User's manual

Catalog # 6440FS

FIELD SCOUT™

TDR 100
Soil Moisture Meter

Spectrum
Technologies, Inc.

CONTENTS

This manual will familiarize you with the features and operation of your new Field Scout™ TDR 100 Soil Moisture Meter. Please read this manual thoroughly before using your instrument. For customer support, or to place an order, call Spectrum Technologies, Inc. at (800)248-8873 or (815) 436-4440 between 7:30 am and 5:30 p.m. CST, FAX at (815)436-4460, or E-Mail at info@specmeters.com.
www.specmeters.com

Spectrum Technologies, Inc at 23839 W Andrew Rd.
Plainfield, IL 60544

General overview

Thank you for purchasing the Field Scout™ TDR 100 Soil Moisture Meter. This manual describes the features and operation of the meter.

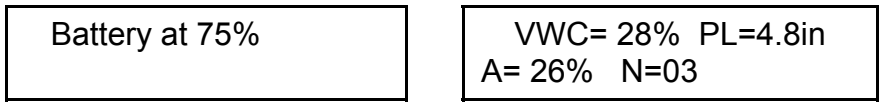
Soil moisture is a critical and, potentially highly variable component of the soil environment. Time-domain reflectometry is a proven technology for quickly and accurately determining volumetric water content in soil.

The Field Scout allows the user to easily and rapidly take many measurements. Through the software the user can change the meter settings as well as program the logger to record relative water content at multiple sites.

Meter operation

ON

The ON switch turns the meter on and off. When the meter is turned on, it will display the battery status for 3 seconds.



Sample meter power-up and data screens

The screen will then display the most recently used MODE screen (Volumetric or Relative water content).

READ

Press the READ button to read the probe and update the screen values. The data point can be cleared from memory with the DELETE/CLR

Delete
Clr Avg

When the DELETE/CLR AVG button is pressed and immediately released, the last data point will be removed from the running average. Pressing and holding this button will reset the running average.

MODE

The meter can be operated in either volumetric water content (VWC) or relative water content (RWC) mode. Press the MODE key to select the mode you are interested in.

Note: To gather RWC data, the meter must already have the "type" programmed into it's memory with the software. The software is also used to select the rod length and unit system for water deficit calculations.

Refer to the "Meter Configuration" section (pg. 3) for more details on configuring the meter.

Meter Configuration

The meter is configured with the software that accompanies the meter. The gray software cable connects the meter to the computer data port. The port in the meter is accessed by removing the meter's face plate. The port is located on the corner of the board opposite the side where the cable is connected to the probe. Use the **Com Port** button to select the port connected to the computer data port. The **Download** and **Clear Memory** buttons are not used with the TDR 100.

Meter Settings

The Meter Settings screen in the Field Scout TDR software is used to configure the meter for your specific application. The fields are described on the following page.

Meter Configuration (Cont.)

Meter Name: This feature is not important for the TDR 100.

Probe Length: Check the box associated with the length of rod installed in the probe head.

Deficit Units: When operating the meter in Relative Water Content mode, the meter will calculate and display the water deficit. Indicate whether these deficits should be displayed in inches or millimeters.

Relative Water Content Set Points: Wet and dry volumetric water content set points can be programmed into the logger for 5 different locations or soil types. Each of these locations can be given a descriptive name of 5 characters. Default values for 5 common mineral soils (using permanent wilting point and field capacity as the set points) are set at the factory with new meters. Appendix 1 (pg. 6) lists general water-holding characteristics for several mineral soils.

Refer to "Relative Water Content" (p. 5) for more details.

Taking Measurements

The volumetric water content is the ratio of the volume of water in a given volume of soil to the total soil volume. At saturation, the volumetric water content (expressed as a percentage) will equal the percent pore space of the soil.

The underlying principal of TDR involves measuring the travel time of an electromagnetic wave along a waveguide. The speed of the wave in soil is dependent on the bulk dielectric permittivity (ε) of the soil matrix. The fact that water (ε = 80) has a much greater dielectric constant than air (ε = 1) or soil solids (ε = 3-7) is exploited to determine the VWC of the soil. The VWC measured by TDR is an average over the length of the waveguide.

Electronics in the TDR 100 generate and sense the return of a high energy signal that travels down and back, through the soil, along the waveguide composed of the two replaceable, stainless steel rods. The sampling volume is an elliptical cylinder that extends approximately 3 cm out from the rods. The high frequency signal information is then converted to volumetric water content.

When taking a measurement, it is important that the rods be fully inserted into the soil. If not, part of the sampling volume will be composed of air and the reading will be inaccurately low. For the same reason, the probe should be inserted with a steady, downward pressure. If the rods are wiggled into the soil, air pockets can be created adjacent to the rods that will result in low readings. The probe should not be struck with a hammer or other blunt instrument as this can cause damage to the internal electronics. Also, care should be taken to ensure the rods are inserted as parallel to one another as possible. This will not have a large affect on the reading but will decrease the chances the rods will be bent or broken. Likewise, it is best to avoid areas with rocks or other material that can cause the rods to deflect or bend.

Factors Affecting Measurements

The TDR 100 senses changes in dielectric permittivity to measure volumetric water content (VWC). However, high amounts of clay (>30%) and high electrical conductivity (EC>2 dS/m) will attenuate the high-frequency signal and affect the reading displayed by the meter. Very high organic matter content will similarly affect the VWC reading.

The meter will still respond to changes in water content. But, the internal equation that converts the electrical response to water content will not be identically applicable. In these cases, if an independent soil moisture content measurement is available, it is possible to generate a conversion from VWC measured by the meter to actual VWC. This is most easily accomplished by regressing one set of data against another. If the independent water content measurement is gravimetric (weight based) water content (GWC) rather than volumetric water content, some useful relations to keep in mind when doing the regression are:

$$GWC = \frac{(\text{wet weight of soil} - \text{oven dry weight of soil})}{\text{oven dry weight of soil}}$$

VWC = Volume of water in soil/ Total soil volume

Bulk Density = oven dry weight of soil/Total soil volume

VWC = (GWC * Bulk Density)/Density of water

Relative water content

RWC= 58% DEF=1.2in
A= 61% N=06 PLFLD

In addition to displaying volumetric water content, the meter can also display and record the relative water content (RWC) and Water Deficit (refer to Meter Operation, p. 3). RWC is an index value calculated with respect to upper (wet) and lower (dry) volumetric water content set points. The set points are configured with the software "Meter Configuration" section (pg. 4) . An RWC of 0 indicates the soil is at the dry set point while an RWC of 100 indicates the soil has reached the wet set point. It is possible to get a negative RWC or an RWC greater than 100 if the soil's volumetric water content is outside the range of the set points.

The water deficit is the amount of rain or irrigation water necessary to raise the soil water content to the wet set point. This calculation applies to a soil depth equal to the probe rod length. The water deficit can be extrapolated further into the profile if the porosity and water-holding characteristics are similar to the volume of soil sampled by the probe.

Specifications

Measurement Units	Percent volumetric water content
Resolution	1.0%
Accuracy	±3.0% volumetric water content with electrical conductivity <2 dS m^{-1} and clay content < 30%
Range	0% to saturation (Saturation is typically around 50% volumetric water)
Power	4 AAA alkaline batteries Approximately 12 month life
Display	16 character, 2 line LCD
Weight	1.5 lbs. (0.68 kg)
Probe Head Dimensions	4.1" x 2.8" x 0.7" (10.5cm x 7cm x 1.8cm)
Rod Dimensions	Length : 4.8" (12cm) or 7.9" (20cm) Diameter: 0.2" (0.5cm) Spacing: 1.3" (3.3cm)

The meter's LCD screen displays data in two forms: Volumetric water content and Relative water content mode.

Appendix 1
Soil moisture Guideline

The following table gives a general idea of the volumetric water content for various mineral soils at field capacity (FC) and permanent wilting point (PWP). The water holding characteristics and bulk density (ρ_b) of any given soil will not exactly match the tabulated values.

Soil Type	FC (%)	PWP (%)	ρ_b (g/cm^3)
Clay	44.3	21.7	1.3
Clay Loam	35.7	16.9	1.4
Loam	31.1	14.2	1.4
Loamy Sand	18.4	8.1	1.6
Sand	14.8	6.3	1.6
Sandy Clay	33.4	16.3	1.4
Sandy Clay Loam	29.4	14.0	1.5
Sandy Loam	21.3	9.5	1.5
Silt	38.4	17.2	1.2
Silty Clay	39.9	19.2	1.3
Silty Clay Loam	39.8	18.7	1.2
Silty Loam	35.3	16.0	1.3

Table A.1: Water holding capacities and bulk densities for selected mineral soils. (New Mexico Climate Center)

Warranty

The Field Scout™ TDR 100 Soil Moisture Meter is warranted to be free from defects in materials and workmanship for a period of 1 year from the date of original purchase. During the warranty period, Spectrum will, at its option, either repair or replace products that prove to be defective. This warranty is void if the product has been damaged by customer error or negligence, or if there has been an unauthorized modification.

Returning Products to Spectrum

Before returning a failed unit, you must obtain a Returned Goods Authorization (RGA) number from Spectrum. You must ship the product(s), properly packaged against further damage, back to Spectrum (at your expense) with the RGA number marked clearly on the outside of the package. Spectrum is not responsible for any package that is returned without a valid RGA number or for the loss of the package by any shipping company.

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