FIELDSCOUT®

Direct Soil EC Meter

PRODUCT MANUAL

Item #'s
2265FS, 2265FSTP

Spectrum®
Technologies, Inc.

CONTENTS

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

Spectrum Technologies, Inc.
3600 Thayer Court
Aurora, IL 60504

Introduction

Congratulations on the purchase of your FieldScout Direct Soil EC Meter. This instrument has been specifically designed for direct measurement of salts in soil media as well as water or nutrient solutions. This manual describes how to use your meter and keep it working accurately for many years. Please read it thoroughly to get effective performance from your meter.

The salinity of the soil solution, irrigation water or fertilizer solution is an important parameter affecting the root zone environment. Any of these factors can have a significant effect on plant growth and physiology. The easiest way to monitor salinity is by measuring the electrical conductivity (EC). EC is strongly correlated to the salinity of the soil solution. EC measurement is also affected by temperature and, to a lesser degree, by soil moisture content.

Use this portable EC meter and probe to measure salinity in greenhouse soil media right on the spot without tedious soil sampling and preparation. Greenhouse production managers can compare readings from plant to plant and fine-tune their fertility program because measurements can be made directly in a plug tray cell without cannibalizing the seedlings. Turf managers can monitor for high salt levels on golf course greens and determine when to flush (leach) salts before turf quality declines.

The meter comes with the Field Scout Soil/Water EC probe. This single, stainless steel probe has a specially designed conical tip. It can measure liquid EC (water or nutrient solutions) or in-situ soil salinity. The probe automatically compensates for temperature.

EC Probe

Electrical conductivity (EC) is an important parameter in evaluating irrigation water and fertilizer solutions. Crops can be damaged if irrigated with water with a high conductivity. The quality of irrigation water has been classified into 5 separate categories (See Appendix 3, p. 21). EC is also an indicator of the strength of fertilizer solutions. In greenhouse applications and other situations requiring frequent fertilization, EC should be checked regularly to ensure the plants are getting sufficient nutrients while avoiding the effects of salt toxicity. See Appendix 2 (p. 20) for a list of preferred EC values for some common plants. Typically, younger plants will require lower EC than mature plants.

The stainless steel soil EC probe is designed to be inserted directly into soil. The sensing surface is composed of 2 pairs of electrodes on the probe tip. Additionally, the probe is narrow in diameter so it can be used effectively in plug trays.

Because EC readings are affected by moisture content, it is important that soil moisture content does not differ significantly between readings. An easy way to achieve this condition is by taking measurements approximately 30 to 60 minutes after an irrigation. This should ensure the soil moisture level has approximately reached field capacity.

The probe should be inserted in the root zone. The measurement region is at the tip of the probe. For turf, the root zone is approximately 2" - 4". For vegetables and small plants, this is about 8" - 12". Wait until the meter reading stabilizes before withdrawing the probe. Taking several measurements will allow a representative average to be computed.

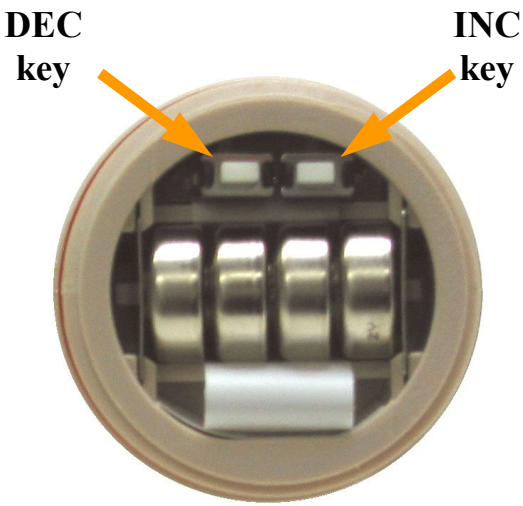
Important: Do not touch the sensor tip with your fingers. The oils on the skin will affect the probe's measurement accuracy.

PROBE CALIBRATION

The meter and probe are factory calibrated. However, to ensure accuracy, the meter should be calibrated at least once a month. The meter is shipped with 2.76 mS/cm calibration solution. If you are interested in calibrating to a concentration less than 2 mS/cm, you will need to change the range mode of the meter to AUTO (see **Range Selection,** p. 9). Periodically, the calibration of the meter can be checked by immersing the sensor in the calibration solution. This solution should not be re-used at a later date.

Calibration Procedure

1. Open battery compartment lid on the top of the meter to access the small white Increment (**INC**) and Decrement (**DEC**) calibration keys. When looking at the battery compartment with the calibration keys above the batteries, the **DEC** key will be to the left.



2. If necessary, clean the probe with alcohol to remove any residual oils. Rinse the electrode tip in de-ionized (or distilled) water and then rinse it in the calibration standard.

3. Switch unit on with the **ON/OFF** button. Place probe tip into a container of calibration standard. Take care that the 4 exposed electrodes on the tip are not touching the side or bottom of the container holding the buffer solution. Wait for display to stabilize (display value is unchanged and stable for 3 seconds).

4. Pressing either calibration key will put the meter into CALIBRATION mode. Press the **INC** or **DEC** key to adjust the reading. If a key is held down, the adjustment will happen more rapidly.

5. When the EC of the calibration standard is reached, release the keys for 3 seconds. The temperature reading will briefly flash “CO”. The Waterproof EC Tester accepts the calibration value and returns to MEASUREMENT mode.

NOTE: After calibration, the probe should read 0.01 mS/cm or less in air.

Meter Configuration

The digital reader for the Field Scout EC meter is shipped in Manual, 1-Point calibration, HI range mode. In this mode, the EC units will always be displayed as mS/cm. If you are working with less concentrated solutions and want to calibrate or read at a lower concentration, the range mode should be changed to one of the other modes. This will allow the meter to read in units of μS/cm.

Configuring the calibration mode

1. Switch off the display.
2. Press and hold the **INC** key (see p. 6 for diagram of calibration keys) then simultaneously press the **ON/OFF** button to switch on the display. The meter will go into calibration selection mode.
3. The lower display shows "A.CAL" and the upper display blinks the current choice (YES or NO). Press either the **INC** or **DEC** key to select the NO option. This disables the Automatic calibration mode and configures the display for Manual calibration.
4. Press the **HOLD/ENTER** button to confirm the selection. The display shows "CO".
5. After 1 second, the lower display will show "1.Pnt" and the upper display blinks the current choice (YES or NO). Press either the **INC** or **DEC** key to select the YES option. This enables the 1-Point calibration option.
4. Press the **HOLD/ENTER** button to confirm the selection. The display shows "CO" and, after a few seconds, goes to measurement mode.

Range selection

1. Switch off the display.
2. Press and hold the **°C/°F** button then press and release the **ON/OFF** button to switch on the display. Release the **°C/°F** button. The meter will go into Range selection mode and the lower display will show the current choice. The options are "AUTO", "PU", "LO", and "HI". See table 1 for a description of each range.
3. Press the **HOLD/ENTER** button to select the desired option. If the **HOLD/ENTER** button is not pressed quickly after the **°C/°F** button is released, the meter will transition to measurement mode. Return to step 1 and repeat.

Abbreviation	EC Range
PU	0 to 200.0 µS/cm
LO	0 to 2000 µS/cm
HI	0 to 20.00 mS/cm
AUTO	Automatic

Table 1. Definition of the 4 EC range modes that can be set on the meter. The mode will be displayed briefly during the meter power-up sequence.

Direct Soil EC Readings

Greenhouse Soils

The stainless steel probe of the Field Scout Soil & Water EC Meter can be inserted directly into the soil. By taking measurements at different soil depths, you can determine where the fertilizer is concentrated in the soil. Be aware that the soil moisture content will significantly influence the measured EC value. To ensure accurate measurement, it is recommended that in-situ readings be taken when soil moisture is close to field capacity or saturation. The probe tip (sensor) must be held still in the soil to achieve a stable measurement. Soil EC measurements made with soils at field capacity or saturation will have readings 10-15% more than SME measurements due to a lesser amount of water in the soil.

Soil EC measurements should be made 30-60 minutes after irrigation.

Procedure

- Press **On/Off** button to power up the meter.
- Insert the probe tip 1 inch below soil surface.
- Wait for reading to stabilize (stable for 3 seconds) [Automatic Temperature Compensation (ATC) will correct for temperature changes].
- Repeat at 1 inch increments in the pot.

Golf Course Greens

A similar procedure can be followed for golf course greens following irrigation or deep-soaking rain event. Probe to the depth of the turf root zone. Measurements exceeding 0.7 mS/cm (approximately equivalent to 2.7 mS/cm in a saturated paste extract) will result in cool season turf grass stress. See Appendix 4 (p. 22) for more details.

SME Measurement

Saturated Media Extract (SME) Measurements

Growth media used in most greenhouse operations is high in organic material and processed materials and low in mineral soil. These materials are easier to handle, are well aerated and have good moisture-holding properties, but have limited ability to retain nutrients. Therefore, tests developed for field soils do not always yield meaningful results. Saturated Media Extract (SME) analysis has been shown to eliminate these problems. The samples should not be dried, sieved or pulverized as this will affect the growth medium properties and alter the results. Traditionally, the soil solution from the saturated medium is extracted by a vacuum pump. However, the Field Scout Soil & Water EC Meter allows the saturated sample to be tested directly.

Procedure

- Moisten the media sample with distilled water to reach a consistent “saturated” moisture level. When saturated, the media should glisten and slide from the mixing spatula with little or no free water.
- Wait 15 minutes and add more water if needed. The sample should have the consistency of a paste with slightly more water than if the media was in a pot and fully irrigated.
- Press On/Off button to power up the meter.
- Insert the probe tip into the media and read the results.

Liquid measurement/ Other Features

Water (Liquid) Measurements

The Field Scout Soil & Water EC Meter can also measure the EC of liquids. Simply dip the electrode tip into the solution and wait for the reading to stabilize (a stable reading occurs when the readout has not changed for 3 seconds).

Other Features

Hold

Pressing the **HOLD/ENTER** button will freeze the display. Press **HOLD/ENTER** again to release.

Temperature Units

Press the **°C/°F** button to toggle between displaying temperature in Fahrenheit and Celsius.

Auto Ranging

If the meter's range mode is set to AUTO (see **Meter Configuration**, p. 8), the LCD will automatically transition from mS/cm to μS/cm as the unit of measure when the EC value gets smaller (about 2 mS/cm). They differ by a factor of 1000. For example: 1 mS/cm = 1000 μS/cm.

Maintenance/ Battery Replacement

Maintenance:

To improve performance and avoid transferring soil-borne diseases, clean the sensor tip by rinsing in alcohol for 5 - 10 minutes.

Replace all batteries if low battery indicator appears, or if readings are faint or unstable.

Store the probe sensor dry.

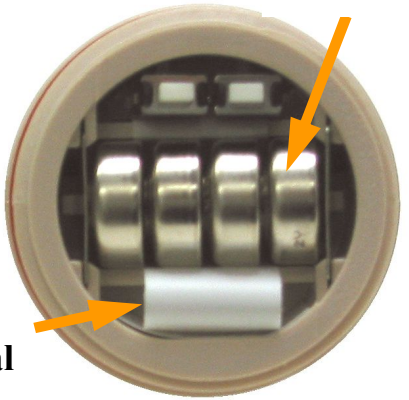
Important: Do not touch the sensor tip with your fingers. The oils on the skin will affect the probe's measurement accuracy.

Changing Batteries:

1.) Open battery compartment lid (located near the LCD screen).

2.) Remove and replace the old batteries. Note polarity shown in battery compartment. When inserting new batteries, take care to place them over the white removal tab. This will make future battery removal much easier.

3.) Recalibrate meter after every battery change.



Probe/Tip Replacement

If the probe cannot be calibrated, or if it does not hold the calibration for a reasonable amount of time, the probe or tip must be replaced. Current versions of the 24" T-handle probe come with a replaceable tip (item 2266). With these probes, the cable and shaft do not need to be replaced.

An "OR" reading on the LCD (see Appendix 1, p. 19) may indicate a failed probe or simply that the probe has come unplugged from the meter. See **Checking Probe Connection** (p. 16) before replacing the probe or tip.

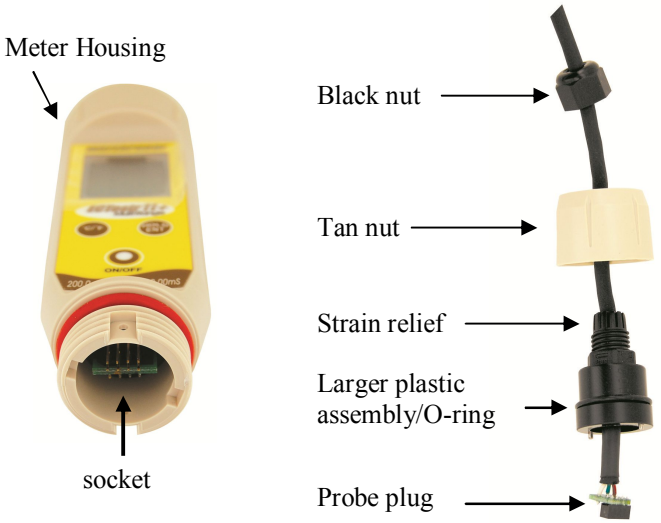
Replacing a tip (24" probes only)

The replaceable tip (left) is designed to thread in and out of the end of the probe. A new tip has two flat faces on opposite sides. This allows the tip to be tightened onto the probe with a pliers or 5/16" wrench.

I. Removing a direct-insert probe

The 8" probe and older 24" probes do not have a replaceable tip. The replacement procedure is outlined below.

1. Remove the black nut from the strain-relief where the cable feeds into the meter.
2. Remove the tan nut on the cable end of the meter.
3. Detach the probe cable plug from the socket in the meter.
4. Remove the tan nut and large o-ring. For the 24" probe, also remove the strain relief from the larger plastic assembly.



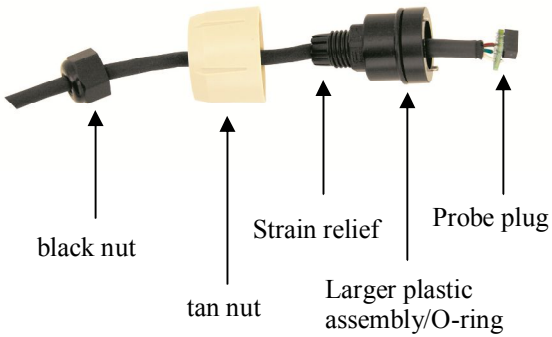
II. Attaching a direct-insert probe

1. If you are connecting an 8” probe, slide the tan nut over the probe and down the black cable. Skip to step 4.
2. If you are connecting a 24” probe, remove the strain relief from the larger plastic assembly.
3. Feed the cable and strain relief through tan nut and re-connect the strain relief and the assembly.
4. Attach the probe plug to the socket in the meter housing.
5. Push the assembly onto the meter housing so the metal pegs on the assembly line up with the notches on the inner diameter of the meter opening. Be sure that the small o-ring sits at the base of the large plastic assembly.
6. While holding the assembly in place hand-tighten the nut to the strain relief
7. Connect and tighten the tan nut to the meter housing.

Checking Probe Connection

If the meter is giving an out-of-range (OR) error message, it may be that the probe has come unplugged from the meter. The procedure for checking this is outlined below.

1. Remove the black nut from the strain-relief where the cable feeds into the meter.
2. Remove the tan nut on the cable end of the meter.
3. Ensure that the probe cable plug is firmly connected to the socket in the meter.
4. Push the assembly onto the meter housing so the metal pegs on the assembly line up with the notches on the inner diameter of the meter opening. Be sure that the small o-ring sits at the base of the large plastic assembly.
5. While holding the assembly in place hand-tighten the nut to the strain relief.
6. Connect and tighten the tan nut to the meter housing.



Resetting Meter

The reset option allows you to restore the calibration and other parameters back to factory default settings. After resetting the meter, automatic calibration should be disabled (see **Meter Configuration**, p. 8). The meter should then be calibrated.

1. Switch off the display.
2. Press and hold the **HOLD/ENTER** button and then switch on the tester using the **ON/OFF** button. Release **HOLD/ENTER** button.
3. The lower display shows “rSt” (reset) and the upper display blinks “No”. **INC** or **DEC** key to select “Yes” (to reset to factory defaults) or “No” (to quit without resetting).
Note: Press **°C/°F** button if you wish to skip to measurement mode without making any selection.
4. Press the **HOLD/ENTER** button to confirm your selection. LCD displays “CO”. LCD shows power-up sequence and tester goes to measurement mode.

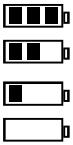
Parameter	Factory Default
Temperature unit	Celsius (°C)
Auto calibration	Enabled
1-point calibration	Enabled

Specifications

Readout	LCD digital display
EC Range	0.00 - 19.99 mS/cm
Temperature Range	0 - 55 °C (32 - 122 °F)
Accuracy	EC: ±1% Full Scale Temperature: ±0.5 °C
EC Resolution	0.01 mS/cm
Calibration	1-point, manual calibration
Temperature Compensation	Automatic from 0 to 50°C
Power	Four LR44 1.5V alkaline batteries
Battery Life	150 hours
Auto Shutoff	After 8.5 minutes
Probe Length	2265FS (2265PROBE) 7.7 in (19.5 cm) 2265FSTP (2265FST24P) 24 in (61 cm)
Probe Diameter	2265FS (2265PROBE) 0.30 in (0.8 cm) 2265FSTP (2265FST24P) 0.35 in (0.9 cm)

Appendix 1
Diagnostic Messages

Low Battery Indicator

 - Battery 100% full
- Battery 50% full
- Battery 25% full
- Replace battery soon

OR/UR (steady)
- Measured EC or temperature value exceeds specified maximum or minimum value.
- Sensor electrodes have short circuited.
- Sensor probe tip may need to be replaced.

- Sensor is not connected properly (see **Checking Probe Connection** p. 16).

OR/UR/ATC (blinking)
- Short or open circuit at the built-in temperature sensor.

Er.0
- Temperature not within specified range.

Er.1
- EC not within specified range.

Appendix 2
Preferred EC Values for Selected Plants

Plant	EC (mS/cm)
Asparagus	1.5 - 2.0
Watermelon	1.5 - 2.5
Carrot	1.5 - 2.0
Cabbage	2.0 - 3.0
Cucumber	2.0 - 3.0
Crysanthemum	1.5 - 2.5
Onion	1.5 - 2.0
Bean	2.0 - 2.5
Strawberry	2.0 - 2.5
Lettuce	1.0 - 1.5
Eggplant	2.5 - 3.0
Melon	1.5 - 2.5
Potato	2.0 - 3.0
Pepper	2.0 - 3.0
Pea	1.0 - 1.5
Tomato	2.5 - 5.0
Celery	2.0 - 2.5
Marrow	2.0 - 2.5

Recommended soil EC for selected vegetable crops.

Note: The values on this table refer to measurement of a saturated media extract (SME).

	Recommended EC Value (mS/cm)		
	SME [a]	1 to 2 [b]	Pour thru
Poinsettia during weeks 2-12.	2.0 - 3.0	0.85 - 1.25	2.8 - 4.1
Pansies during active growth.	0.25 - 1.5	0.1 - 0.6	0.35 - 2.1
Geraniumus during active growth.	1.6 - 2.4	0.65 - 1.0	2.2 - 3.3

Comparison of substrate tests for various EC sampling methods. (Calvins, Whipker, and Fonteno, North Carolina State University).

[a] saturated media extract
[b] 1 part soil to 2 parts water

Appendix 3
Classification of Irrigation Water

Excellent	EC < 0.25 mS/cm
Good	0.25 mS/cm < EC < 0.75 mS/cm
Permissible	0.75 mS/cm < EC < 2.0 mS/cm
Doubtful	2.0 mS/cm < EC < 3.0 mS/cm
Unsuitable	EC > 3.0 mS/cm

Categories of irrigation water quality based on electrical conductivity. [Wilcox L.V. (1948) The Quality of Water for Irrigation Use, USDA Technical Bulletin 962]

Appendix 4
Interpreting EC Readings From Turf Grass

When taking direct-insert EC readings in turf grass with the Field Scout meter, it is often helpful to convert the measurement to the equivalent Saturated Media Extract (SME) value. This conversion will vary for different soils. For sandy soils, the expression:

SME = 2.7FS + 0.8

provides a good approximation. FS refers to the reading taken by the Field Scout meter. This equation is the basis for table 1. Table 2 lists a variety of grass species and the range of EC values (converted to SME) they can tolerate.

FS	SME	FS	SME	FS	SME
0.1	1.1	1.1	3.8	2.1	6.5
0.2	1.3	1.2	4.0	2.2	6.7
0.3	1.6	1.3	4.3	2.3	7.0
0.4	1.9	1.4	4.6	2.4	7.3
0.5	2.2	1.5	4.9	2.5	7.6
0.6	2.4	1.6	5.1	2.6	7.8
0.7	2.7	1.7	5.4	2.7	8.1
0.8	3.0	1.8	5.7	2.8	8.4
0.9	3.2	1.9	5.9	2.9	8.6
1.0	3.5	2.0	6.2	3.0	8.9

Table 1: Conversion from Field Scout direct readings (**FS**) to equivalent Saturated Media Extract (**SME**) values. (*Reference 9:3*. PACE Turfgrass Research Institute. San Diego, CA)

Sensitive < 3 mS/cm	Moderately Sensitive 3 - 6 mS/cm	Moderately Tolerant 6 - 10 mS/cm	Tolerant >10 mS/cm
Annual Bluegrass	Annual Ryegrass	Bent cv. Seaside	Alkaligrass
Colonial Bluegrass	Chewings Fescue	Perennial Ryegrass	Bermudagrass
Kentucky Bluegrass	Creeping Bentgrass	Tall Fescue	Seashore Paspalum
Rough Bluegrass	Hard Fescue	Buffalograss	St. Augustinegrass
Centipedegrass	Bahiagrass	Zoysiagrass	

Table 2. Relative tolerance of turfgrasses to soil salinity measured by the SME Method ("Salinity in Turfgrass", Harivandi M.A, Butler J.D., Lin W. 1992).

Note: The values on this table refer to measurement of a saturated media extract (SME) . Use table 1 to convert from direct-insert readings to SME.

Appendix 5
Greenhouse Media

Classification of Greenhouse Media

	Electrical Conductivity (mS/cm)		
Comments	**SME [a]**	**1 to 2 [b]**	**1 to 5 [c]**
Very low levels. Indicates very low nutrient status.	0 - .74	0 - .25	0 - .12
Suitable range for seedlings and salt sensitive plants.	.75 - 1.99	.25 - .75	.12 - .35
Desirable range for most established plants. Upper range may reduce growth of some sensitive plants.	2.00 - 3.49	.75 - 1.25	.35 - .65
Slightly higher than desirable. Loss of vigor in upper range. OK for high nutrient requiring plants.	3.50 - 5.00	1.25 - 1.75	.65 - .90
Reduced growth and vigor. Wilting and marginal leaf burn.	5.00 - 6.00	1.75 - 2.25	.90 - 1.10
Severe salt injury symptoms with crop.	6.00+	2.25+	1.10+

Soluble salt guidelines for greenhouse media using various media to water ratios (Testing and Nutrition Guideline, MSU Ag Facts Extension Bulletin E-1736, September, 1983).

[a] saturated media extract
[b] 1 part soil to 2 parts water
[c] 1 part soil to 5 parts water

Interpreting EC Readings from Soilless Media

The FieldScout EC meter allows for quick and easy readings of salinity in a greenhouse container. The following equations give an approximation of how a direct-insert reading relates to more conventional soil sampling techniques. The FieldScout reading is designated by the variable FS.

Pour-through Method (PT)
PT = 1.637 * FS + 0.556

1:2 Dilution (OTT)
OTT = 0.448 * FS - 0.13

Saturated Media Extract (SME)
SME = 1.178 * FS - 0.294

Source:
Scoggins, H. L., Vanlersal, M.W. 2006. *In Situ* Probes for Measurement of Electrical Conductivity of Soilless Substrates: Effects of Temperature and Substrate Moisture Content. HortScience. 41:210-214

Appendix 6
Celsius to Fahrenheit Conversion Chart

The Field Scout Soil & Water EC Meter gives temperature readings in Celsius. The conversion from Celsius to Fahrenheit is calculated with the following equation:

$$F = 9/5 * C + 32$$

This information is also contained in the following table:

C	F	C	F	C	F
0	32.0	15	59.0	30	86.0
1	33.8	16	60.8	31	87.8
2	35.6	17	62.6	32	89.6
3	37.4	18	64.4	33	91.4
4	39.2	19	66.2	34	93.2
5	41.0	20	68.0	35	95.0
6	42.8	21	69.8	36	96.8
7	44.6	22	71.6	37	98.6
8	46.4	23	73.4	38	100.4
9	48.2	24	75.2	39	102.2
10	50.0	25	77.0	40	104.0
11	51.8	26	78.8	41	105.8
12	53.6	27	80.6	42	107.6
13	55.4	28	82.4	43	109.4
14	57.2	29	84.2	44	111.2

Warranty

This product is warranted to be free from defects in material or workmanship for one year from the date of purchase. During the warranty period Spectrum will, at its option, either repair or replace products that prove to be defective. This warranty does not cover damage due to improper installation or use, lightning, negligence, accident, or unauthorized modifications, or to incidental or consequential damages beyond the Spectrum product. Before returning a failed unit, you must obtain a Returned Materials Authorization (RMA) from Spectrum. Spectrum is not responsible for any package that is returned without a valid RMA number or for the loss of the package by any shipping company.

CE

This equipment has been manufactured for
Spectrum Technologies, Inc.
3600 Thayer Court
Aurora, IL 60504 USA

The Manufacturer's **DECLARATION OF CONFORMITY** is on file at the above address, and certifies conformity to the following:

Model Number:	2265FS/2265FSTP
Description:	Electrical Conductivity Meter
Type:	Electrical Equipment for Measurement, Control, and Laboratory Use
Directive:	89/336/EEC
Standards:	EN 50081-1 (EN 55022) EN 50082-1

Douglas L. Kieffer,
Soil/Water Products Manager April 7, 2009

Spectrum®
Technologies, Inc.

3600 Thayer Court
Aurora, IL 60504
(800) 248-8873 or (815) 436-4440
Fax (815) 436-4460
E-Mail: info@specmeters.com
www.specmeters.com