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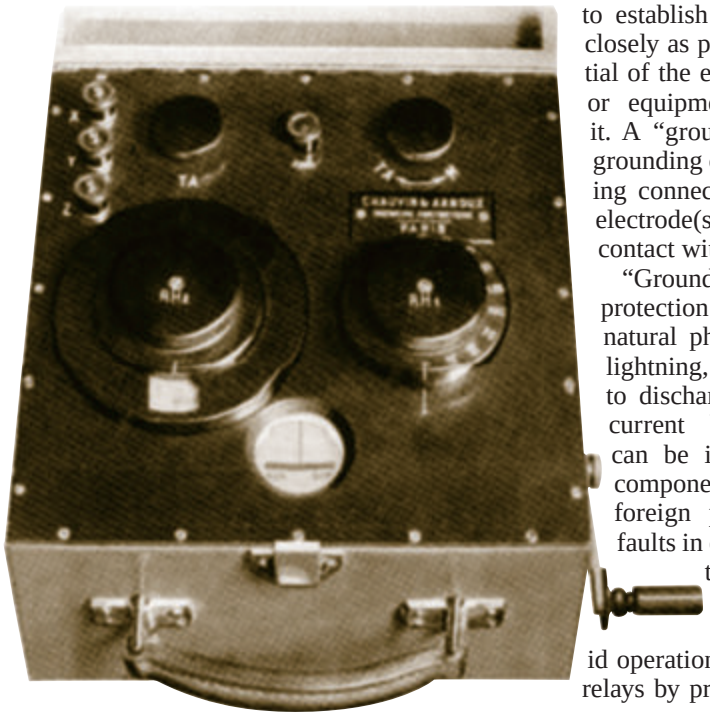
FOR FREE INFO, CIRCLE 1 ON READER SERVICE CARD

Next Generation Ground Resistance Tester for the Typical User

BY JOHN OLOBRI

GROUND RESISTANCE TESTING also referred to earth resistance testing finds its roots in the early 1930s. Limited technology was available, so a null balance galvanometer, a decade resistance box and a DC power source combined to make one of the first ground testers.

Years later hand-cranked technology, first using a generator, provided the test voltage. Electronics set in the 1950s and 60s gave birth to electronic ground testers with electronic amplifiers. Eventually, digital displays came to the scene, though analog meters remained due to customer familiarity and preference. Over 20 years ago, AEMC® revolutionized the ground testing market by offering clamp-on ground testers that eliminated the need to test with using auxiliary rods. AEMC continues to advance the technology with both sophisticated instrumentation instruments designed for testing transmission tower grounding as well as simplifying fall of potential testing operation with models that are attractive for those who have to perform ground resistance testing on a sporadic basis. This article introduces one such model designed to ensure that the right measurements are performed, but first let us review some of the fundamentals of grounding and fall of potential testing.



The term "ground" is defined as a conducting connection by which a circuit or equipment is connected to the earth. The connection is used to establish and maintain, as closely as possible, the potential of the earth on the circuit or equipment connected to it. A "ground" consists of a grounding conductor, a bonding connector, its grounding electrode(s), and the soil in contact with the electrode.

"Grounds" have several protection applications. For natural phenomena such as lightning, grounds are used to discharge the system of current before personnel can be injured or system components damaged. For foreign potentials due to faults in electric power systems with ground returns, grounds help ensure rapid operation of the protection relays by providing low resistance fault current paths. This provides for the removal of the external potential as quickly as possible. The ground is designed to drain the extraneous potential before personnel are injured and the power or communications system is damaged.

Ideally, to maintain a reference potential for instrument safety, protect against static electricity, and limit the system to frame voltage for operator safety, a ground resistance should be as close to zero ohms as possible.

Finally, low ground resistance is essential to meet electrical safety standards such as provided by OSHA and NEC®.

The basic components of a typical grounding electrode system include the following components:

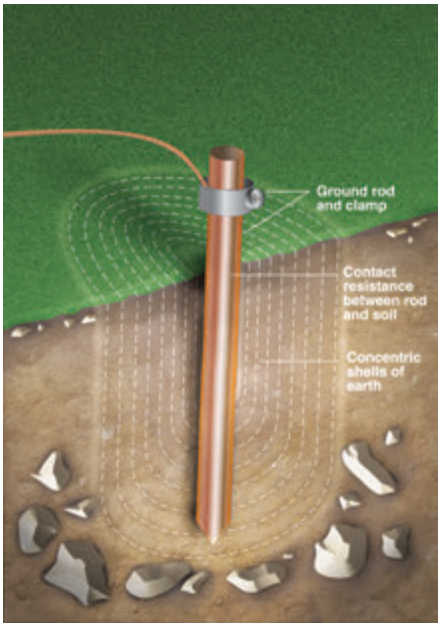
- The resistance of the metal and that of the connection to it.
- The contact resistance of the surrounding earth to the electrode.
- The resistance in the surrounding earth to current flow referred to as soil resistivity which is often the most significant factor.

Grounding electrodes are usually made of a very conductive metal (copper or copper clad) with adequate cross sections so that the overall resistance is negligible. The National Institute of Standards and Technology (NIST) has demonstrated that the resistance between the electrode and the surrounding earth is negligible if the electrode is free of paint, grease, or other coating, and if the earth is firmly packed around it.

The only component remaining is the resistance of the surrounding earth.

The electrode can be thought of as being surrounded by concentric shells of earth or soil, all the same thickness. The closer the shell to the electrode, the smaller its surface; hence, the (CONTINUED ON PAGE 10)

AEMC® Instruments (CONTINUED FROM PAGE 9)



greater its resistance. The farther away the shells are from the electrode, the greater the surface of the shell; hence, the lower the resistance. Eventually, adding shells at a distance from the grounding electrode will no longer noticeably affect the overall earth resistance surrounding the electrode. The distance at which this effect occurs is referred to as the effective resistance area and is directly dependent on the depth of the grounding electrode.

The Fall of Potential test method requires the placement of two auxiliary electrodes, an injector internationally referred to as H and a potential electrode referred to as S.

The goal in precisely measuring the resistance to ground is to place the auxiliary current injecting electrode H far enough from the grounding electrode under test, which we will label E so that the auxiliary potential electrode S will be outside of the effective resistance areas of both the grounding electrode and the auxiliary current electrode. The best way to find out if the auxiliary potential rod S is outside the effective resistance areas is to move it between E and H and to take a reading at each location. If the auxiliary potential rod S is in an effective resistance area (or in both if they overlap), by displacing it, (see diagram A) the readings taken will vary noticeably in value, typically by 5% or more. Under these conditions, no exact value for the resistance to ground may be determined.

On the other hand, if the auxiliary potential rod S is located outside of the effective resistance areas (see diagram B), as it is moved back and forth the reading variation is minimal. The readings taken should be relatively close to each other, and are the best values for the resistance to ground of the system E. The readings should be plotted to ensure that they lie in a "plateau" region as shown in diagram B. The region is often referred to as the "62% area." Readings generally are taken every 10% of the distance from the ground under test and the injector electrode for a total of nine measurements. The average of the three closest readings which usually occur between 50 and 70% along the test path is the effective resistance of the system under test.

The simplified test method a.k.a. the 62% method has been adopted after many years of analyzing actual test data. In this case only three measurements are taken at 52, 62 and 72% of the distance between the ground system and the injector electrode with the average of the three readings used to determine the effective resistance of the system under test as long as the electrodes are placed outside of the influence of each other.

Now let us look at AEMC's new Model 6424 Ground Resistance Tester. It is understandable that for those who need to perform ground resistance testing on a sporadic basis remembering all requirements involved in properly conducting a fall of potential test can be easily overlooked.

The Ground Resistance Tester Model 6424 offers several novel features and advantages for testing grounding electrode systems. (CONTINUED ON PAGE 12)

DIAGRAM A

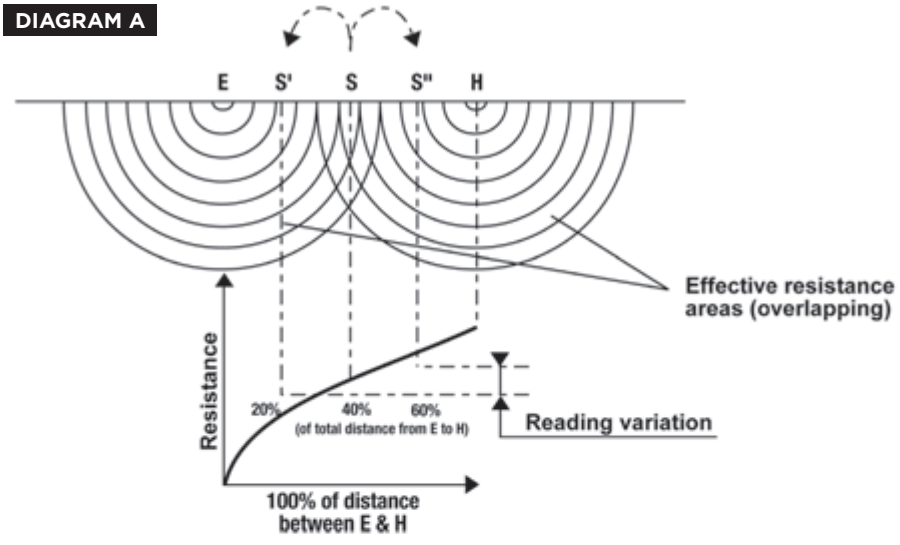
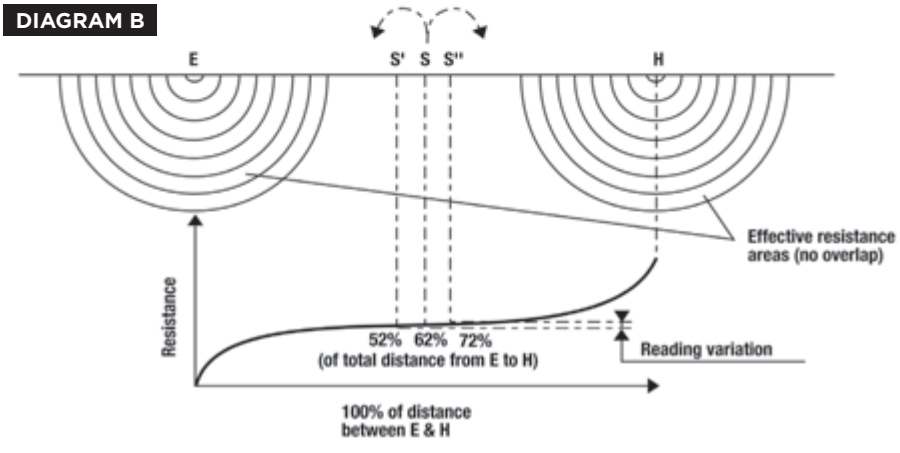


DIAGRAM B



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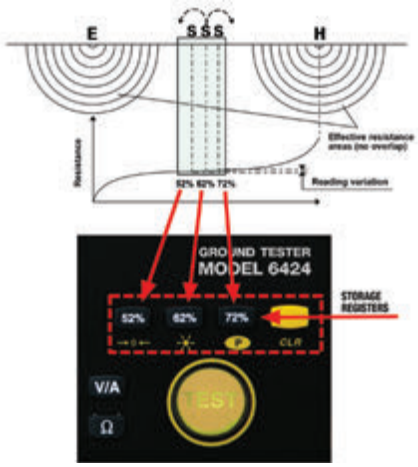
AEMC® Instruments (CONTINUED FROM PAGE 10)

Main functions include:

2-point test (2P): When turned on, the Model 6424 is initially in the 2-point mode. In this mode, the 2P symbol appears on the bottom right side of the screen. The main display shows the resistance measurement while the bottom of the screen shows the voltage between the H and E terminals. In this mode the instrument can be used as an ohmmeter to check bond resistance and general resistance measurements. Measurements are taken between the red H terminal and the green E terminal. This change confirms that the injector auxiliary electrode (H) is connected before a fall of potential test is conducted.

3-point test (3P): Pressing the TEST button initiates 3P mode. The 3P symbol is displayed on the bottom right side of the screen. The TEST button blinks red while the measurement is taken. When the measurement stabilizes, TEST stops blinking and turns green, indicating the completion of the test. The resistance measurement is displayed and automatically held. The bottom display shows the resistance of the injector electrode (RH) and the voltage used to conduct the test (UH-E).

A unique feature of the Model 6424 is its ability to store the three resistance measurements used to complete the simplified 62% ground test (52%, 62% and 72%) and calculate the average percentage difference between them saving time and ensuring accuracy. After a measurement is taken and stabilized and the test button turns green, simply press the percentage button associated with the Potential electrode (S) distance used for the measurement (for example 52%). The reading will be stored and displayed



at the bottom of the screen, and the instrument will return to the 2-point mode. Move the S electrode the next test distance (62%) and repeat the process and store it. Then do the same for the 72% measurement.

When all three readings are stored, they will be displayed on the bottom line of the display and the average and percent deviation will display at the top of the screen. If the percent deviation is above 5% the display will blink indicating the test electrodes are within the influence of each other which will indicate that the injector electrode needs to be moved out further and the three tests repeated.

The model 6424 also can detect hazardous voltages up to 700 Volts AC or DC and prevent the test from starting while alerting the operator of a safety hazard. An optional current probe (Model MN72) accessory facilitates leakage current measurement as well to further assist in troubleshooting.

Key features that will especially assist the users who perform ground resistance testing on an infrequent basis are:

Simple operation

- Only one button to press (no set up required) to get test results
- Test button turns green when measurement is stable, turns red if an error occurs
- Ensures that the measurement is valid when button remains green

4 Instruments in one, saves time checking the complete system

- Measures ground resistance
- Checks bond resistance
- Detects hazardous voltages
- Measures leakage AC current
- Color coded inputs and test leads
- Fast error free hook-up and operation
- Large back-lit digital display
- Easy to read in all lighting conditions
- Automatic hold function
- Retains last measurement after the reading stabilizes
- Automatic test frequency selection between 128 and 256 Hz
- Provides stable results in adverse environments
- Stores 52, 62 and 72% measurements
- Eliminates the potential error in determining the ground resistance
- Built-in test lead compensation capability
- Improves the accuracy of low resistance measurements
- Automatically checks the injector lead connection when connected to the H auxiliary rod
- 600V Cat IV rated
- Provides a high level of operator safety

Whether you are an infrequent or daily user of ground test equipment, the AEMC model 6424 greatly reduces the possibility of testing errors while ensuring confidence that the measurements are valid in a simplified process. It also pro-vides a high level of safety and alerts to hazardous conditions. ❑