



Direct Soil EC Meter

PRODUCT MANUAL

Item #'s
2266FS, 2266FSTP



Spectrum[®]
Technologies, Inc.

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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.

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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 2, p. 19). 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 1 (p. 18) 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.



METER SETTINGS

Accessing the Setup Screen

Power on the tester. Press the MENU/▼ button. The meter will briefly display the Key Info screen before transitioning to the Setup screen. Follow the instructions for the specific parameter that is to be modified. Pressing the Cal/Esc button will return you to the measurement screen.

Measurement Parameter

1. Press MENU/▼ to scroll to Measurement option.
2. Press HOLD. The display shows Cond, TDS and Salinity.
3. Use the MENU/▼ button to toggle between Cond, TDS and Salinity. Press HOLD to select desired option.
4. The display shows the selected parameter with a checkmark and returns to the Setup screen.

TDS Factor

1. Press MENU/▼ to scroll to Settings option.
2. Press HOLD. The display shows TDS factor and Backlight.
3. Use the MENU/▼ button to scroll to the TDS Factor option
4. Press HOLD. Current adjustment factor will be displayed.
5. Adjust the setting with the MENU/▼ button. Note that the setting can only be adjusted down. The value will flip to 1.00 after you scroll past 0.40.
6. Press HOLD to confirm the TDS factor setting. The display shows the TDS factor with a check mark then returns to the Setup screen.

Backlight

The backlight increases screen readability in low-light conditions.

1. Press MENU/▼ to scroll to Settings option.
2. Press HOLD. The display shows TDS factor and Backlight.
3. Use the MENU/▼ button to scroll to the Backlight option.
4. Press HOLD. The options are ON and OFF.
5. Use MENU/▼ to scroll to the desired option.
6. Press HOLD to select. The display shows the selection with a check mark and returns to the Setup screen.

Temperature units

1. Press MENU/▼ to scroll to Temp Set option.
2. Press HOLD. The display shows options
3. Press MENU/▼ to select Set °C/°F. Press HOLD.
4. Press MENU/▼ to select desired units and press HOLD to confirm. The display shows the selected unit with a check mark and returns to the Setup screen.

Temperature Calibration

1. Press MENU/▼ to scroll to Temp Set option.
2. Press HOLD. The display shows options.
3. Press MENU/▼ to select Temp Cal. Press HOLD.
4. The lower display shows the current measured temperature reading based on the last set offset. The upper display shows the current measured temperature reading based on the factory default calibration.
5. Dip the tester into a solution of known temperature and allow time for the built-in temperature sensor to stabilize.
6. Press MENU/▼ to adjust the temperature value or press HOLD to confirm the calibrated value as the new temperature value of the solution.

Note: To exit this program without confirming the calibration, press CAL/ESC.

Temperature Coefficient

1. Press MENU/▼ to scroll to Temp Set option.
2. Press HOLD. The display shows options
3. Press MENU/▼ to select Temp Coeff. Press HOLD.
4. Press HOLD to select Temp Coeff or MENU/▼ to adjust the Temp Coeff.
5. Press HOLD to confirm the Temp Coeff value. The new value is automatically confirmed with a checkmark.

User Reset

Resets the meter's calibration to the user's default settings. Temperature user calibration is not affected by the user reset function.

1. Press MENU/▼ to scroll to Reset option.
2. Press HOLD. The display shows options
3. Press HOLD to select User Reset.
4. The display automatically shows No and Yes. Use MENU/▼ to scroll to the desired option.
5. Press HOLD to confirm selection. Display shows User Reset option with a checkmark.

Factory Reset

1. Press MENU/▼ to scroll to Reset option.
2. Press HOLD. The display shows options
3. Press MENU/▼ to select Factory Reset. Press HOLD.
4. The display automatically shows No and Yes. Use MENU/▼ to scroll to the desired option.
5. Press HOLD to confirm selection. Display shows Factory Reset option with a checkmark.

TAKING MEASUREMENTS

The procedure below illustrates the general process for taking pH readings. When taking measurements in liquids, ensure that the tip is fully immersed and not touching the side of the container. Stir and let the reading stabilize. Information on measuring other media are given in subsequent sections.

1. If necessary, power on the tester.
2. The timer icon will blink during this time. Once the reading is stabilized, the timer stops blinking and will appear to indicate the stability of the reading.
3. Note the value or press HOLD to freeze the reading. To release the reading, press HOLD again.
4. Press and hold the power button for 5 seconds to turn off tester. If key is not pressed for 8.5 minutes, the tester will automatically shut off to conserve batteries.

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

- Power up the meter.
- Insert the probe tip 1 inch below soil surface.
- Wait for reading to stabilize
- 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 3 (p. 20) 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.
- Power up the meter.
- Insert the probe tip into the media and read the results.

PROBE CALIBRATION

Conductivity, TDS, or Salinity

For best results, periodic calibration with an accurate standard is recommended prior to measurement. Prior to calibration, the tip of the probe should be cleaned with alcohol. The tester will retain one calibration value in each mode (conductivity, TDS, salinity) when the instrument is powered off. The conductivity value can be calibrated automatically or manually. The TDS and salinity values require manual calibration. The tester will begin in the measurement mode that was used when it was powered off. See Measurement Parameter Setting (p. 6) for how to change the desired parameter.

Note: It is strongly recommended that calibration be done with 1.41 mS/cm solution. Manual calibration is possible with other solutions. But, there are EC concentrations for which even manual calibration cannot be done.

Automatic Calibration (Conductivity only)

1. Power on the meter.
2. Completely immerse the tip in calibration standard.
3. Stir gently and press the CAL/ESC button to begin the calibration. The meter will briefly display the Key Info screen before transitioning to the Cal screen.
4. The display will show CAL in the upper left corner. The values for automatically recognized standards (84 μ S/cm, 1413 μ S/cm, and 12.88 mS/cm) will cycle beneath the meter value.
5. If the reading is within the calibration range of one of the standards, the cycling will stop and a check mark icon is displayed at the top of the screen.

6. Press HOLD to accept the auto conductivity standard and finish the calibration.
7. Display returns to Measurement window.

Manual Calibration

When the conductivity reading is outside the calibration range of the automatic conductivity standards or when TDS or salinity is used, the tester will require manual adjustment.

1. Repeat steps 1 to 4 from “Automatic Calibration”.
2. Wait until the display settles on a measured value. Press MENU/▼ to manually adjust the value to the desired reading.

Note: The adjustment will decrease only, however the adjustment will eventually cycle to the highest available value after decreasing by 40% of the initial value.

3. Press HOLD to accept and finish the calibration when the desired value is selected.

Note: To abort calibration, press CAL/ESC to escape.

4. Once the calibration is finished and user has accepted the changes, the Measurement window will show the calibrated reading.

SENSOR/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. The 24" T-handle probe comes with a replaceable tip (item 2266). With these probes, the cable and shaft do not need to be replaced.

An "Temperature out of Range" message on the LCD may indicate a failed probe or simply that the probe has come unplugged from the meter. See **Attaching a direct-insert probe** (p. 15) before replacing the probe or tip.

Replacing a tip (24" probes only)

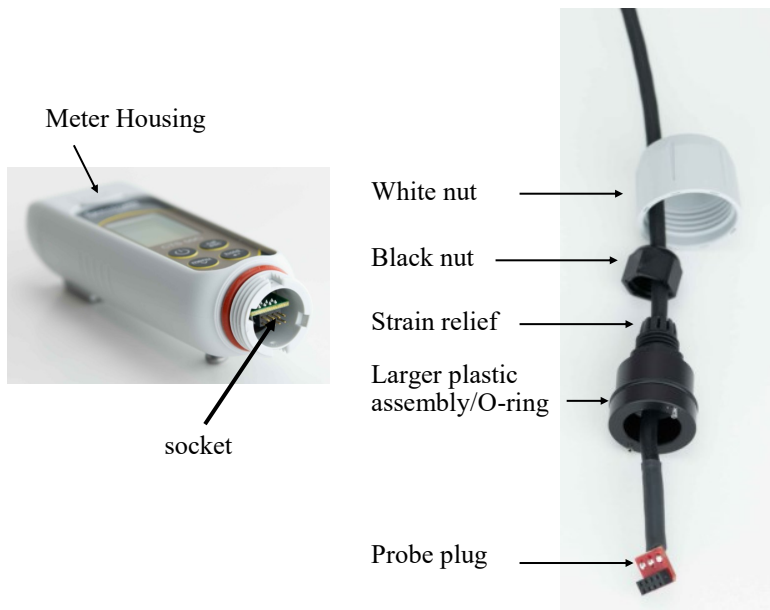
The replaceable tip (left) is designed to thread in and out of the end of the probe. A new tip has two flat faces on opposite sides. This allows the tip to be tightened onto the probe with a pliers or 5/16" wrench.



I. Removing a direct-insert probe

The 8" probe 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 white nut on the cable end of the meter.
3. Detach the probe cable plug from the socket in the meter.
4. Remove the white nut and large o-ring.



II. Attaching a direct-insert probe

1. If you are connecting an 8" probe, slide the white 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 white 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 white nut to the meter housing.

BATTERY REPLACEMENT

The meter uses four AAA 1.5 V batteries.

1. To remove the battery cover, see Figure 1. Clear the front catch then the back catch, before sliding the cover off.
2. To remove the battery plate, push the center tab towards the front of the tester as shown in Figure 2. Once unlocked, remove the plate to access the batteries.
3. Turn the tester upside down to remove the batteries. Each side uses two AAA batteries. Orient each battery with positive terminal facing downward.
4. To lock the battery plate, align the small tabs (Figure 3) into the guide ribs on the housing and then press down. See Figure 4.



Fig. 1: Removing battery cover

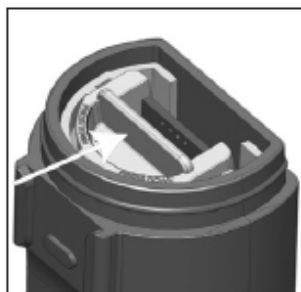


Fig. 2: Push to unlock

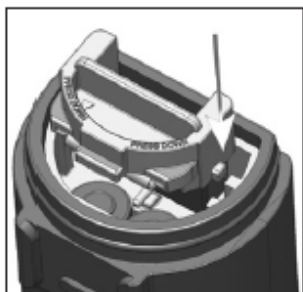


Fig. 3: Align tabs



Fig. 4: Push down to lock

SPECIFICATIONS

Conductivity

Range	0.0 to 200.0 μ S, 200 to 2000 μ S, 2.00 to 20.00 mS
Resolution	0.1 μ S, 1 μ S, 0.01 mS
Relative accuracy	$\pm$ 1% full scale
Normalization temp.	25.0°C (77°F)
Temperature co-efficient	0.0% to 10.0%
Calibration points	Up to 3 points

TDS

Range	0.0 to 100.0 ppm, 100 to 1000 ppm, 0.10 to 10.00 ppt (TDS Factor 0.5)
Resolution	0.1 ppm, 1 ppm, 0.01 ppt
Relative accuracy	$\pm$ 1% full scale
Calibration points	Up to 3 points
TDS factor	0.40 to 1.00 (selectable)

Salinity

Range	0.00 to 10.00 ppt
Resolution	0.10 ppt
Relative accuracy	$\pm$ 1% full scale
Calibration points	1

Temperature

Range	0 to 60°C (32.0 to 140.0°F)
Temperature resolution	0.1°C / 0.1°F
Temperature accuracy	From 0 to 50°C ($\pm$ 0.5°C / $\pm$ 0.9°F + 1 LSD); from 50 to 60°C ($\pm$ 1.0°C / $\pm$ 1.8°F + 1 LSD)

General

Display Graphics	Dot matrix 80 x 100 pixel
Auto off	8.5 minutes (from last key press)
Power requirement	Four AAA 1.5 V batteries
Battery life	>150 hours
Water proofing	IP67

Environmental operating conditions

Ambient temperature	5 to 45°C / 41 to 113°F
Relative humidity	5% to 85% noncondensing
Storage temperature	-20 to 60°C / -4 to 140°F
Storage humidity	5% to 85% noncondensing

Probe Dimensions

2266FS
Length 7.7 in (19.5 cm)
Diameter 0.30 in (0.8 cm)
2266FSTP
Length 24 in (61 cm)
Diameter 0.35 in (0.9 cm)

APPENDIX 1

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 2

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 3

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:

$$\text{SME} = 2.7\text{FS} + 0.8$$

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. Au- gustinegrass
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 4

GREENHOUSE MEDIA

Classification of Greenhouse Media

Comments	Electrical Conductivity (mS/cm)		
	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

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.



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: 2266FS/2266FSTP
Description: Electrical Conductivity Meter
Type: Electrical Equipment for Measurement, Control, and Laboratory Use

Directive: 2014/30/EU

2011/65/EU

Standards: EN 61236-1:2013

EN 50581:2012

Douglas L. Kieffer,
Soil/Water Products Manager

February 19, 2020

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