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Exact Model for the Cable Losses in TDR Electrical Conductivity Measurements

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We developed a model for accounting for extra probe ohmic dissipations (indicated as cable losses) in TDR measurements of electrical conductivity (σ). The feeding line (including cable, connectors, multiplexers etc.) is modeled as a generic two port network, and its behavior at low frequency analyzed using basic results from network theory. We found that the line is characterized by two parameters, nearly corresponding to longitudinal and transverse losses, which can be easily obtained from calibration in empty and short-circuited probe. The procedure for the validation of the model involves measurements of the sample resistance with different feeding lines, and does not require prior knowledge of the cell constant. Experimental data with cables up to 160 m confirm the correctness of our results. The analysis also shows that the popular two-resistor model (2RM) fails in the conductivity range of most interest in soil science, with relevant errors even with cables of medium length. This behavior is well explained by the equivalent circuit here suggested, and the resulting errors can be predicted, and therefore corrected. Finally, in this paper we discuss of the waveform analysis for determining the reflection coefficient. We claim that the procedure normally adopted for measuring input and reflected voltage at long time is incorrect, and indicate an alternative method.