

1. Soil Moisture Sensors

Decagon Devices, Inc. provides a number of sensors to measure soil/substrate moisture, temperature and electrical conductivity. The moisture sensors are capacitance sensors and provide indirect measurement of soil moisture. Capacitance sensors measure the dielectric permittivity of a medium, which can then be translated to moisture content. Soil properties such as soil texture, electrical conductivity and temperature are factors that affect the readings of capacitance sensors.

Decagon Devices, Inc. provides both analog and digital capacitance sensors. The digital sensors are calibrated against dielectric permittivity standard to improve repeatability of readings.

EC-5 and 10HS Sensors

Both the EC-5 (Figure 1) and 10HS (Figure 2) sensors are analog sensors and give volumetric water content of soils/substrates by measuring the dielectric permittivity of mediums. The sensors have two prongs that have dimensions of 5 cm (EC-5) and 10 cm (10HS). The 10HS sensor, however, has a volume of influence that is much higher than the EC-5 sensor (1320 ml vs 240 ml). The EC-5 and 10HS are low cost soil moisture sensors that can be deployed in sensor networks to provide accurate soil moisture reading with minimal interference from soil salinity and texture.

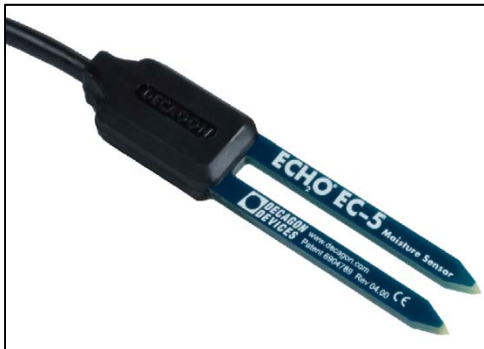


Figure 1. EC5 sensor (Courtesy of Decagon Devices, Inc.)



Figure 2. 10HS sensor (courtesy of Decagon Devices, Inc.)

Due to its relatively small volume of influence, the EC-5 sensor is suitable for use when accurate soil moisture reading from a specific area is required, for example in small sized pots. The 10HS sensor, on the other hand, has a large volume of influence and is suitable for use with large pots and when accurate measurements over large areas are required.

Both 10HS and EC-5 are analog sensors with raw/voltage output. Although raw readings from these sensors can be utilized to estimate soil moisture conditions, it is strongly recommended to calibrate the sensors for the specific substrate they are to be used with. During installation, these sensors need to have a good contact with the substrate/soil for proper reading. Presence of air gaps between sensor surface and substrate/soil can easily lead to inaccurate reading.

The sensors are easy to install in soils in the field and can simply be installed in nursery pots as well. Their sharp prongs and flat surface makes them suitable for use in soils/substrates without any type of

disturbance. When working with hard surface and in soils with gravels, care must be taken not to break the sensor prongs.

5TM and 5TE Sensors

Both the 5TE (Figure 3) and 5TM (Figure 4) are digital sensors that measure soil temperature in addition to soil moisture. The 5TE sensor also measures electrical conductivity. Both sensors give accurate readings in most soils and soilless substrates with minimal interference from soil salinity and textural effects. The small and compact size makes these sensors easy to install and use in fields and get undisturbed readings. They can also be used in greenhouse conditions as well as laboratories.



Figure 3. 5TE sensor (Courtesy of Decagon Devices, Inc.)



Figure 4. 5TM sensor (Courtesy of Decagon Devices, Inc.)

The 5TE and 5TM sensors measure the various parameters independently. VWC is determined by measuring the dielectric constant of the media, using 70 MHz frequency to minimize salinity and textural effects. Temperature is measured using onboard thermistor. The 5TE measures electrical conductivity using a stainless steel electrode array. VWC readings are obtained using calibration equations, whereas temperature and electrical conductivity readings are factory calibrated for all soil types. Factory calibrations for VWC are provided for mineral soils and a number of soilless substrates. Decagon Devices, Inc. also provides calibration service at a cost.

The 5TE sensor is suitable to monitor salt levels in soils as it measures bulk electrical conductivity. However, appropriate care must be taken during installation to make sure there is good contact between the stainless steel electrode and the soil particles. The presence of large air spaces/pores in soilless substrates makes the 5TE sensor not suitable for use.

GS3 Sensor

The GS3 (Figure 5) is a rugged soil moisture, electrical conductivity and soil temperature digital sensor. The three parameters are measured independently. Volumetric water content is determined by measuring the dielectric constant. As the sensor used a 70 MHz frequency, textural and salinity effects are minimized. Temperature is measured with onboard thermistor. Electrical conductivity is measured using stainless steel needles.

The GS3 sensor stainless steel needles make it suitable for insertion into dry soil and hard substrates. The extended surface area of the stainless steel needles, as opposed to 5TE sensors, optimizes EC

measurements and makes it suitable for use in very porous media such as soilless substrates. The GS3 sensor can also be used in soils. With proper installation, the GS3 sensor can give continuous data without need for any maintenance.



Figure 5. GS3 sensor (Courtesy of Decagon Devices, Inc.)

All of the sensors provided by Decagon Devices, Inc. are compatible with Em50 series data loggers and can be used without any need of programming. However, these sensors are also compatible for use with other data loggers (such as Campbell Scientific data loggers) as they have SDI-12 communication options. In addition, all sensors are optimized to function in a wide range of environmental conditions and to minimize textural and soil salinity effects. Full list of the sensors provided by Decagon Devices, Inc. can be found from their [website](#).