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New approach to water content measurements in soil core using microwave probing

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Abstract – A new approach for water content determination in an *in situ* soil at depths ranging from the soil surface down to a few meters in soil profile is under development. The concept of this method is based on a core drill that will be equipped with a multi-probe sensor working at radio and microwave frequencies. The objective of the presented research focuses on the study of the multi-probe sensor that was carried out on sandy soils and clay.

This solution is based on reflection and transmission measurements using several probes arranged on the circumference of a metal tube. The use of various probes allows us on one hand to detect thresholds of the water in soil and on the other hand to diagnose the homogeneity of the material under test. This sensor is incorporated in a test bench composed of a VNA and a Switch Matrix that allows the VNA to connect with the 6 probes of the sensor. The measurements are the reflection of each probe and the transmission between two identified probes in a band of frequencies between 100MHz and 12GHz.

The first series of measurements with the multiprobe sensor was carried out on sand containing 0 to 20% water with increments of 5%. From the reflection coefficient values of each probe and the transmissions between two respective probes, we were able to verify the variation related to the increase of the water content in the sand. This determination of the water content is made from the modulus of the reflection coefficient and the different cases of transmissions between two probes.

In conclusion, a new concept of a multi-probe sensor, for the determination of a soil moisture profile in the relatively loose and homogeneous sandy and clayey soil has been developed and tested. Thus, we were able to evaluate thresholds of water content in the sand of around 5% with this sensor. In order to continue the study of the sensor, we now plan to test more complex soils, but especially to extrapolate this multi-probe sensor to a system using a core drill to increase the depth of testing. This is a solution to characterize soils without sampling them. Especially, it is hoped that with the developed sensor a soil profile can be measured down to several meters in depth.

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