O42. Quality assessment needs for soil water content sensors

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Electromagnetic-based water content sensor applications in monitoring networks, irrigation systems and research plots are expanding across the globe. This multi-million-dollar sensor market continues to grow despite a lack in test standards and misinformation about sensor performance. Past sensor assessments have presented mixed testing approaches and a commensurate measure of mixed results. Confusion regarding EM sensor-function, -failure rate and -value, stems from testing results that often use non-standard targets including inhomogeneous (variable density and water content) and complex materials (e.g., soils) that may not be widely available. EM sensors employ a variety of different measurement methods, both in the time- and frequency-domains (Table 1), which also operate at a variety of known or unknown measurement frequencies. Sensor output is affected by environmental impacts on circuitry (temperature) combined with effects of porous medium temperature, electrical conductivity, interfacial polarization and dielectric relaxation, which in many cases combine to increase apparent permittivity measurement error and the resulting inferred water content. Although attempts have been made to standardize testing, more work and research is needed before an international standard can be recognized and adopted.

Table 1. Breakdown of electromagnetic (EM) sensor measurement domain, theoretical basis, measurement method and sensor electrode configuration, i.e., point-scale or soil profile-scale.

	Time-Domain			Frequency-Domain		
Theory	**Ampere's- and Faraday's-Laws (GHz)**			**Gauss's Law (MHz)**		
Measurement Method	Time-Domain Reflectometry (TDR)	Time-Domain Transmissometry (TDT)	Tramission-Line Oscillator (TLO)	Impedance-Based	Frequency-Domain Reflectometry	Capacitance-Based
Point-Scale, Handheld, Mobile	TDR-P	TDT-P	TLO-P	I-P	FDR-P	C-P
Segmented, Soil-Profile	TDR-S	TDT-S	TLO-S	I-S	FDR-S	C-S

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