

TIME DOMAIN REFLECTOMETRY PHASE VELOCITY ANALYSIS FOR MEASURING APPARENT DIELECTRIC SPECTRUM OF SOIL

Yin Jeh Ngui, National Chiao Tung University

Chih-Ping Lin

Chun-Hung Lin, National Chiao Tung University, LLC

Abstract

Soil moisture measurements using conventional time domain reflectometry (TDR) signal analysis only generated single-valued apparent dielectric constant (K_a) while sophisticated measurement system is required for measuring spectral complex dielectric permittivity (CDP), limiting experimental convenience and restricting field monitoring applicability. Niching between both approaches, phase velocity analysis (PVA) method is applied in TDR signal interpretations to efficiently measure apparent dielectric spectrum (ADS) of soil in a direct, simple, quick, model-free, and inversion-free nature. By extracting the two reflections from top and end of sensing probe by proper window selection, ADS of soil can be determined from the phase velocity computed from their phase shift at each frequency. Numerical results demonstrated that ADS of soil can be generated from PVA in some frequency band, typically from 100 MHz to 1 GHz. By inspecting correlation of soil volumetric water content to corresponding K_a at various frequencies, soil moisture measurement with frequency-dependent dielectric properties can be obtained. Simple procedure and computationally efficient nature of PVA allows robust field soil moisture monitoring and further PVA applications in geo-environmental measurement is potentially advantageous.

Keywords: Phase velocity analysis, TDR, dielectric spectroscopy, apparent dielectric spectrum, soil moisture