Factors Influencing MiniVNA-Based Dielectric Measurements using Bilinear Analysis

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Soil dielectric permittivity spectrum measurements contain hidden details that inform about the physical and chemical properties of the subsurface. Permittivity spectra have been widely used in industrial applications and could play an important role in quality determination of food products and other porous media including soil. Spectral measurements provide real and imaginary dielectric values, which are key factors for analyzing electromagnetic characteristics. The MiniVNA is a network analyzer with a broad frequency range between 1 and 3000 MHz. The USB-powered device is housed in a small light-weight box with a price tag around $500. Dual SMA-type connectors are provided for S11 and S21 measurements of dielectric spectrum. Bilinear analysis is employed to establish the relationship between the scattering parameter (S11) and dielectric values. Compared with a high-end vector network analyzer (VNA), the outputs are well correlated. Our overall goals were to evaluate and integrate the bilinear model, open-ended probe design and calibration methods, along with identifying factors affecting the dielectric measurement accuracy and ways to improve it.