Fall-of-Potential Testing with the Ground Resistance Tester Model 3640

Grounding is a critical component of electrical systems. Effective grounding provides a low-resistance path for lightning and other phenomena that might otherwise damage electrical systems and injure personnel.

A common method for measuring the resistance of a grounding system is the ***Fall-of-Potential*** test, also known as the 3-point or 3-pole test. This involves injecting a current into the ground at a distance from the grounding system under test, and then measuring potential at different points between the grounding system and injector electrode.

In this Application Note, we demonstrate how to perform a Fall-of-Potential test, using the AEMC® Ground Resistance Tester Model 3640, the simplest and easiest to use member of our Ground Resistance Tester product family. This direct reading instrument measures ground resistances from 10 milliohms up to approximately 2000 ohms at the push of a button – no manual adjustments or settings necessary. Among its features is auto-ranging, which automatically seeks out optimum measurement range for the test being conducted. In addition to 3-point Fall-of-Potential testing, the Model 3640 is also designed for 2-point continuity testing. The instrument ships with all the color-coded leads and electrodes necessary for ground testing.

Before you begin, verify that the grounding system under test is de-energized and isolated from other grounding systems. In addition to safety considerations, this ensures that the measurements truly reflect the resistivity of the grounding system.

We'll start by connecting the leads. Insert the provided spade lugs into the ends of the leads, and attach the lugs to the instrument terminals. The green lead connects the instrument to the grounding system. The red lead connects to the injector terminal, and the blue to the measurement terminal.

Notice the jumper strap attached to the red terminal. This is for connecting the red and blue terminals together for continuity testing, and is not used in Fall-of-Potential tests.

Attach the end of the green lead to the grounding system under test. Fall-of-Potential testing is often performed on rods that have been disconnected from the grounding system in preparation for the test. Another typical subject is a newly installed rod that needs to be qualified before being connected to a grounding system.

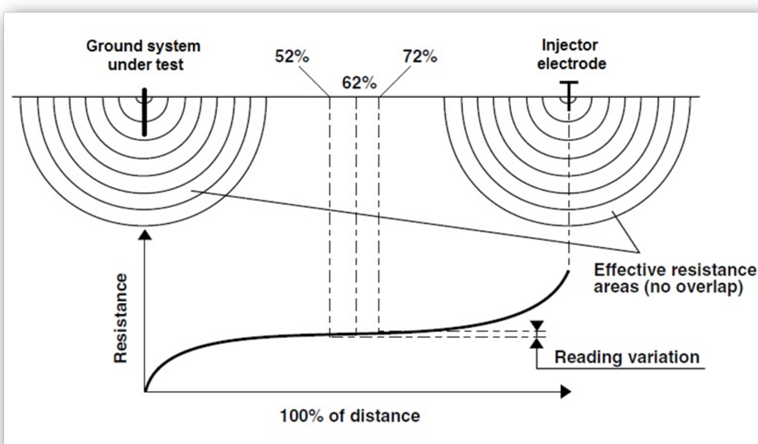
Now let's place the electrodes. For Fall-of-Potential testing, the injector electrode should be placed at a distance at least 8 to 10 times the depth of the grounding system. For example, if you're testing a grounding rod that has been inserted into the soil to a depth of 10 feet, place the injector electrode at least 80 to 100 feet away from the rod. It's good practice to place the electrode further away than is minimally necessary. Placing the electrode further than is necessary has no negative impact on the measurement; but placing the electrode too close can render the measurement invalid.

Note that if you are measuring a ground ring or grid, the longest diagonal length should be used as the rod depth in calculating the injector electrode distance.

When taking the initial measurement, the depth of the auxiliary electrode is not critical. In some locations with very moist soil, the electrode can simply be placed on the ground.

When the injector electrode is installed, attach it to the instrument with the red lead.

Next, place the potential electrode. This is the electrode through which the instrument will obtain its measurements. In full Fall-of-Potential testing, we would take measurements at 10% increments of the distance between the grounding system and the injector electrode. However, today we'll demonstrate a simplified version of the test known as the ***62% method***. This uses three test points at 52%, 62%, and 72% of the distance between the grounding system and injector electrode. If these measurements are close – in other words, if plotted on a graph they produce a more or less flat line as shown in the illustration below – we can be confident that the injector electrode is inserted sufficiently far from the grounding system, and that our results are valid. If the results vary significantly, move the injector electrode further away and retake the measurements.



Our first measurement will be at 62% of the distance between the grounding system and injector electrode, so insert the potential electrode at this point and connect it to the instrument with the blue lead.

To take the measurement, simply press the button and wait a few seconds for the reading on the display to stabilize. The Model 3640 is auto-ranging, so no other manual setup is necessary. As you can see in the following illustration, our measurement at the 62% point is 11 ohms.

The Model 3640 has three fault indicators:

- **X-Z Fault** generally indicates the ground resistance at the injector electrode is too high. If this light flashes, you can insert the electrode deeper into the ground, add additional electrodes in parallel with the first, or moisten the ground around the electrode to improve conductivity. Note that this indicator also flashes when the instrument's fuse is blown, or when the lead is not connected and the circuit is open.

- **X-Y Hi Resistance** is similar to X-Z fault, except that it indicates the resistance at the potential measurement electrode is too high. The same fixes described for X-Z Fault applies.

- **X-Y High Noise** indicates stray voltage is in the soil. This could be due to a source of electromagnetic interference (EMI), for example high tension lines right above the instrument or along the run of the leads, being present in this location. This can be addressed by using shielded leads. Or you can apply a quick fix by twisting the blue and red leads together along their runs.

In addition to these indicators, the LCD displays a reading of 1 if the resistance exceeds the instrument's measurement range. Overrange is also indicated by blinking on the LCD.

After we obtain a valid reading, we now move the potential measurement electrode to a point 52% of the distance between the grounding system and injector electrode, and take another measurement. For our final measurement, we move the potential electrode to 72% of the distance.

We now compare our measurements. If all three are close, the injector electrode has been placed far enough away from the grounding system to produce reliable results. In this case, we simply add the three measurements together and divide by three to obtain the effective resistance of the grounding system. If the readings vary significantly, move the injector electrode further away and repeat the three measurements.

This concludes our quick demonstration of Fall-of-Potential testing. For more information about the Model 3640, consult the documentation that comes with the instrument. You can also visit the Model 3640 Product Page (http://www.aemc.com) for additional specifications.