<table>
<tr><td colspan="2">Document Title:
Description,
AN, Response of ECH2O
Sensor to temp</td><td colspan="2">Part # and Rev.
13394-02

Release Date:
1-12-07</td></tr>
<tr><td>Rev.</td><td>Description</td><td>Revision By</td><td>Date</td></tr>
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Production Filename: 13394 (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

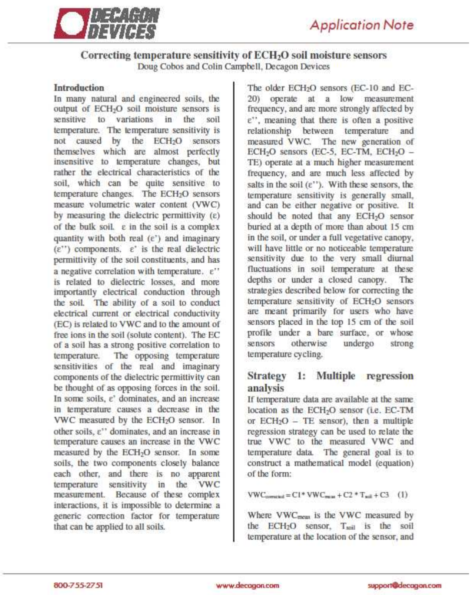
Colors: Color Print on White

Printer: HP Color LaserJet 8550-PS

Finish: None

Adhesive: None

Special Notes: Illustrations are Ref Only ** Not to Scale ** (Shown page 1 of 7)



DECAGON DEVICES Application Note

Correcting temperature sensitivity of ECH_2O soil moisture sensors

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Introduction

In many natural and engineered soils, the output of ECH_2O soil moisture sensors is sensitive to variations in the soil temperature. The temperature sensitivity is not caused by the ECH_2O sensors themselves which are almost perfectly insensitive to temperature changes, but rather the electrical characteristics of the soil, which can be quite sensitive to temperature changes. The ECH_2O sensors measure volumetric water content (VWC) by measuring the dielectric permittivity (ε) of the bulk soil. ε in the soil is a complex quantity with both real (ε') and imaginary (ε'') components. ε' is the real dielectric permittivity of the soil constituents, and has a negative correlation with temperature. ε'' is related to dielectric losses, and more importantly electrical conduction through the soil. The ability of a soil to conduct electrical current or electrical conductivity (EC) is related to VWC and to the amount of free ions in the soil (solute content). The EC of a soil has a strong positive correlation to temperature. The opposing temperature sensitivities of the real and imaginary components of the dielectric permittivity can be thought of as opposing forces in the soil. In some soils, ε' dominates, and an increase in temperature causes a decrease in the VWC measured by the ECH_2O sensor. In other soils, ε'' dominates, and an increase in temperature causes an increase in the VWC measured by the ECH_2O sensor. In some soils, the two components closely balance each other, and there is no apparent temperature sensitivity in the VWC measurement. Because of these complex interactions, it is impossible to determine a generic correction factor for temperature that can be applied to all soils.

The older ECH_2O sensors (EC-10 and EC-20) operate at a low measurement frequency, and are more strongly affected by ε'', meaning that there is often a positive relationship between temperature and measured VWC. The new generation of ECH_2O sensors (EC-5, EC-TM, ECH_2O – TE) operate at a much higher measurement frequency, and are much less affected by salts in the soil (ε''). With these sensors, the temperature sensitivity is generally small, and can be either negative or positive. It should be noted that any ECH_2O sensor buried at a depth of more than about 15 cm in the soil, or under a full vegetative canopy, will have little or no noticeable temperature sensitivity due to the very small diurnal fluctuations in soil temperature at these depths or under a closed canopy. The strategies described below for correcting the temperature sensitivity of ECH_2O sensors are meant primarily for users who have sensors placed in the top 15 cm of the soil profile under a bare surface, or whose sensors otherwise undergo strong temperature cycling.

Strategy 1: Multiple regression analysis

If temperature data are available at the same location as the ECH_2O sensor (i.e. EC-TM or ECH_2O – TE sensor), then a multiple regression strategy can be used to relate the true VWC to the measured VWC and temperature data. The general goal is to construct a mathematical model (equation) of the form:

$$VWC_{corrected} = C1 * VWC_{meas} + C2 * T_{soil} + C3 \quad (1)$$

Where VWC_{meas} is the VWC measured by the ECH_2O sensor, T_{soil} is the soil temperature at the location of the sensor, and

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