking Initial Measurements . . . . .	9
<b>Base Station and Aranet Cloud Configuration, and Data Representation</b>	<b>9</b>
Choosing the Right Calibration Profile . . . . .	10
Notes for Coco-Peat Substrates . . . . .	12
Viewing Your Sensor Data in Aranet . . . . .	13
Example of Data Interpretation . . . . .	14
<b>What Can Influence Measurement Accuracy?</b>	<b>16</b>
<b>Theoretical Background</b>	<b>17</b>
Dielectric Permittivity and Volumetric Water Content (VWC) . . . . .	17

Electrical Conductivity (EC) . . . . . 17  
 Temperature (T) . . . . . 19

## Introduction

The sensor can be used in a wide range of growing media, including mineral soils, peat, coco coir, rock wool, perlite, and other horticultural substrates. By doing so, it helps improve the efficiency and precision of plant growth management.

The sensor itself consists of two main components:

- the WET150 sensor, manufactured by Delta-T Devices, and
- an Aranet Transmitter, which collects WET150 data and sends it to the Aranet Base Station.

This document provides practical guidance for growers using the Aranet Soil Sensor WET150. For more detailed information on WET150 operation, especially in outdoor environments, refer to the Delta-T Devices web page. For complete Aranet WET150 specifications, consult the datasheet available at Aranet.com.

The working principle of the sensor is illustrated in the Figure 1. In simple terms, the WET150 sensor performs measurements, the Aranet transmitter collects the data, and the Base Station processes it. Based on the selected sensor configuration, the Base Station calculates metrics that can be interpreted by growers to guide plant growth.

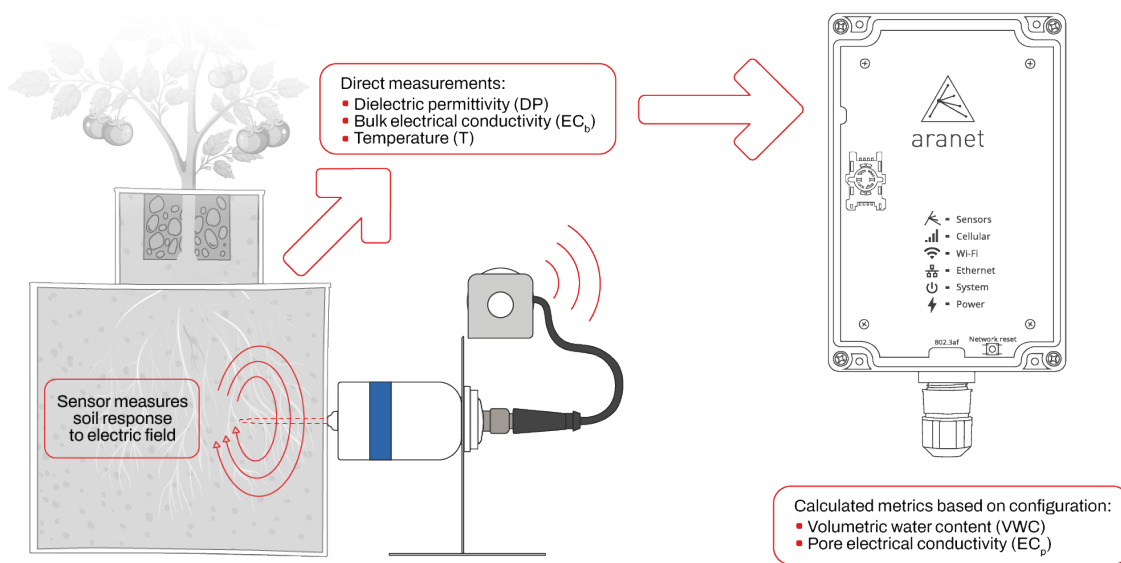


Figure 1: Working principle of WET150 sensor

The sensor influences a volume of approximately 0.4 L, shaped like a short cylinder around the prongs, see Figure 2.

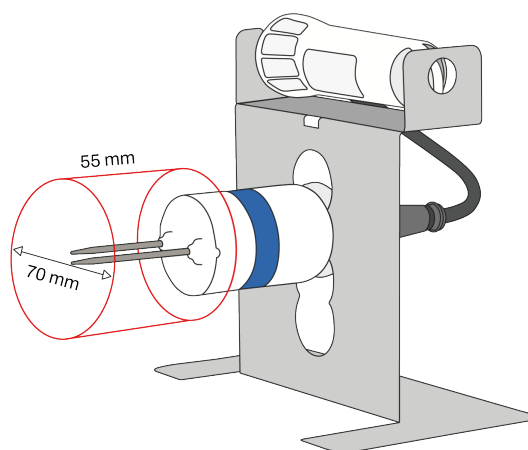


Figure 2: Representation of sensor measurement volume

The sensor measures Volumetric Water Content (**VWC**), not substrate water saturation.

- Substrate saturation ranges from 0% (completely dry) to 100% (fully saturated, when water begins dripping from the substrate)
- **VWC**, however, represents the percentage of the substrate volume that is occupied by water

Because different substrates hold water differently, the same saturation level can correspond to very different **VWC** values — for example:

- Pure perlite may reach about 30% **VWC** when fully saturated
- **VWC**, however, represents the percentage of the substrate volume that is occupied by water

In other words, the **VWC** value depends on the substrate type and packing density.

The sensor includes two electrodes. When inserted into soil or substrate, sensor provide both direct and calculated measurements:

- Direct measurements: dielectric permittivity (**DP**), bulk electrical conductivity (**ECb**), and temperature (**T**)
- Calculated metrics: volumetric water content (**VWC**) and pore electrical conductivity (**ECp**)

More detailed description of the sensor working principle and measurements is described in the section Theoretical Background.

## Setting Up the Sensor

The WET150 sensor is designed for a wide range of media and applications — from outdoor field soils to controlled-environment substrates such as rock wool (mineral wool) slabs and cubes, coconut fiber, peat moss, and perlite-based mixes. While specific installation requirements may vary by substrate type, the following general guidelines help ensure reliable, accurate sensor readings across all environments.

For accurate and repeatable soil sensor measurements, proper physical installation is crucial. **The wrong installation of the sensor can show completely different results.** For example, leaving some part of the prongs out and exposed

to air will lead to much lower results of **VWC**, leading to problematic decision-making.

## General Guidelines for Sensor Placement

Proper sensor placement is essential for obtaining accurate and representative soil or substrate measurements. As 90% of problems with the data come from inappropriate installation of the sensor. The Aranet Soil Sensor WET150 should be installed where it best reflects typical plant growth conditions and root activity. Factors such as container size, substrate type, irrigation method, and crop growth stage all influence the ideal location. In general, the sensor should be positioned within the main root zone where moisture remains stable between irrigations, avoiding areas that are excessively wet, dry, or exposed. Consistent and well-considered placement ensures reliable readings of volumetric water content (**VWC**) and electrical conductivity (**EC**), supporting precise monitoring and optimized growing conditions.

### Choosing the Installation Location

Select a representative location that reflects the typical growing conditions in your facility. Avoid areas that may distort readings, such as:

- spots directly next to irrigation emitters
- at the extreme end of slabs
- location with poorly mixed or uneven substrate

Ensure that the sensor's prongs are surrounded by a uniform and compact medium without large air pockets. Always align sensor placement with the main root uptake zone, which may vary depending on the plant's growth stage. When comparing trials, use consistent reference sensors to ensure reliable comparisons.

### Key Positioning Principles

Moisture distribution and root activity are rarely uniform. They typically concentrate in areas that remain evenly moist between irrigations. Therefore, correct positioning should always reflect the root-active moisture zone. Factors influencing placement:

1. Container dimensions and volume
  - The sensor height should correspond proportionally to the container height and the root zone depth.
  - For most pots or growbags, position the sensor one-quarter to one-third of the total substrate height from the bottom.
  - This placement ensures readings represent root-available water, avoiding overly wet (drainage) or overly dry (surface) zones.
2. Substrate or soil density
  - Loose media (e.g., coir, perlite, rock wool): the electromagnetic field generated by the sensor extends farther in media and is more sensitive to air gaps. Install the sensor slightly deeper or more compacted to ensure good contact.
  - Dense media (e.g., peat, mineral soil): water moves more slowly and evenly, so the sensor can be positioned slightly higher in the root zone and still capture representative readings.

### 3. Irrigation type and emitter position

- Drip systems: place the sensor a few centimeters away from the dripper (not directly underneath) so that it measures the redistributed moisture front, not the saturated zone.
- Overhead or mist systems: position the sensor in the central root-zone depth that reflects the average wetting pattern after irrigation.

### 4. Root system development and crop type

- Young or fine-rooted plants absorb water closer to the surface.
- Mature or coarse-rooted plants draw water from deeper layers.
- Adjust sensor height according to the dominant root-active zone based on plant age and species.

### 5. Avoid extremes

- Too low → readings skewed by drainage and saturation.
- Too high → readings fluctuate due to surface drying.
- Target zone: the moisture equilibrium zone, where water content stays relatively stable between irrigations and corresponds to the densest root region.

### Recommended Installation Location in Slabs

For long slabs, place the sensor on the side, approximately midway along the slab's length. If you have one sensor, then placing it in the middle would be a good location to place the sensor. This placement will give the best reference for the middle plant and if the substrate is uniform and uniformly watered.

If you have 2 sensors, then the 2 places between the 3 plants would be best for the most accurate measurements for all 3 plants.

See the Figure 3 for an example on possible locations to place the sensors in slabs - under the plant and between two plants.

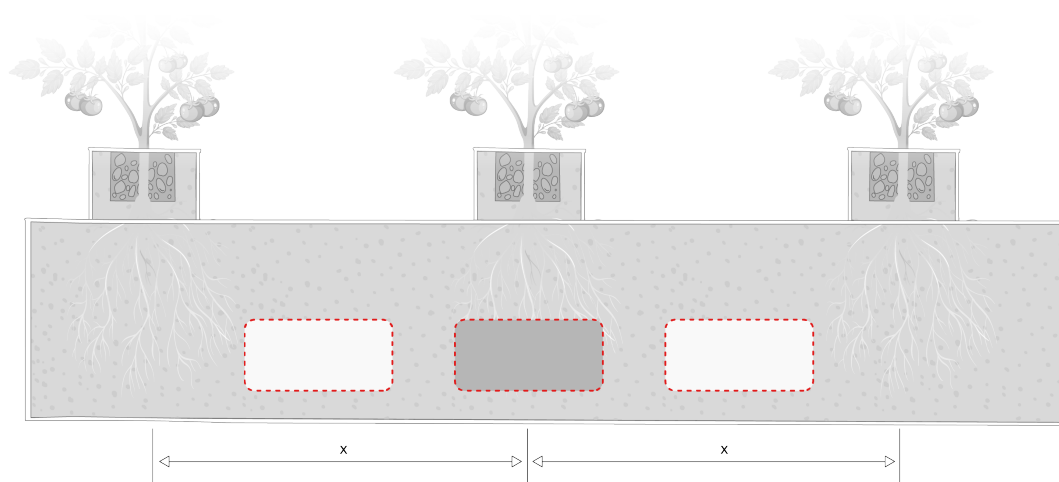


Figure 3: Recommended sensor placement options for slabs.

Of course if you have as many sensors as plants, then placing each sensor in each plants root uptake zone would be best.

For typical horticultural substrates (e.g., slabs 3–4 in / 7.5–10 cm high):

- Aranet recommends positioning the sensor horizontally, 32 mm (1.25 in) from the bottom. This height is also used for substrate profile calibration in Aranet Substrate Laboratory, providing the most accurate **VWC** correlation.
- The 32 mm position corresponds to Position 1 on the Aranet WET150 Sensor Installation Bracket (product number TDAWSH01), designed for tabletop growing systems, shown in Figure 4.



Figure 4: WET150 sensor with an installation bracket

For added rigidity, use the Aranet WET150 Sensor Stand (TDKWSH01.004) — ideal for gutter installations, see Figure 5. While 32 mm is the recommended starting point, the sensor may be installed higher in thicker substrates. Maintaining consistent proportional height-to-volume ensures the readings represent the same root-active moisture zone across different container sizes.



Figure 5: WET150 sensor with a plastic sensor stand

### Recommended Installation Location in Containers and Pots

While sensor calibration is performed at 32 mm from bottom, for taller pots, install the sensor at the depth where the root uptake zone is for your plant. Table below represents the recommended positions for the sensor if Aranet WET150 Sensor Installation Bracket (product number TDAWSH01) is being used depending on container volume

Accessory position	Container volume	Approx. Height of container (cm)	Sensor Height TDAWSH01
1	1.9 gal / 3.8–7.2 L	7–8 cm	32 mm (1.25 in)
2	3.9 gal / 7.6–14.75 L	18–23 cm	51 mm (2.0 in)
3	7 gal (Standard) / 15.15–26.5 L	28–30 cm	70 mm (2.75 in)
4	7 gal (Tall & Narrow) / 15.15–26.5 L	30–35 cm	89 mm (3.5 in)

If possible, measurements at 51, 70 or 89 mm can be compared with results at 32 mm. Compare trends and conclude the difference in **VWC** to get a sense of water distribution. The Figure 6 illustrates the sensor installation height relative to substrate size. For pots and blocks, always install the sensor centrally, equidistant from the container edges. Used in the image is 1 gallon and 2 gallon pots:

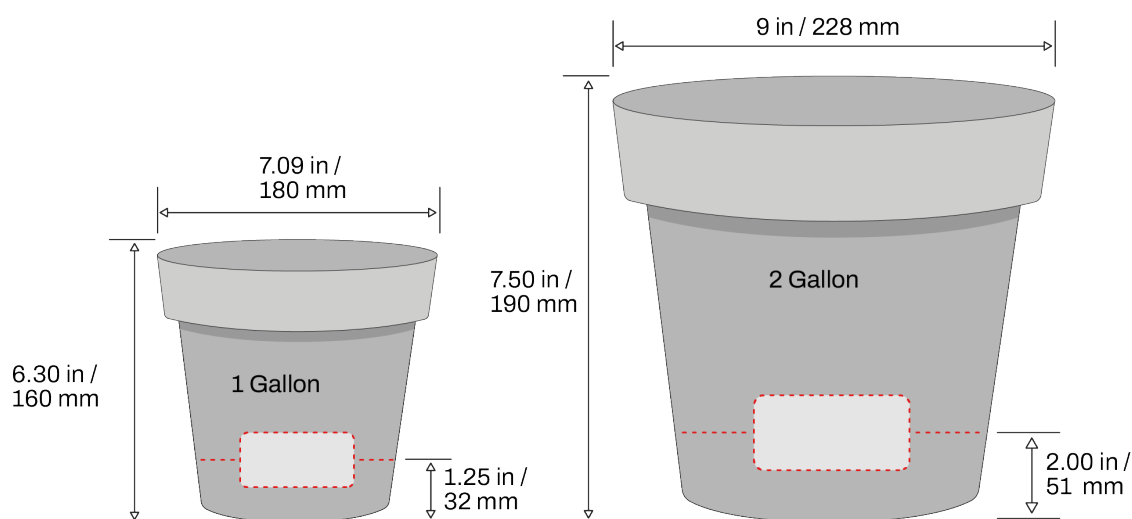


Figure 6: Recommended installation positions for pots

## Installing the Sensor

### Inserting Prongs into the Substrate

When the position of the sensor is chosen, installation of the sensor can be started. When inserting the prongs into the substrate take into account the following:

- Insert the sensor prongs fully into the substrate so that no part of the prongs remains exposed. Figure 7 illustrates correct and incorrect installation of prongs into slab, however this applies for any of the substrates types used.

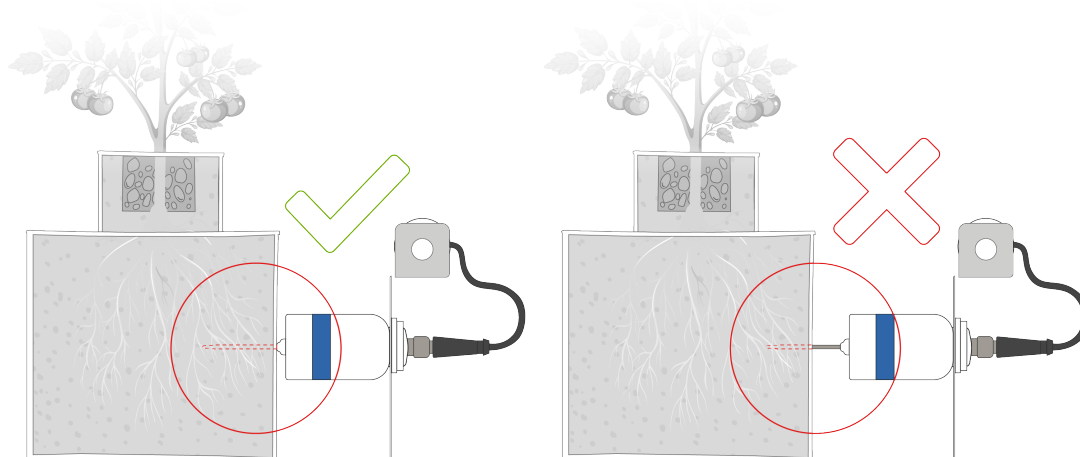


Figure 7: Insert prongs fully into the substrate

- When installing the sensor from the side, insert the prongs parallel to the substrate base with as little angle as possible.
- Ensure that sensors are placed at the same height and position across all samples or containers to maintain consistent and comparable measurements.
- Avoid reinstalling the sensor in the same holes, as this can create air gaps between the prongs and substrate. If the sensor must be reinserted, choose a new nearby location to form fresh contact with the substrate.
- Keep the sensor pins at least 30 mm away from the container edge to avoid edge effects. Although horizontal side installation is recommended, vertical installation (from the top down) is possible. Vertically placed sensors typically record lower **VWC** values, and the medium around the pins may dry faster than surrounding substrate.

### Interaction Between Multiple Sensors

Keep a minimum distance of 100 mm between any two sensors to prevent electromagnetic interference and inaccurate readings, see Figure 8. This 100 mm spacing applies to both sensor prongs and sensor bodies—they should not be closer than this in any orientation.

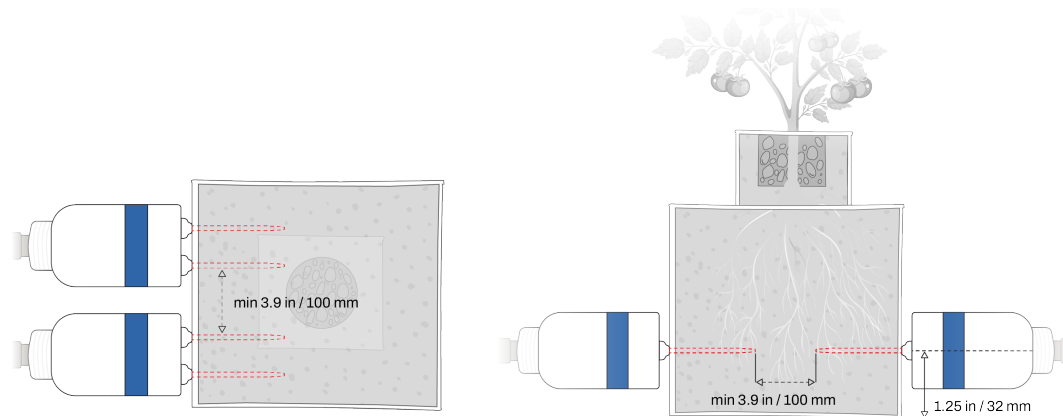


Figure 8: Representation of minimum distance between two sensors is 100 mm. Dimensions in illustration is not in scale!

### Outdoor Installation in Soil

When used for outdoor (field) soil moisture measurements, the WET150 sensor should be entirely buried in the soil so that the sensing prongs are surrounded by undisturbed soil. This ensures stable reading and protects the sensor from temperature fluctuations, direct sunlight, and mechanical damage. However, this guideline material mainly focuses on greenhouse applications.

### Positioning the Transmitter

If the sensor uses an extended cable, position the transmitter body (white housing) above the plant canopy to ensure strong and reliable wireless communication. If a longer cable is required, use the WET150 Transmitter Extension Cable for proper installation.

### Taking Initial Measurements

After installation, perform at least one full saturation cycle to ensure that the substrate reaches its theoretical maximum volumetric water content (**VWC**). If the sensor is relocated or reinserted, resaturate the substrate to the runoff level. This eliminates air pockets that may have formed during installation and ensures accurate and stable readings.

## Base Station and Aranet Cloud Configuration, and Data Representation

To get the most accurate and reliable results from your Aranet Soil Sensor WET150, it's essential to configure the sensor correctly after installation. This involves selecting the correct Volumetric Water Content (**VWC**) profile for your substrate. Both the Aranet Base Station **GUI** and Aranet Cloud offer identical configuration options once the sensor is paired with the base station. The setup process and interface are the same on both platforms. Figure 9 shows the setting options during sensor configuration in the Aranet Cloud user interface.

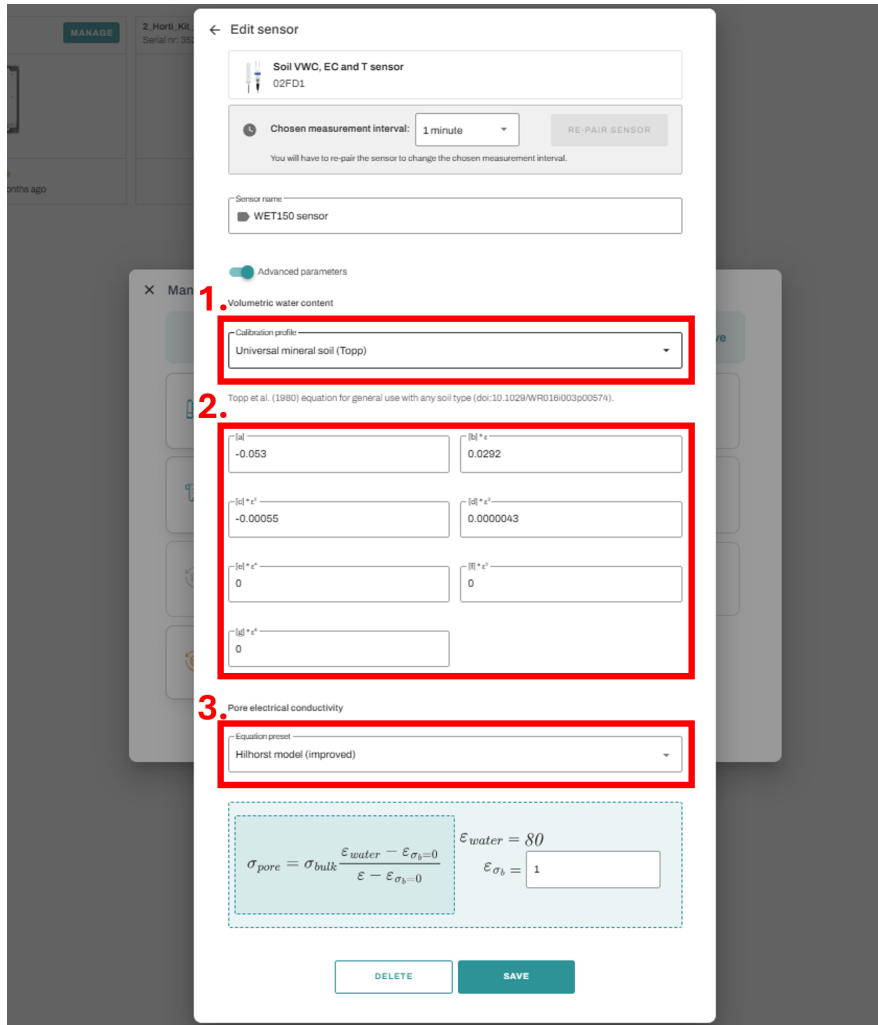


Figure 9: Setting options during sensor configuration in the Aranet Cloud user interface

In this window, you can adjust the following settings:

1. Calibration Profile – This is the most important step. Choose a profile that matches your growing substrate. Selecting an incorrect profile will reduce measurement accuracy.
2. Custom Profile Parameters – If you have your own calibration data, you can enter custom coefficients here to create a custom profile.
3. Hilhorst Model Selection – Choose between two models:
  - Hilhorst model
  - Hilhorst model (improved) — this version provides better accuracy at lower **WVC** values and is generally recommended.

## Choosing the Right Calibration Profile

There are six preset **WVC** profiles available in the Aranet Base Station for the WET150 sensor. These presets are designed for the most common substrate types but can be edited or customized if none of the presets fit your specific growing media. You can adjust the coefficients and save the configuration as a custom profile.

Different sensors may require different calibration profiles even for the same substrate type. Aranet provides dedicated calibration profiles for both the WET150 and TEROS 12 sensors manufactured by METER Group, see Figure 10.

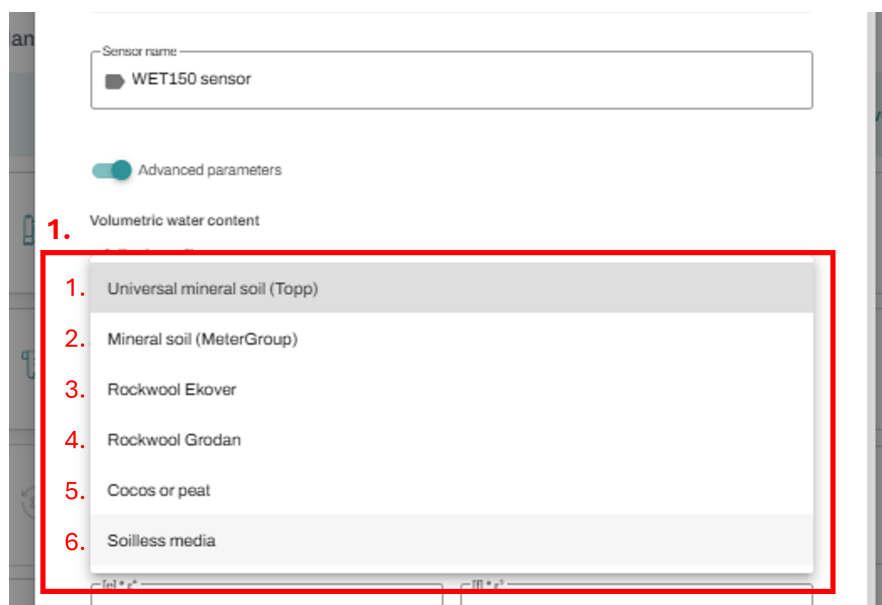


Figure 10: List of calibration profiles available during sensor configuration

Because **VWC** sensors may show slight variations between units, it's important to select the profile that best fits your sensor and substrate type. The table below summarizes the six preset profiles, the corresponding growing media, and their optimal **VWC** ranges. Substrates with narrower **VWC** ranges provide higher accuracy within those limits.

Generally, substrates can be grouped into three main categories:

- Mineral soils
- Coir (coco peat)
- Wool (rock wool)

If your growing medium matches one of these substrate types, select the 1st Choice Profile from the table below. If the expected **VWC** range does not align with your usual water content, use the profile with the maximum **VWC** range instead. If the readings appear inconsistent, try the 2nd Choice Profile as an alternative.

Growing medium	1st choice profile	2nd Choice profile
Mineral soil	Mineral soil (MeterGroup) for 0–60% <b>VWC</b>	Universal mineral soil (Topp) for 0–100% <b>VWC</b>
Mineral soil with additional constituents (e.g., coir, peat, perlite)	Universal mineral soil (Topp) for 0–100% <b>VWC</b>	Mineral soil (MeterGroup) for 0–60% <b>VWC</b>
Rock wool: Ekover Grunt Tomato, Grunt Green 1.0, Grunt Green 2.0, and analogues	Rockwool Ekover for 0–100% <b>VWC</b>	Rockwool Grodan for 0–100% <b>VWC</b>

Rock wool: Grodan DM32 40/40 Hugo, Grodan GT Master, Grodan Prestige, and analogues	Rockwool Grodan for 0–100% <b>VWC</b>	Rockwool Ekover for 0–100% <b>VWC</b>
Coco coir, coco peat, and their mixtures	Soilless media for 0–100% <b>VWC</b>	Custom calibration*
Other rockwool blocks and slabs; medium and fine perlite; other soilless media	Soilless media for 0–100% <b>VWC</b>	Rockwool Grodan for 0–100% <b>VWC</b>

Always verify that the selected profile corresponds to your specific substrate composition and moisture characteristics. Using the correct profile ensures that **VWC** and **EC** readings accurately reflect the physical properties of your growing medium, leading to more precise irrigation and nutrient control.

For custom calibration, contact Aranet technical support.

To verify the performance and accuracy of the **Aranet Soil Sensor WET150**, you can compare its readings with another reference measurement. This can be done by using an additional WET150 sensor or another soil moisture sensor installed under the same growing conditions. Alternatively, overall water content changes can be monitored with a weighting solutions. Aranet provides **Aranet Weight Sensor** (product number TDSPSV02), as well as **Slab Weight Sensor** (product number TDSPSS01), which provides an independent measurement reference.

The existing calibration profiles are designed to perform reliably in moderately saline nutrient solutions with electrical conductivity (**EC**) values between 0–8 dS/m. These profiles assume the sensor is installed horizontally (from the side). Installing the sensor vertically (from the top) or using it in environments with higher **EC** values may introduce some measurement discrepancies.

## Notes for Coco-Peat Substrates

One of the most common substrates in horticulture is the group of materials derived from coconut husks — coco coir and coco peat. These materials vary in their composition of coco pith, chips, and fiber, which affects their physical and water retention properties.

- Coco coir (coco fiber): Coarser and more fibrous, with lower density and higher aeration. It holds less water and drains more easily.
- Coco peat: Finer and more powder-like, with high water-holding capacity. When used alone or mixed with potting soil, it can retain large amounts of water.

Another organic substrate often used in horticulture is peat moss (peat). Despite the similar name, peat is not related to coco peat — it is formed from the partial decomposition of sphagnum moss and other plants. Like coco substrates, peat contains no mineral soil particles.

Volumetric Water Content (**VWC**) readings can differ significantly between these substrates, especially above 60% **VWC**. Figure 11 shows an example of Aranet Soil Sensor WET150 measurements in three substrate types using the Soilless Media profile.

Sensors were installed at a height of 32 mm from the bottom, and measurements were taken using a moderately saline

solution ( $\approx 4$  dS/m).

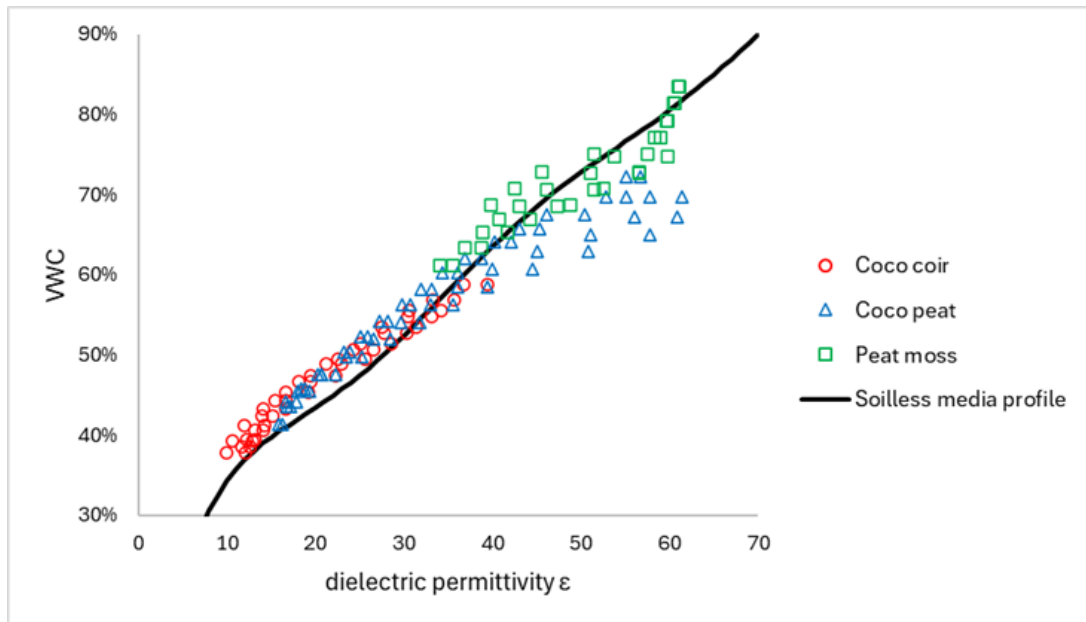


Figure 11: Example of measurements in different substrate types by using Soilless Media profile

The results indicate that:

- Coco peat retains more water due to its fine pith fraction and shows a larger **VWC** range
- Coco coir has coarser particles and thus lower water retention
- Peat moss holds a substantial amount of water, which is often difficult to drain

In general, the Soilless Media profile provides reliable results across these substrates. However, for coco peat, the sensor may slightly overestimate **VWC** values above 60%. When monitoring high saturation levels in coarser coco substrates, consider that the actual water content may be up to 10% lower than the measured value.

## Viewing Your Sensor Data in Aranet

To view all of the data the sensor gives you from the Aranet Cloud or the Base Station GUI, you must first enable the desired metrics or Cloud, click this button on the sensors tab:

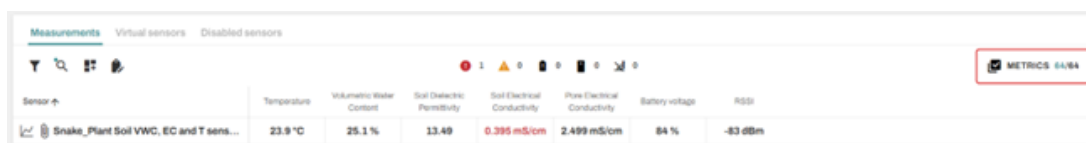


Figure 12: Menu for metric selection in Base Station user interface

On the right side of the screen, select which metrics you want to display—such as **VWC**, **EC<sub>b</sub>**, and **EC<sub>p</sub>**—to access them quickly.

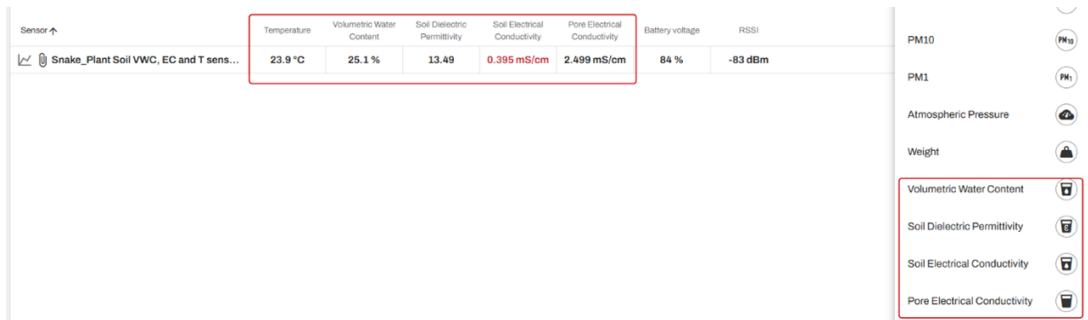


Figure 13: Selecting metrics in Base Station user interface

You can also view these metrics and corresponding graphs in the Analytics section of the Cloud. In the Base Station interface, open the Graphs section. Click the Metrics button, then select Show for each parameter you want to see.

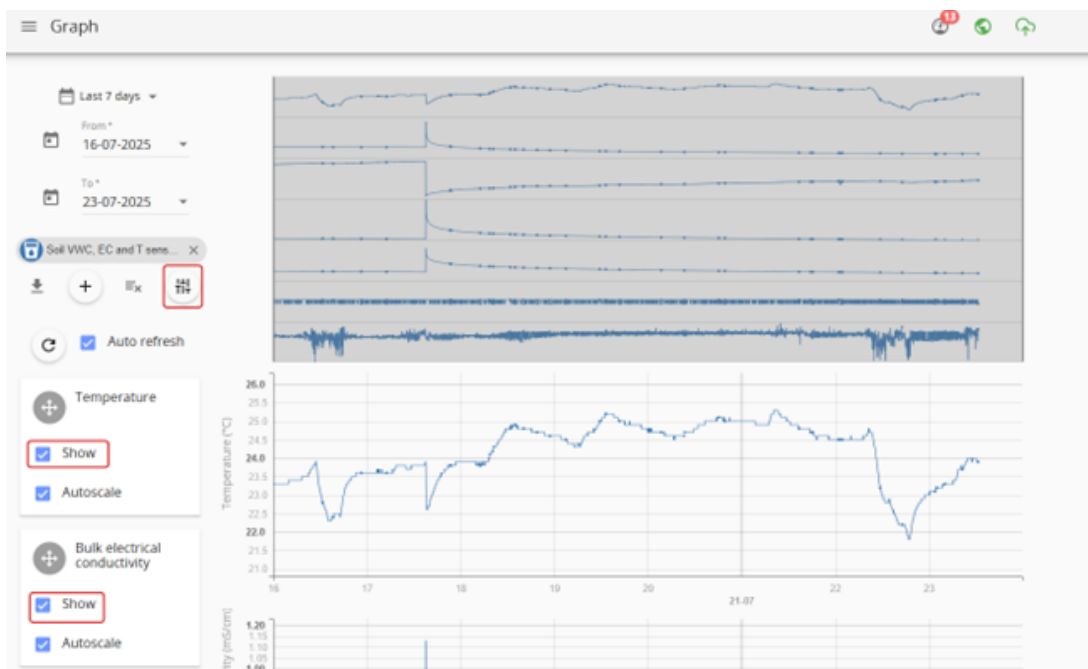


Figure 14: Example of graph view

## Example of Data Interpretation

Once multiple metrics are enabled, the graphs can provide useful insights into water dynamics and electrical conductivity under various growing conditions.

In Figure 15, the graphs show **VWC**, **ECb**, and **ECp** data. The values change in cycles as water is added to maintain substrate saturation. Over time, plants absorb water and evaporation occurs, causing **VWC** (orange curve) to decrease until the next irrigation. When more water is applied, **ECb** (blue curve) rises—since irrigation water or fertilizer solution typically has higher electrical conductivity than dry substrate. This makes **ECb** an indirect indicator of how much water is present.

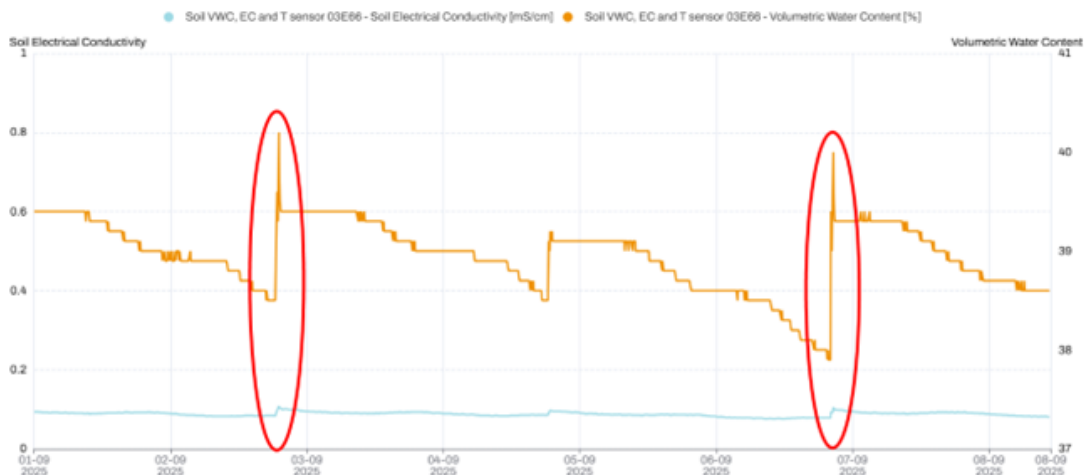


Figure 15: Example of VWC and EC data

Figure 16 shows the relationship between bulk electrical conductivity (**EC<sub>b</sub>**) and pore electrical conductivity (**EC<sub>p</sub>**). Generally, higher **EC<sub>b</sub>** corresponds to higher **EC<sub>p</sub>**, but this can vary as conditions change. When the substrate dries slightly, water content decreases while salts remain in the medium. These effects can balance out, so **EC<sub>b</sub>** may appear stable.

Sometimes, **EC<sub>p</sub>** increases even as **EC<sub>b</sub>** decreases. This happens because the Hilhorst or Hilhorst (improved) model used in the calculations adjusts for low **VWC** values. As shown in the Hilhorst model explanation examples in Figure 17 and Figure 18, **EC<sub>p</sub>** can rise slightly when **VWC** decreases while **EC<sub>b</sub>** stays constant.

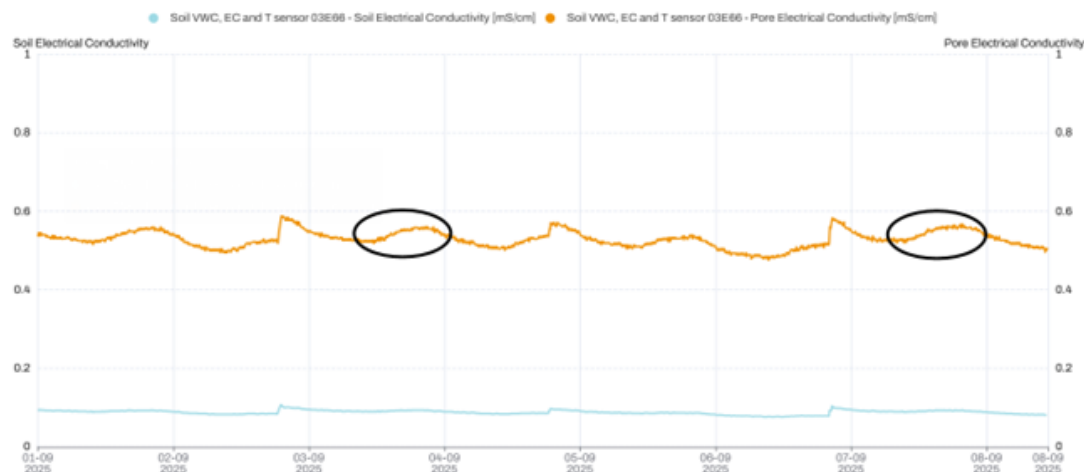


Figure 16: Example of relationship between bulk electrical conductivity (**EC<sub>b</sub>**) and pore electrical conductivity (**EC<sub>p</sub>**)

In practice, small changes in **VWC** can lead to short fluctuations in **EC<sub>p</sub>**. If the substrate becomes very dry and **EC<sub>b</sub>** reaches its minimum value, the sensor may show unusually high or even negative **EC<sub>p</sub>** readings. With the Hilhorst (improved) model, this behavior typically occurs only when the sensor is exposed to air.

## What Can Influence Measurement Accuracy?

The most important factor affecting measurement accuracy is installation — where and how you install the sensor has the greatest impact on data quality. Even small variations in placement or substrate contact can significantly change readings.

Below are the key factors that influence accuracy:

- Positioning: Sensor placement strongly affects VWC readings.
  - When the sensor is installed closer to the bottom of the pot or slab, **VWC** will appear higher because this area retains more water due to drainage.
  - When placed from the top, **VWC** will appear lower since gravity causes water to accumulate at the bottom.
- Edge Effects and Interference - If the sensor is placed too close to pot edges or other sensors, interference may occur, affecting accuracy.
  - When sensors face each other at the same or similar height, keep at least 1 cm (0.4 in) between their prongs.
  - When installed through the same substrate plane, maintain at least 2 cm (0.8 in) separation between sensors.
- Air Gaps - Any part of the sensor prongs exposed to air will drastically reduce accuracy. This can happen if:
  - The cable weight slowly pulls the sensor down, exposing part of the prongs.
  - The sensor is reinserted into the same holes, which no longer fit snugly and allow air pockets.
  - The pot is moved after installation, loosening the substrate around the sensor.

Always ensure firm, even contact between the sensor and substrate.

- Substrate Homogeneity - Install the sensor in a uniform section of the substrate — avoid areas with air pockets, uneven compaction, or debris. This is particularly important for potting soils, where structural variation can distort readings.
- Roots, Rocks, and Metals - Objects such as roots, rocks, or ferrous metals near the prongs can alter the sensor's electromagnetic field. Keep at least 25 mm of clearance around the sensor prongs to minimize interference.
- Calibration Profile - The calibration profile selected in the Aranet Base Station or Cloud settings also impacts accuracy. Each substrate type has its own **VWC** calibration curve. Using the wrong profile can lead to readings that differ by 10–20% from the actual value. Always select the correct substrate profile for your growing medium.
- Sensor Tolerances - Each sensor has its own inherent measurement uncertainty that cannot be fully eliminated. For WET150 sensors:
  - **VWC** accuracy is  $\pm 3\%$  from 5 – 100% vol, provided the calibration matches the substrate
  - **Ecb** accuracy is  $\pm (0-500 \text{ mS/m})$ , provided the calibration matches the substrate

For example: If one WET150 sensor measures 33% **VWC** and another measures 38% **VWC** in the same pot (using the same calibration), both readings are correct. The first sensor's true range is 30 – 36% The second's is 35 – 41% The overlap (35–36%) represents the most likely actual **VWC** value. This applies to other compatible sensors, such as Teros-12, which may have slightly different calibration profiles and tolerances.

## Theoretical Background

The WET150 sensor operates using frequency-domain impedance measurement at 100 MHz to determine the dielectric constant of the surrounding material.

The sensor generates a short electromagnetic pulse around its pins, producing a field that covers approximately 0.4 L of the surrounding medium. This electromagnetic field interacts with the substrate, altering the capacitance between the sensor's electrodes. By analyzing these changes, the sensor captures both the real and imaginary components of impedance.

From these simultaneous measurements, the WET150 processor calculates the dielectric permittivity (**DP**) of the medium. Because the dielectric permittivity is closely related to water content, it is possible to determine the water content of any soil or substrate if certain composition properties are known.

### Dielectric Permittivity and Volumetric Water Content (VWC)

Dielectric permittivity (**DP**) is a key parameter needed to determine volumetric water content (**VWC**).

**VWC** is defined as the ratio of the volume of water contained in a sample to the total sample volume. Soils and substrates are composed of three main components:

- solid matter (organic or inorganic)
- water and water solutions
- air

Changes in the proportions of these components alter the permittivity value. For reference:

- the dielectric permittivity of air at 20 °C is approximately equal to 1
- the dielectric permittivity of water is approximately equal to 80

Most soil measurements fall somewhere within this range.

The relationship between **VWC** and **DP** depends on the specific soil or substrate type. This relationship is non-linear across the full range of water content, meaning that as **DP** increases, **VWC** also increases — but not in a strictly linear way. It is generally assumed that the permittivity of the solid portion of a soil or substrate remains constant. Therefore, changes in measured permittivity primarily reflect changes in water content. To ensure accurate results across a variety of applications, the Aranet Base Station provides calibration profiles for different soil and substrate types.

### Electrical Conductivity (EC)

Electrical conductivity is the ability of a material to conduct electric current and is directly related to the concentration of dissolved salts (ions). Fertilizers are often applied to supply nutrients to plants. However, when nutrient concentrations are too low or too high, plants can experience stress. Because nutrient concentration is proportional to electrical conductivity (**EC**), monitoring **EC** helps maintain optimal soil productivity for your chosen growing strategy.

The WET150 sensor measures bulk electrical conductivity (**ECb**) from impedance data, which represents the overall conductivity of the soil–water–air mixture. Using this value, along with the measured water content, the sensor can calculate pore electrical conductivity (**ECp**).

- **ECb** represents the general salinity level of the soil

- **EC<sub>p</sub>** represents the conductivity of the solution within soil pores — in other words, the concentration of soluble salts available to plants

**EC<sub>p</sub>** is calculated from **EC<sub>b</sub>** using the Hilhorst equation. For more details, refer to: *Hilhorst, M.A. (1998). Dielectric Characterisation of Soil. ISBN 90-5485-810-9.*

While bulk **EC (EC<sub>b</sub>)** provides insight into overall soil salinity, pore **EC (EC<sub>p</sub>)** indicates the nutrient availability within the substrate. When the substrate is saturated with fertilizer solution, **EC<sub>p</sub>** values are typically higher than **EC<sub>b</sub>** values. Both parameters depend on the amount of water present — more water generally results in higher **EC** readings. However, after drainage or evaporation, salts can accumulate, leading to increased conductivity even as water content decreases. This is why volumetric water content (**VWC**) and electrical conductivity (**EC**) provide complementary information essential for managing plant health and optimizing growth.

In the Aranet Base Station, users can select between two models for **EC<sub>p</sub>** calculation:

- the Hilhorst model
- the Hilhorst model (improved)

The improved model includes a modification that reduces inaccuracies at low **VWC** values. Aranet recommends always using the improved Hilhorst model for best accuracy.

**EC<sub>p</sub>** is calculated from **EC<sub>b</sub>** using the Hilhorst formula shown below. In this expression:

$\epsilon$  (epsilon) and **EC<sub>b</sub>** are direct sensor measurements, while  $\epsilon_{\text{water}}$  and  $\epsilon_{\text{EC}_b=0}$  are constants. For further details, refer to: *Hilhorst, M.A. (1998). Dielectric Characterisation of Soil. ISBN 90-5485-810-9*, and the Delta-T Devices web page for WET150

$$EC_p = \frac{\epsilon_{\text{water}}}{\epsilon - \epsilon_{\text{EC}_b=0}} EC_b = \frac{80}{\epsilon - 4.1} EC_b$$

However, the Hilhorst equation is less accurate when there is insufficient water present. For better performance in low **VWC** conditions, use the improved Hilhorst model included in the Aranet PRO base station configuration settings for the Soil sensor (WET150). This model provides more stable **EC<sub>p</sub>** measurements with smaller data fluctuations when substrate **VWC** is low.

$$EC_p = \frac{\epsilon_{\text{water}} - \epsilon_{\text{EC}_b}}{\epsilon - \epsilon_{\text{EC}_b}} EC_b = \frac{80 - 1}{\epsilon - 1} EC_b$$

The graphs in Figure 17 show how the modification of the Hilhorst equation changes the appearance of pore conductivity values. When we approach low water levels in substrate, bulk electrical conductivity typically also decreases. We choose a low **EC<sub>b</sub>** value of 0.2 dS/m to represent **EC<sub>p</sub>** output one can get at a lower range.

In Figure 17 the dependence of **EC<sub>p</sub>** on the volumetric water content is by using Rockwool Grodan profile. At about 15% **VWC**, the Hilhorst model approaches very large pore conductivity values. To decrease this effect, Hilhorst modified model shifts this peak to provide more realistic **EC<sub>p</sub>** at the lower range of **VWC**. In a real-life scenario, high values can appear in the air or dry substrate.

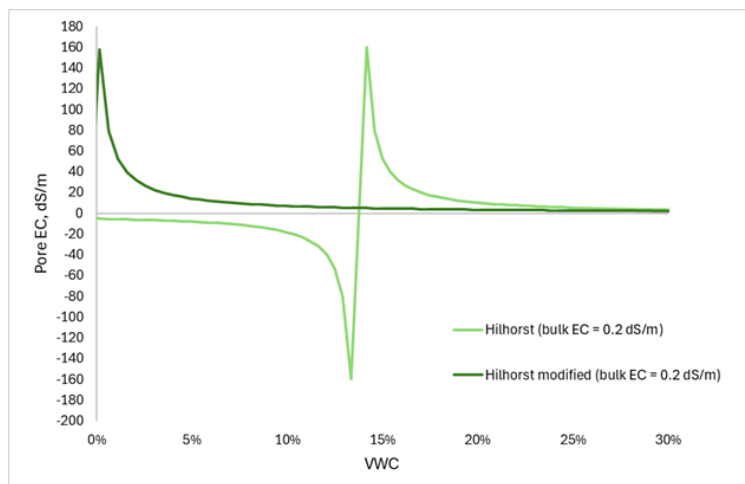


Figure 17: Dependence of pore EC on VWC content of Rockwool Grodan profile

The graph in Figure 18 shows a similar dependence on Soilless media profile. Here, unrealistically high values can appear at about 20% VWC. Modified model peak is also found at the low VWC range.

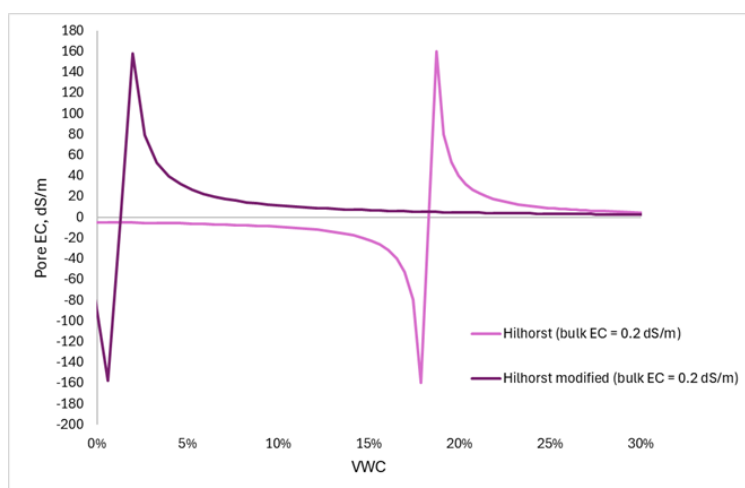


Figure 18: Dependence of pore EC on VWC content. Soilless media profile.

## Temperature (T)

Along with dielectric permittivity and bulk electrical conductivity, the WET150 output gives temperature measurements. **DP**, **EC<sub>b</sub>**, and **EC<sub>p</sub>** are temperature-dependent. Generally, in a sodium chloride (**NaCl**) water mixture, conductivity increases approximately by 2% per °C. For **EC<sub>b</sub>**, the exact rate can vary depending on soil type and water content. The relationship between the dielectric permittivity of the soil and temperature is less predictable. However, the permittivity of water or pore permittivity decreases by approximately 0.37 per increase in °C (*Kaatze and Uhlendorf, 1981*).