A new TDR multiplexing system for reliable electrical conductivity and soil water content measurements

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Time domain reflectometry (TDR) is a standard method to estimate soil water content and bulk soil electrical conductivity. In many applications, several TDR probes are installed in soil columns or field setups, and TDR measurements are acquired using a multiplexing system. Commercially available multiplexers share a common ground, which might lead to inaccurate TDR measurements when probes are installed close together or at sites with high electromagnetic noise. Therefore, a new eight-channel differential multiplexer (50C81-SDM) was developed that allows communication with standard TDR equipment. In a first step, the new multiplexer was tested to analyse channel noise and channel to channel variability for all eight channels. Results of the ANOVA for the eight replicated measurements showed that the noise (inner channel variability) is larger than the channel to channel variability for the open reflection coefficient. Overall, the 50C81-SDM multiplexing system resolved all shortcomings and provided accurate soil water content and electrical conductivity data even in challenging environments with significant electromagnetic noise.

**50C81-SDM Multiplexer**

- 50 Ω differential eight channel coaxial multiplexer
- Supporting Campbell SDM communications protocol

**Experimental Setup**

- Measurement of electrical conductivity in different electrolyte solutions using different TDR spacing
- EC ranges from 0.007 S m⁻¹ to 1.553 S m⁻¹
- TDR-probes either connected to SDMX50 or 50C81-SDM
- Calculation of EC

\[
\sigma_{\text{soil}} = \frac{K_p}{R_l - (DR + R_c)}
\]

\(K_p\) = probe constant \(L\) = cable length \(R_l\) = load resistance \(D\) = cable resistance \(R_c\) = additional series resistance

**Results**

Acquiring of TDR waveforms typically used for water content and electrical conductivity estimation

Absolute difference in measured electrical conductivity [S m⁻¹] of the sand for five water contents measured by probe 1 for the SDMX50 (red curves), and probe 12 for the 50C81-SDM multiplexer (black curves) both connected to channel 1, whereby all other (passive) TDR probes were connected to channel 2. Acquired TDR waveforms at different window length with and without 50 Hz interference from ground-current at the test site Selhausen. Note that all waveform were acquired with the same TDR probe and the 50C81-SDM multiplexer either connected or disconnected from the permanent power supply.

**References**


**Acquiring of TDR waveforms:** Typically used for water content and electrical conductivity estimation.