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Polarization at TDR probe rods: An issue when collecting waveforms with the TDR100

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Time Domain Reflectometry (TDR) is commonly used to determine the soil bulk electrical conductivity. To obtain accurate measurements, the three parameters of a series resistor model (probe constant, K_p; cable resistance, R_C; and remaining resistance, R_0) are typically calibrated using liquids with known electrical conductivity. Several studies have reported discrepancies between calibrated and directly measured parameters of the series resistor model. In this study, we suggest that a technical issue with the TDR100 cable tester contributed to part of these inconsistencies. Our results show that with an increasing level of waveform averaging the reflection coefficient, as well as the calibration parameters K_p, R_C, and R_0, approached a maximum value. A comparison with independently determined values indicated that a high level of waveform averaging provided the physically most plausible results. Based on our results, we propose to average at least 16 waveforms each consisting of at least 250 points. An oscilloscope-based signal analysis showed that the increase in reflection coefficient with increasing waveform averaging in saline media is related to a capacitance associated with electrode polarization in combination with a change in the pulse period of the pulse train when the TDR100 starts collecting data points. This capacitance resulted in a slow change of the average voltage in the TDR pulse train until a stable average voltage was reached. Higher levels of waveform averaging cancel the impact of the first erroneous voltage measurements out. In practical applications, the errors in the determination of the bulk electrical conductivity can be as high as 5% for the low conductivity range (< 0.1 S m^{-1}) and up to 370% in saline media (~ 1.4 S m^{-1}), when waveform averaging is changed after calibration.