



## **Permittivity measurement of sand and clay soil with a capacitive sensor**

S. Ferraris (1) and P. Savi (2)

(1) University of Torino, DEIAFA-Idraulica Agraria, Grugliasco (TO), Italy (stefano.ferraris@unito.it, +39 0116708619), (2) Politecnico di Torino, Dipartimento di Elettronica, C.so Duca degli Abruzzi 24, 10129 Torino, Italia.

The determination of permittivity of sand and clay soil over a wide frequency band can be useful in several applications. Fringing Capacitive sensors can be used to measure the real and imaginary part of the permittivity of materials in the RF and microwave frequency bands.

In this paper the use of a commercial capacitive sensor has been exploited in order to characterize sand and clay soils with different water content. Liquid and granular materials are particular suited for this kind of sensor because the sensor can be dipped into the sample thus avoiding contact problems between the surface of the sensor and the material as for solid one.

The measurement setup is composed by an Agilent Coaxial Probe kit 85070D, an HP 8720B Network analyzer and PC for data acquisition. This sensor works in the frequency range 200MHz-20GHz. The calibration procedure is based on three reference measurements (air, short circuit and deionized water).

The setup and the calibration procedure has been tested by measuring the permittivity of several reference liquids (methanol, ethanol, acetone, water with different salt concentration). The comparison with the Cole-Cole model was also performed. Then, several samples of sand and clay soil with different water content have been considered. This measurement technique has also been compared with a frequency domain approach for the permittivity determination based on the double-delay method.