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APPLICATION NOTE

Getting Started with a Ground Test

Figuring out how to get started with the performance of a ground test can be challenging, and for good reason. Most electrical testing involves discrete manmade equipment. Ground testing does not. Aside from a ground rod or another point of connection to a larger structure like a grid, ground testing is basically left up to planet Earth. Determining the correct placement of the leads can be trickier than it seems if you're unfamiliar with the process.

Lead placement for ground testing

Although this all sounds a bit complicated, in reality it is actually fairly simple. There are two leads and two probes that are set up to do a ground test. These are in addition to the short connection to the electrode being tested (IUT).

It is frequently asked where to attach the common lead, or the two short leads if running a four-pole test, from the instrument to the IUT. Of course, that's a no brainer if it's a ground rod. The head of the rod or the grounding conductor are fine. But on a large grid, there may be many test wells or other points of contact. Be sure to select the most convenient one. They should all read the same, as the grid should be uniform from all points.

Unlike a multimeter, the current and potential circuits are separate. If they were not separate, the resistance associated with driving the probe into the ground would be part of the measurement because the probe has an associated resistance, just like the ground rod being tested. This would result in not being able to tell the resistance of the rod under test. With a separate potential probe, you are able to plot a series of readings at various distances. These readings are expected to show you the resistance of the rod under test, free of the extraneous resistance of the current probe.

Figure 1: Placing ground testing probes

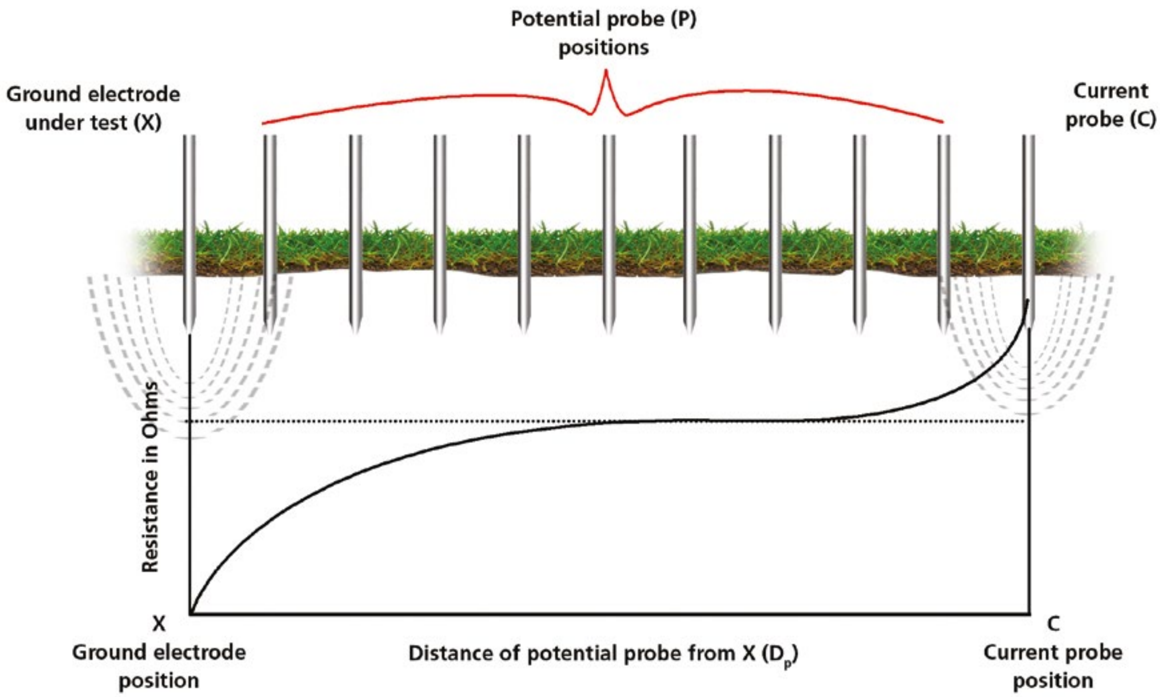
Performing the ground test

The first step is to place the current probe as far away from the IUT as you can conveniently get it. The aim is merely to have the current probe far enough away from that the IUT that its resistance does not overlap the resistance zone of the electrode you are trying to measure. If the two resistances overlap, it is difficult to tell one from the other.

Testing guides frequently include tables or recommendations for how far to place the current probe from the electrode under test (IUT). These recommendations are based on some multiple of the maximum dimension of the IUT, which would be depth, if a single rod, or diagonal, if a grid. The important thing to remember is that these are convenient recommendations, not scientific mandates. They are based on operator experience, not scientific calculation. They are only suggestions that give you a decent chance of getting a good test on the first try and not having to repeat at a greater distance. If you work at a shorter distance and still get a coherent result, your test is successful.

How do you know if you've gotten a 'good' test? If doing a Fall of Potential, the associated graph will tell you. If the data points on the graph just keep rising, you need more distance on the current probe in order to clearly separate the two resistance fields. If you are performing a Slope test or any other standard procedure, there will be a math test built into the test that will throw out bad results. If you pass the test, you're good. If you can't meet the suggested distance for the current probe, work in whatever area you have and if you pass the test (graph or math), you're good, no matter what distances you used.

Figure 2: Fall of Potential



We haven't said much about the potential probe. That's because its placement is dictated by the current probe and the method being used. There is no trial and error with the potential probe as there is with the current.

What happens if your ground test fails

What if your result doesn't pass whatever built in test applies to the procedure you used? This could be a sign of trouble, but not always. You can try to find more room, maybe by going in a different direction. Or you can switch to a method that has been formulated just for this contingency, including Slope, Intersecting Curves, Four Potential and Star Delta. These methods are all described in Megger's ground testing manual *Getting Down To Earth,* which can be downloaded from the Megger website, https://us.megger.com/support/technical-library/technical-guides/getting-down-to-earth-a-practical-guide-to-earth.

Remember, you can't do a test 'wrong' and not know it, provided you used a method that has a proof associated with it. This would be either visual proof from a graph or math proof from a required calculation. Single-point tests, like the commonly referenced 62% rule, can be wrong. This is because the rule only applies to an ideal model, which your test site may or may not be. Ideally, you've gotten the current probe far enough away and the site has soil uniformity. However, what if a live power line is running right under the potential probe at 62%? There goes your reading.

Reliability in ground testing

Testing services are frequently required by clients to submit a Fall of Potential graph with the test report. This is an assurance that the result is reliable. If it isn't, you can see it on the graph (see Figure 2).

Similarly, tests with built-in mathematics guarantee reliability. We mentioned earlier that if you can't get enough distance to separate the two resistance fields, you can still test. Specific methods have been designed for this contingency. The most popular is the Slope Method. A graph would show a continually rising line and it would not be possible to visually determine the resistance of the IUT. But it should be there somewhere. That's where the math comes in. The math test determines where the IUT resistance stops and the probe resistance starts.

If the probe is contained completely inside the field of the IUT, which is possible with large grids, then the mathematics simply don't work. They give you no answer rather than a wrong answer. This means you need to try again in another direction.

Finals tips for ground testing

While the unpredictable nature of the earth as an integral part of ground testing can cause some confusion or concerns when performing a test, the guidelines are actually easy to follow. Continued practice with ground testing yields only better knowledge for future experiences. If something is truly strange during a test, check if you're using the proper test equipment and that the equipment is operating properly. The technology has advanced to the point of taking away much of the guesswork. Other questions can generally be answered in *Getting Down to Earth* or with a conversation with a colleague or Megger team member.

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