RHT – Soil Moisture sensor
(Rev.3 011019)

Description and measuring principle

The probe measures the dielectric constant of the soil in order to find its volumetric water content. Since the dielectric constant of water is much higher than that of air or soil minerals, the dielectric constant of the soil is a sensitive measure of water content.

The RHT sensor supplies a 70 MHz oscillating wave to the sensor prongs that induces an electromagnetic field in the medium (soil) surrounding the sensor.
The charging and discharging of the sensor is controlled by the dielectric of the surrounding soil.

A microprocessor on the sensor measures the charging of the sensor, and therefore the dielectric constant of the soil which is related to the water content of the soil. The microprocessor makes a dielectric measurement and updates the transmitted current once per second.

The transmitted 4-20 mA current can be converted to the water content of the soil using a simple calibration function.
The RHT was designed to be used with standard 4-20 mA controllers and monitoring systems

Advantages

- ✓ High accuracy
- ✓ Suitable for the main applications
- ✓ No maintenance and long lifetime
- ✓ Low time of response

Main applications

- ✓ Meteorology and Hydrogeology
- ✓ Irrigation Systems and Agriculture
- ✓ Biocompost monitoring and landfills
- ✓ Monitoring of forests

Specifications

Model	RHT-I – Soil moisture sensor
Range	0 – 0.57 m3/m3 (0 -57% VWC Soil volumetric water content)
Transducer	Electromagnetic
Output	Standard 4…20 mA, 2-wire analog transmitter
Power requirements	+7…32Vdc (typ. 12Vdc); Overvoltage and Reverse polarity protections included
Accuracy	± 1-2% VWC with medium-specific calibration in most porous medium ± 4 % VWC with factory mineral soil calibration in a typical mineral soil;
Resolution	Depends on current measurement (data acquisition) device
Measurement Time	1s
Operating Temperature	-40…+50 °C
Cable	5 m, 3 wires (22 AWG tinned Red and Black wire, 24 AWG tinned bare wire)
Dimensions	8.9 x 1.8 x 0.7 cm

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Testing the Sensor

After integrating the RHT into your PLC or other data acquisition system, it is always a good idea to test the sensor output to verify that it is functioning correctly with your system. Two convenient test conditions are having the sensor surrounded by air and water. To test in air, suspend the sensor from the cable, making sure that it is at least 6 inches from any object. To test in water, place the sensor in a bucket of tap water (do not use de-ionized or distilled water). The entire sensor (prongs + black plastic electronics portion) should be immersed in water, and should be at least 2 inches from any container surface. Under these conditions, the sensor should transmit in the following ranges (approximate):

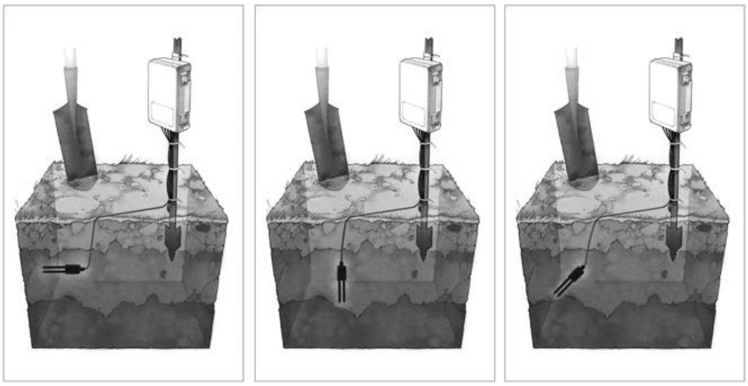
- Air: 3.4 to 4.7 mA
- Tap water: 18.1 to 22.4 mA

Installing the RHT

When selecting a site for installation, it is important to understand that the soil adjacent to the sensor surface has the strongest influence on the sensor reading and that the sensor measures the volumetric water content. Therefore any air gaps or excessive soil compaction around the sensor can profoundly influence the readings. Also, do not install the sensors adjacent to large metal objects such as metal poles or stakes. This can attenuate the sensor's electromagnetic field and adversely affect sensor readings. Because the RHT has gaps between its prongs, it is also important to consider the size of the media you are inserting the sensor into. It is possible to get sticks, bark, roots or other material stuck between the sensor prongs, which will adversely affect readings. Finally, be careful when inserting the sensors into dense soil, as the prongs will break if excessive sideways force is used when pushing them in.

Procedure

1. The RHT sensor was designed for easy installation into the soil. After digging a hole to the desired depth, push the prongs on the sensor into undisturbed soil at the bottom of the hole or into the sidewall of the hole. Make sure that the prongs are buried completely up to the black overmolding. The sensor may be difficult to insert into extremely compact or dry soil. If you have difficulty inserting the sensor, try loosening the soil somewhat or wetting the soil. Never pound it in!
2. Carefully backfill the hole to match the bulk density of the surrounding soil. Be careful to not over stress the cable or overmold by bending when installing the sensor.



Orientation

The sensor can be oriented in any direction. However, orienting the flat side perpendicular to the surface of the soil will minimize effects on downward water movement.

Removing the Sensor

When removing the sensor from the soil, do not pull it out of the soil by the cable! Doing so may break internal connections and make the sensor unusable.

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Calibration

The current transmitted by the RHT is proportional to the dielectric permittivity of the medium surrounding the sensor, and therefore its volumetric water content (VWC) of the medium. The VWC is calculated by applying a calibration equation to the current transmitted by the RHT. The following are generic calibration equations for common growth media. Applying these equations will generally result in accuracy of ± 4% VWC as long as the electrical conductivity of the medium is less than 8 dS/m. If you wish to use the RHT in a medium that isn't listed below, if you need better than ± 4% accuracy, or if you are working in a high salinity material, then you should develop a custom calibration for your particular medium.

Mineral Soils

A single calibration equation will generally result in good accuracy for all mineral soil types with electrical conductivity < 8 dS/m. VWC is given by:

$VWC = 0.00328 * mA^2 - 0.0244 * mA - 0.00565$

If your data acquisition system isn't capable of higher order mathematical operations, the mineral soil calibration can be approximated by the following linear model. This will result in slightly worse accuracy at low VWC, with errors becoming large above 35% VWC.

$VWC = 0.0479 * mA - 0.391$

Potting Soil/Peat

The following equation can be used to convert RHT transmitted current into VWC in potting soil and peat potting mixes. Please note that different potting soil types are quite variable, so this calibration equation may not result in good accuracy in your particular mix (although precision should still be good). We recommend a custom calibration for best accuracy when using the RHT in potting soils.

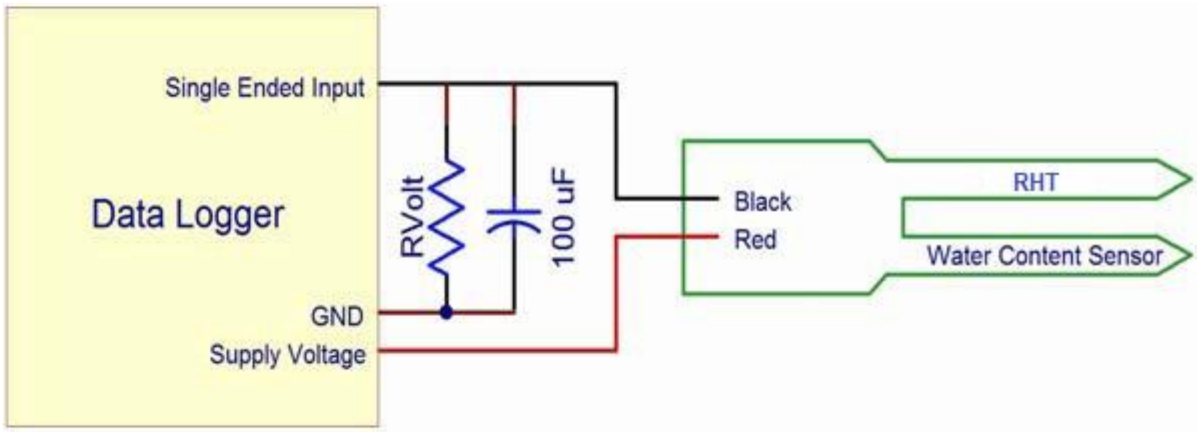
$VWC = 0.00531 * e^{(0.29*mA)}$

Rock Wool

The RHT was calibrated in several eletrical conductivities. VWC can be calculated as:

$VWC = 0.00446 * mA^2 - 0.0359 * mA + 0.0741$

Electrical connection



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