Document Title: Description, AN, ECH2O Dielectric probes vs. TDR		Part # and Rev. 13397-02	
		Release Date: 1-12-07	
Rev.	Description	Revision By	Date

Production Filename: 13397 (In Product Library)

Path to Working Files: DecaDoc\Application Notes\Master

Dimensions: 8.5 inch wide, 11 inch tall

Material: Paper, 92 Bright White or better, 75g/m² or heavier

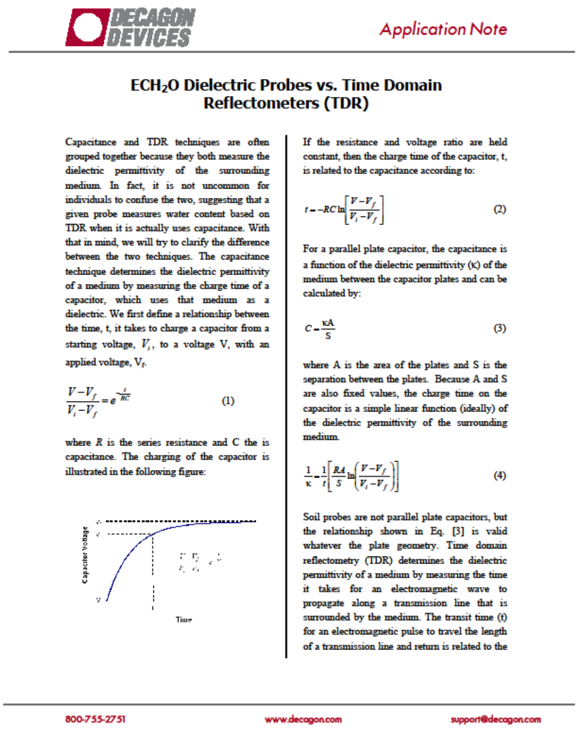
Colors: Color Print on White

Printer: HP Color LaserJet 8550-PS

Finish: None

Adhesive: None

Special Notes: Illustrations are Ref Only ** Not to Scale ** (Shown page 1 of 2)



DECAGON DEVICES Application Note

ECH_2O Dielectric Probes vs. Time Domain Reflectometers (TDR)

Capacitance and TDR techniques are often grouped together because they both measure the dielectric permittivity of the surrounding medium. In fact, it is not uncommon for individuals to confuse the two, suggesting that a given probe measures water content based on TDR when it is actually uses capacitance. With that in mind, we will try to clarify the difference between the two techniques. The capacitance technique determines the dielectric permittivity of a medium by measuring the charge time of a capacitor, which uses that medium as a dielectric. We first define a relationship between the time, t, it takes to charge a capacitor from a starting voltage, V_i, to a voltage V, with an applied voltage, V_f.

$$\frac{V-V_f}{V_i-V_f}=e^{-\frac{t}{RC}} \quad (1)$$

where R is the series resistance and C the is capacitance. The charging of the capacitor is illustrated in the following figure:

If the resistance and voltage ratio are held constant, then the charge time of the capacitor, t, is related to the capacitance according to:

$$t=-RC\ln\left[\frac{V-V_f}{V_i-V_f}\right] \quad (2)$$

For a parallel plate capacitor, the capacitance is a function of the dielectric permittivity (κ) of the medium between the capacitor plates and can be calculated by:

$$C=\frac{\kappa A}{S} \quad (3)$$

where A is the area of the plates and S is the separation between the plates. Because A and S are also fixed values, the charge time on the capacitor is a simple linear function (ideally) of the dielectric permittivity of the surrounding medium.

$$\frac{1}{\kappa}=\frac{1}{t}\left[\frac{RA}{S}\ln\left(\frac{V-V_f}{V_i-V_f}\right)\right] \quad (4)$$

Soil probes are not parallel plate capacitors, but the relationship shown in Eq. [3] is valid whatever the plate geometry. Time domain reflectometry (TDR) determines the dielectric permittivity of a medium by measuring the time it takes for an electromagnetic wave to propagate along a transmission line that is surrounded by the medium. The transit time (t) for an electromagnetic pulse to travel the length of a transmission line and return is related to the

800-755-2751 www.decagon.com support@decagon.com