MAN190

SOIL RESISITIVITY TEST KIT MANUAL

(FOR USE WITH M. C. MILLER SOIL RESISTIVITY TEST KIT EQUIPMENT (cat # 156225))

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1. Earth Resistivity Measurements using 4 Soil Pins and the M. C. Miller Test Reel

This application uses 4 electrodes (4 soil pins). The electrodes are driven down into the earth the same distance and are evenly spaced in a straight line. A schematic of this arrangement is illustrated in Figure 1 below.

Note: It is recommended that the electrodes (pins) be firmly driven into the earth (pins cannot be loose). Also, in dry soils, it is recommended that the soil around the pins be moistened in order that reliable (low resistance) contact is made to the surrounding soil.

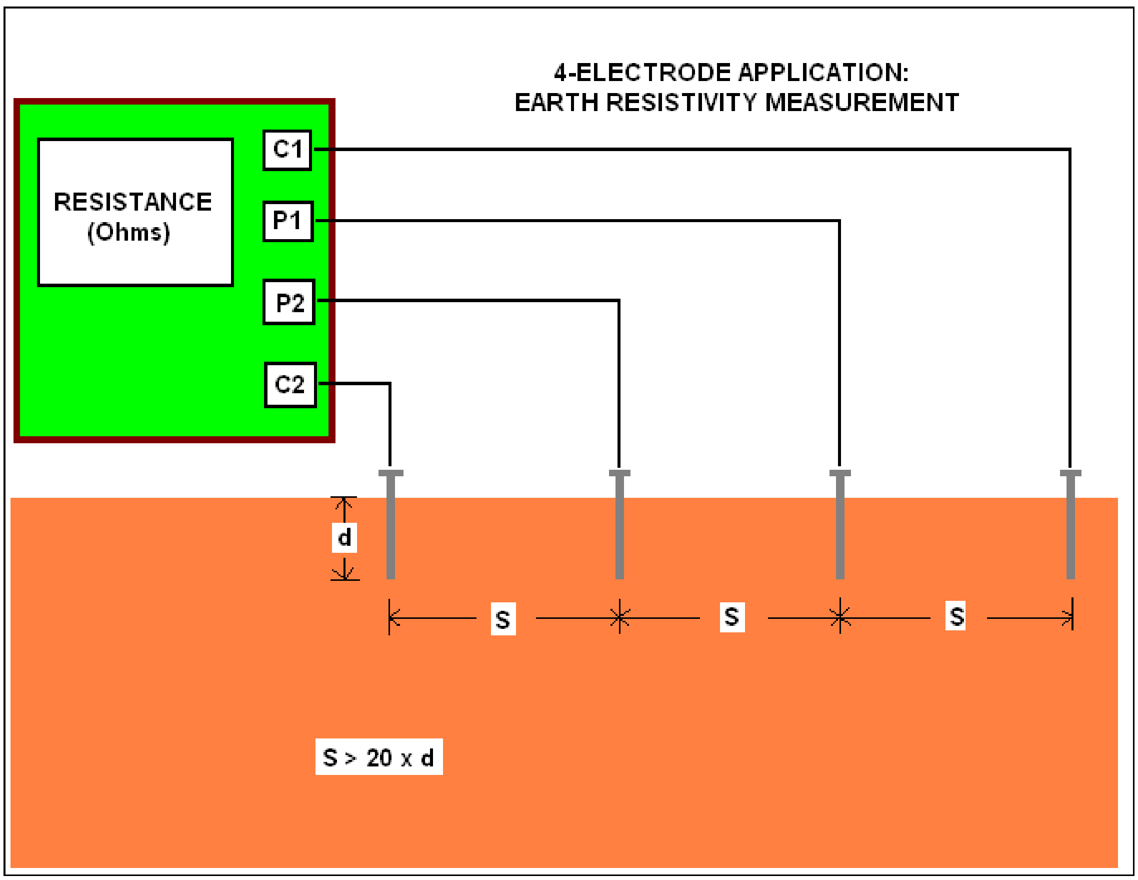

Figure 1

M. C. Miller's 4-lead (color-coded) test reel (catalog # 44700) and four heavy-duty (stainless steel) electrodes (soil pins) – catalog # 44720, are used in conjunction with a suitable 4-terminal resistance meter, such as the Miller 400A, the Miller 400D or the Nilsson 400.

The standard M. C. Miller Test Reel provides a maximum soil pin spacing of 20 feet (the reel contains one 5 foot long (yellow) wire, one 25 foot long (orange) wire, one 45 foot long (red) wire and one 65 foot long (black) wire. Your test reel may have different wire lengths (measured in either feet or meters) in order to provide for different soil pin spacings (other than 20 feet), depending on your order, however, the color coding will be the same.

In the case of the standard test reel (20 feet soil pin spacing), measure off a 60 feet distance between the planned location for the closest pin (to the meter) and the pin to be furthest away from the meter. Place markers on the ground roughly at 20 foot intervals (in a straight line between the closest planned pin location and the furthest away planned pin location). Starting at the furthest away location, insert a soil pin into the ground and connect the black wire (C1) to the pin. Carefully feed out the wire harness as you walk back to the next marked location and insert the next pin into the ground. Connect the red wire (P1) to the pin. Note: With the black wire fully extended, and, assuming that you are using the standard Test Reel, the spacing between these two pins will be 20 feet. Proceed back to the third marked location and insert the third soil pin into the ground. Connect the orange wire (P2) to the pin. Note: With the red wire fully extended, and, assuming that you are using the standard Test Reel, the spacing between the middle two pins will be 20 feet. Proceed back to the fourth marked location (closet to the meter) and insert the fourth soil pin into the ground. Connect the yellow wire to the pin. Note: With the orange wire fully extended, and, assuming that you are using the standard Test Reel, the spacing between the third and fourth soil pins will be 20 feet.

Note: By measuring off other pin separation distances, for example, 15 feet, 10 feet, or 5 feet, the soil pins can be inserted into the ground in order to evenly-space the pins at distances that are different from the standard 20 feet for depth profiling purposes.

Finally, fully extend all four wires on the test reel 5 feet (approx.) back to the meter location and connect the test reel wires to your 4-terminal resistance meter via the 15 inch long color coded banana plug leads (C1 to C1, P1 to P1, P2 to P2 and C2 to C2).

With the arrangement shown in Figure 1, the resistance meter effectively measures the earth's average resistance to a depth equal to the electrode (soil pin) spacing (S). For a fully-extended standard Test Reel, S would be 20 feet, for example.

If the electrode (soil pin) depth (d) is kept small relative to the separation between the electrodes (S), the earth's average resistivity to a depth equal to the electrode spacing (S) can be obtained by applying the following formula:

$$\rho = 2 \pi S R$$

where R is the resistance value in ohms as determined using the resistance meter, ρ is the resistivity in ohm.cm, π is the constant 3.1416, and S is the electrode separation in cm.

Typically, the electrode (soil pin) spacing is not measured in centimeters but, rather, in feet (in the U.S.) or in meters (in most other countries).

U.S. Example (electrode spacing measured in feet):

Since there are 30.38 centimeters in 1 foot, the above formula can be written as:

$$\rho\ (\Omega.\text{cm}) = 2\pi \times 30.38 \times (\text{electrode spacing in feet}) \times R\ (\text{ohms})$$

$$\text{or,}\quad \rho\ (\Omega.\text{cm}) = 191.5 \times (\text{electrode spacing in feet}) \times R\ (\text{ohms})$$

So, for example, if the resistance meter indicates a resistance value of 15 ohms for an electrode (soil pin) spacing of 20 feet, the earth's average resistivity value to a depth of 20 feet would be:

$$\rho = 191.5 \times 20 \times 15 = 57{,}450 \text{ ohm.cm}$$

If the resistivity value is required to be expressed in ohm.m, rather than ohm.cm, the ohm.cm value is divided by 100. In the above example, the resistivity would be 574.5 ohm.m

Metric Example (electrode spacing measured in meters):

Since there are 100 centimeters in 1 meter, the above formula can be written as:

$$\rho\ (\Omega.\text{cm}) = 2\pi \times 100 \times (\text{electrode spacing in meters}) \times R\ (\text{ohms})$$

$$\text{or,}\quad \rho\ (\Omega.\text{cm}) = 628.32 \times (\text{electrode spacing in meters}) \times R\ (\text{ohms})$$

So, for example, if the resistance meter indicates a resistance value of 15 ohms for an electrode (pin) spacing of 7 meters, the earth's average resistivity value to a depth of 7 meters would be:

$$\rho = 628.32 \text{ x } 7 \text{ x } 15 = 65{,}973.6 \text{ ohm.cm}$$

If the resistivity value is required to be expressed in ohm.m, rather than ohm.cm, the ohm.cm value is divided by 100. In the above example, the resistivity would be 659.73 ohm.m

Note: The above formula is accurate only if the electrode depth (d) is small relative to the electrode spacing (S). An "S" value equal to, or greater than, 20 times the "d" value is recommended. This means that if d is 1 foot, for example, then S has to be at least 20 feet (or, if d is 0.3 meter, then S has to be at least 6 meters)

2. Soil Sample (or Liquid) Resistivity Measurement

This application also uses 4 electrodes, however, in this case, the electrodes are an integral part of an electrolyte box, which is more commonly referred to as a soil box. For this application, a 4-terminal resistance meter can be used in conjunction with one of M. C. Miller's soil boxes (catalog # 37008 or catalog # 37006) and 4 test leads (catalog # 37009).

A schematic of the test arrangement is illustrated in Figure 2 below.

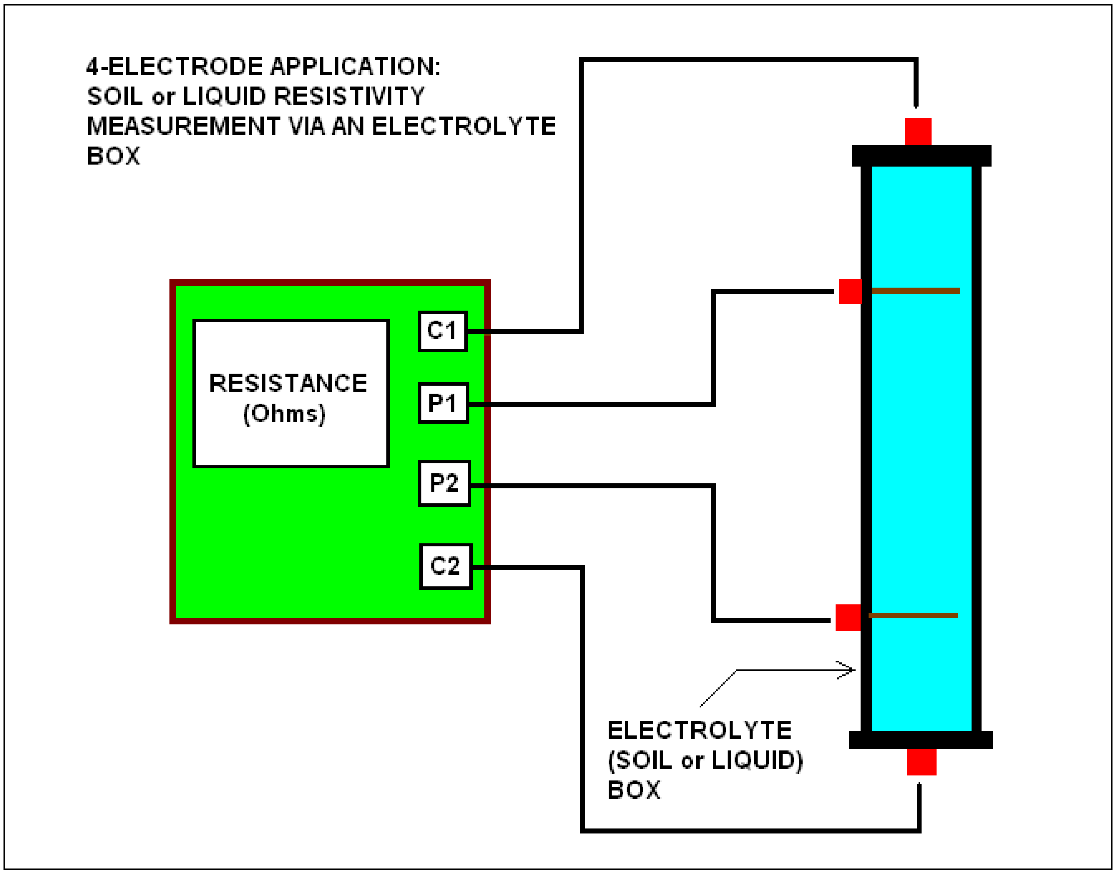

Figure 2

With this arrangement, the resistance meter determines the resistance of the soil sample, or of the liquid that fills the electrolyte box.

In general, for a particular volume of soil sample (or liquid), as defined by the geometric constraints of the electrolyte box, the sample's resistivity can be calculated from the resistance value determined using the resistance meter by applying the following formula:

$$\rho = R\ A/L$$

where ρ is the resistivity in ohm.cm, R is the resistance in ohms, A is the cross-sectional area of the current electrodes in cm squared, and L is the separation between the potential electrodes in cm.

Consequently, the ratio A/L represents a multiplication factor that needs to be applied to the resistance reading in order to obtain the sample's resistivity value.

Conveniently, for both M. C. Miller soil boxes, the A/L ratio is exactly 1cm.

Consequently, when M. C. Miller soil boxes are used, the resistance reading in ohms determined using the resistance meter becomes the resistivity value in ohm.cm.

If the resistivity value is required to be expressed in ohm.m, rather than ohm.cm, the ohm.cm value is divided by 100. For example a resistivity value of 2500 ohm.cm would be equivalent to 25 ohm.m