IEEE Guide for Measurement of Impedance and Safety Characteristics of Large, Extended or Interconnected Grounding Systems

Sponsor
Power System Instrumentationand Measurements Committee
of the
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Abstract: Practical instrumentation methods are presented for measuring the ac characteristics of large, extended or interconnected grounding systems. Measurements of impedance to remote earth, step and touch potentials, and current distributions are covered for grounding systems ranging in complexity from small grids (less than 900 m^2), with only a few connected overhead or direct burial bare concentric (2) neutrals, to large grids (greater than 20 000 m^2), with many connected neutrals, overhead ground wires (sky wires), counterpoises, grid tie conductors, cable shields, and metallic pipes. This standard addresses measurement safety; earth-return mutual errors; low-current measurements; power-system staged faults; communication and control cable transfer impedance; current distribution (current splits) in the grounding system; step, touch, mesh, and profile measurements; the foot-equivalent electrode earth resistance; and instrumentation characteristics and limitations.
Keywords: Grounding systems, impedance, safety

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Foreword

(This foreword is not a part of IEEE Std 81.2-1991, IEEE Guide for Measurement of Impedance and Safety Characteristics of Large, Extended or Interconnected Grounding Systems.)

During the late 1970's, in an effort to increase its usefulness, this guide was divided into two parts. The first part is entitled IEEE Std 81-1983, IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System. It covers the majority of field measurements that do not require special high-precision equipment and measuring, and that do not encounter unusual difficulties such as may be found with extensive grounding systems, abnormally high stray ac or dc currents, etc. IEEE Std 81 (Part I) has been extensively revised and updated. Part I was approved in 1983 and reaffirmed in 1991. This part of the guide (Part II) is entitled IEEE Std 81.2-1991, IEEE Guide for Measurement of Impedance and Safety Characteristics of Large, Extended or Interconnected Grounding Systems. This new part covers measurement of very low values of ground impedance (less than 1 Ω). The extensive use of specialized instrumentation, measuring techniques, and safety aspects are incorporated.

This guide was prepared by the Measurement of Impedance and Safety Characteristics of Large, Extended or Interconnected Grounding Systems Working Group of the RLC Measurements Subcommittee of the Power Systems Instrumentation and Measurements Committee of the IEEE Power Engineering Society.

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1. Purpose

The purpose of this guide is to present practical instrumentation methods that may be used for the measurement of impedance to remote earth, step and touch potentials, and current distributions of large extended or interconnected grounding systems ranging in complexity from small grids (less than 900 m^2), with only a few connected overhead or direct burial bare concentric neutrals, to large grids (greater than 20 000 m^2), with many connected neutrals, overhead ground wires (sky wires), counterpoises, grid tie conductors, cable shields, and metallic pipes.

2. Scope

Test methods and instrumentation techniques used to measure the ac characteristics of large grounding systems include the following topics:

1) Measurement safety
2) Earth-return mutual errors
3) Low-current measurements
4) Power-system staged faults
5) Communication and control cable transfer impedance
6) Current distribution (current splits) in the grounding system
7) Step, touch, mesh, and profile measurements
8) The foot-equivalent electrode earth resistance
9) Instrumentation characteristics and limitations

Grounding electrodes consisting of a single ground rod, arrays of ground rods, tower footings, and many grids (if no external grounding is connected) can be measured, interference voltages permitting, with methods outlined in IEEE Std 81-1983 [2][1]. Even if a large grid has an impedance phase angle of 18° the resistance component will be only 5% lower than its impedance. However, for large grounding grids in low-resistive earth (<75 Ω-m) and for grounding

[1]The numbers in brackets correspond to those of the references in Section 3.