Attached Rod Technique (ART)

Fall-of-potential testing is extremely reliable, highly accurate, conforms to IEEE 81 and gives the operator complete control over the set-up. Unfortunately, it is exceedingly time consuming and labor intensive, and requires that the individual ground electrodes be disconnected from the system.

Clamp-on testing is quick and easy, but has many limitations. This method requires a good return path, is susceptible to noise, has reduced accuracies and cannot be used on isolated grounds. It is not applicable for installation checks or commissioning new sites and has no built in proof.

The Attached Rod Technique (ART) provides some of the advantages of clamp-on testing (not having to disconnect the ground electrode) while remaining true to the theory and methodology of fall-of-potential testing. To understand the method, it is necessary to understand the theory and math behind it. In theory, a fall-of-potential measurement could be made without disconnecting the ground electrode if additional measurements were made with an earth leakage clamp meter (milliamp meter). Figures #1 and #2 show the three measurements that would be made.

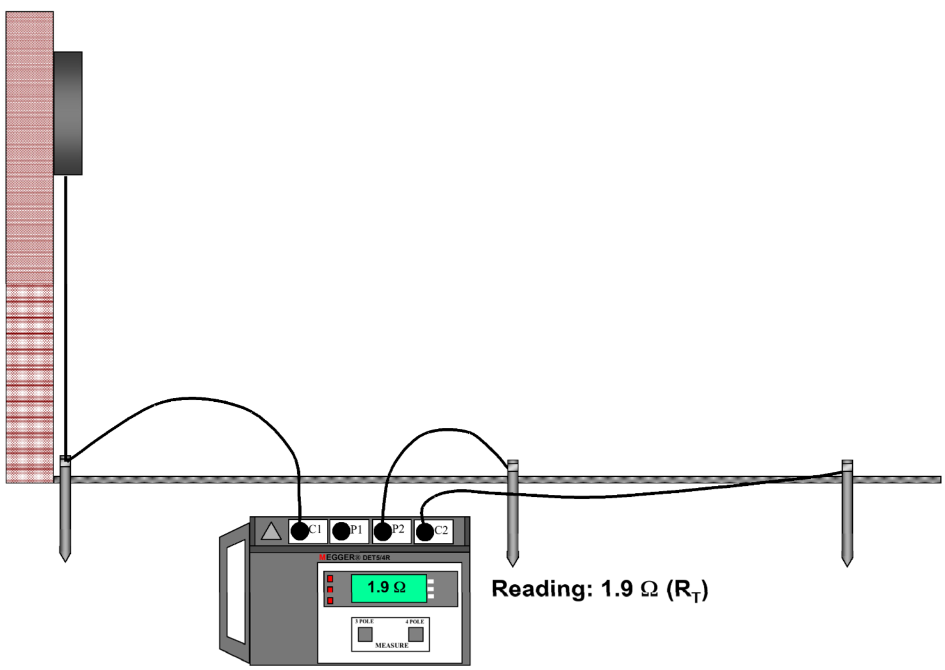

Figure #1: Ground Resistance Measurement

The first step is to measure the resistance (R_T) of the entire system using a typical fall-of-potential configuration. In this example, the reading for R_T is 1.9 Ω.

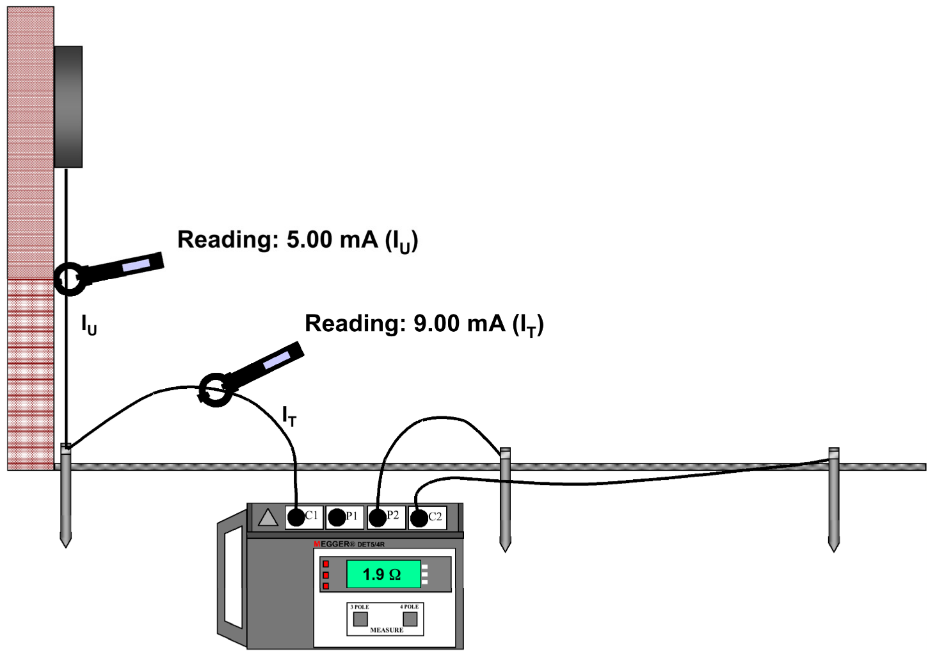

Figure #2: Leakage Current Measurements

Step two involves measuring the total current (I_T) being injected into the system from C1. For this example, I_T is 9.00 mA. The next step is to measure the amount of current (I_U) flowing to the service. In this case, I_U is 5.00 mA. With these measurements, the voltage drop from the selected volume of soil to the point of the P2 can be determined as follows:

$V = I_T \times R_T$

$V = 0.009 \text{ A} \times 1.9\ \Omega$

$V = 0.017 \text{ V}$

The current through the ground electrode (I_G) can also be determined.

$I_G = I_T - I_U$

$I_G = 9.00 \text{ mA} - 5.00 \text{ mA}$

$I_G = 4.00 \text{ mA}$

Using the voltage drop and the current through the ground electrode, the resistance of the ground electrode (R_G) can be determined.

$R_G = V \div I_G$

$R_G = 0.017 \text{ V} \div 0.004 \text{ A}$

$R_G = 4.25\ \Omega$

As noted, this is a theoretical approach that requires perfect conditions. Any additional current flowing from the service through the ground electrode would reduce the accuracy of the measurement. The earth leakage clamp meter would have to filter out all but the current generated by the instrument through C1 to ensure accuracy. Additionally, this approach requires that a number of mathematical calculations be made.

The Attached Rod Technique is based on the theory outlined above. Figure #3 shows an ART test being made.

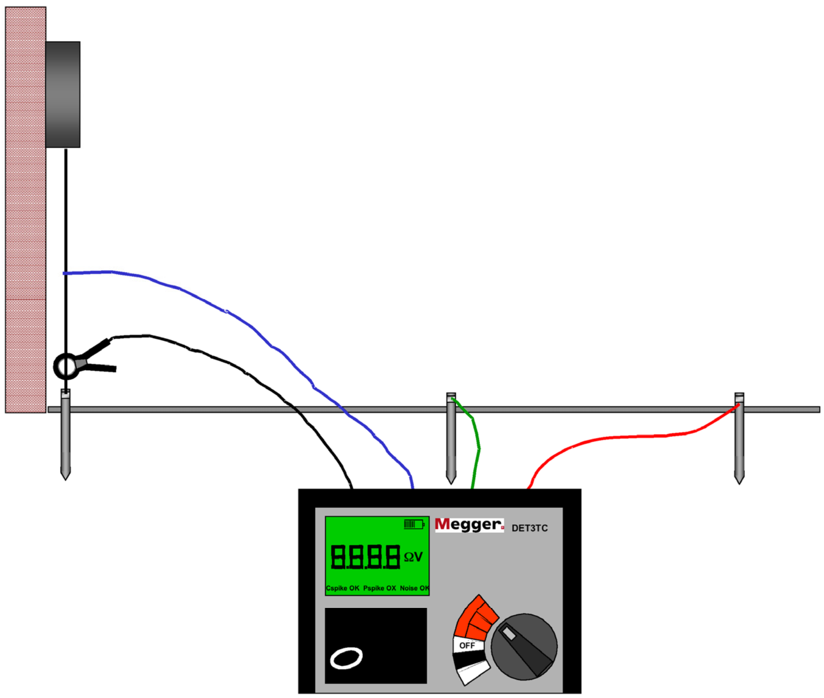

Figure #3: Attached Rod Technique Measurement

Ground testers that are designed to make ART measurements include a special built-in current clamp that is placed between the C1 connection and the earth. This type of instrument includes noise protection and digitally filters out all currents other than that generated by the instrument. The instrument's microprocessor automatically performs all the calculations necessary to generate a resistance measurement for the ground electrode.

The test is a fall-of-potential test, meaning that all the "rules" still apply. Ideally, the operator would take ten measurements and plot the results to determine true resistance. Proper probe spacing remains critical, and fall-of-potential procedure and methodology must be followed. As with a traditional fall-of-potential test, the results can be proofed by increasing the probe spacings.

The advantage of the ART method over traditional fall-of-potential testing is that the ground electrode under test does not have to be disconnected from the system.