

# Grounding System

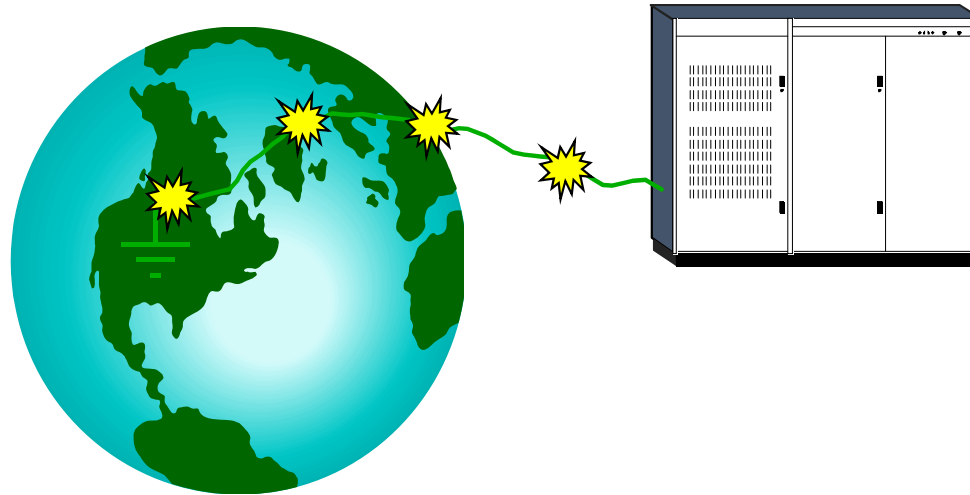
## Design and Testing for Critical Facilities

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2019 **BICSI FALL**  
Conference & Exhibition

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# What Is Grounding ?

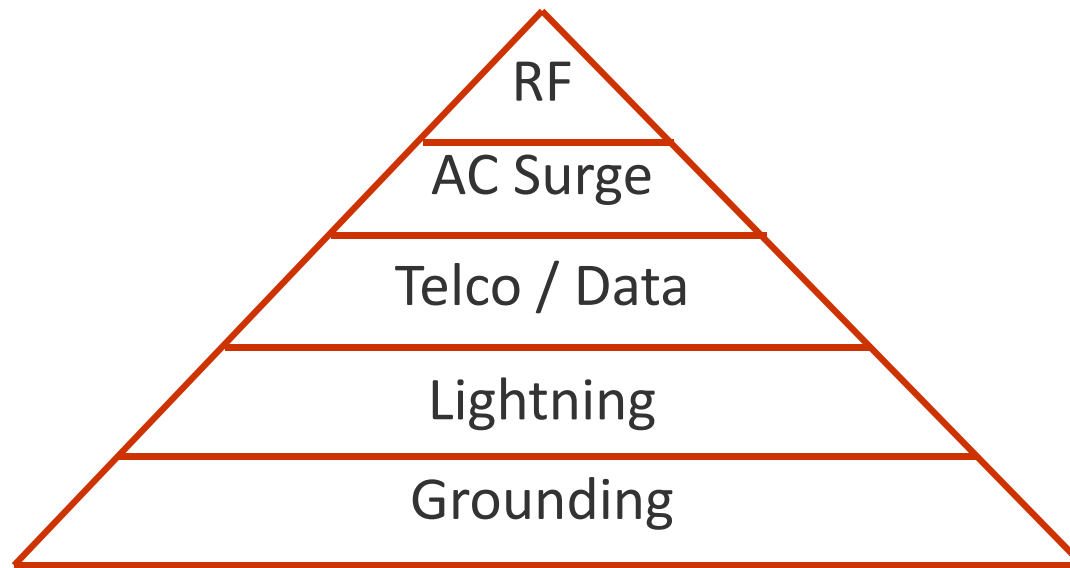


An electrical connection , whether intentional or accidental between an electrical circuit or equipment and the earth, or to some conducting body that serves in place of the earth.

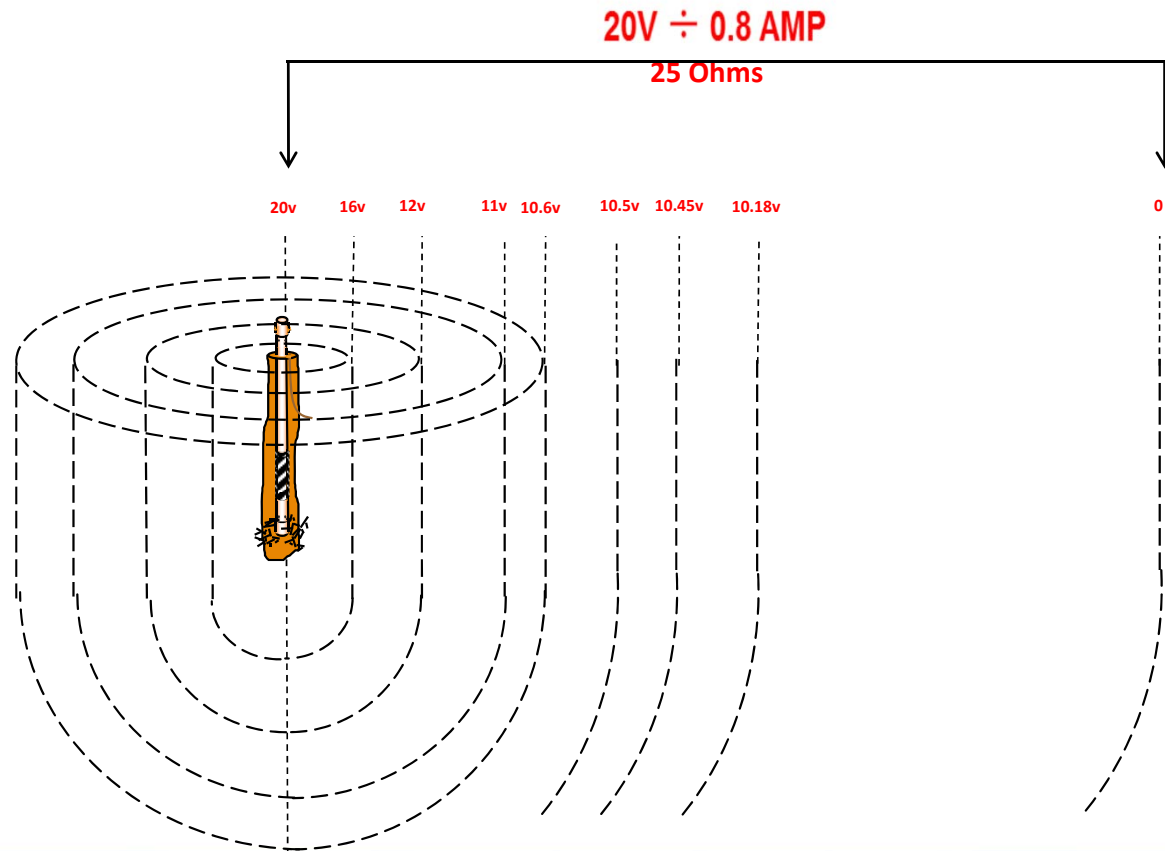
## Reasons For Grounding

- Personnel safety and equipment protection by providing a path to safely dissipate any unwanted charges or potentials.
- Ensure equipment performance and protection
- Satisfy manufacturer's warranty

# Electrical Protection Pyramid<sup>®</sup>



# Resistance To Earth



# Soil Resistivity Basics

# Soil Resistivity

## Key Variable in System Design

- Determines grounding system resistance
- Changes from Site to Site
- Dependent on:
  - Soil type
  - Moisture
  - Electrolytes
  - Temperature

## Soil Resistivity Comparison

<u>Soil Type</u>	<u>Resistivity (ohm-cm)</u>	
Surface Soils	100	- 5,000
Clay	200	- 10,000
Sand and Gravel	5,000	- 100,000
Surface Limestone	10,000	- 1,000,000
Limestone	500	- 400,000
Shale	500	- 10,000
Sandstone	2,000	- 200,000
Granites, Basalts, etc		100,000
Decomposed Gneisses	5,000	- 50,000
Slates, etc	1,000	- 10,000

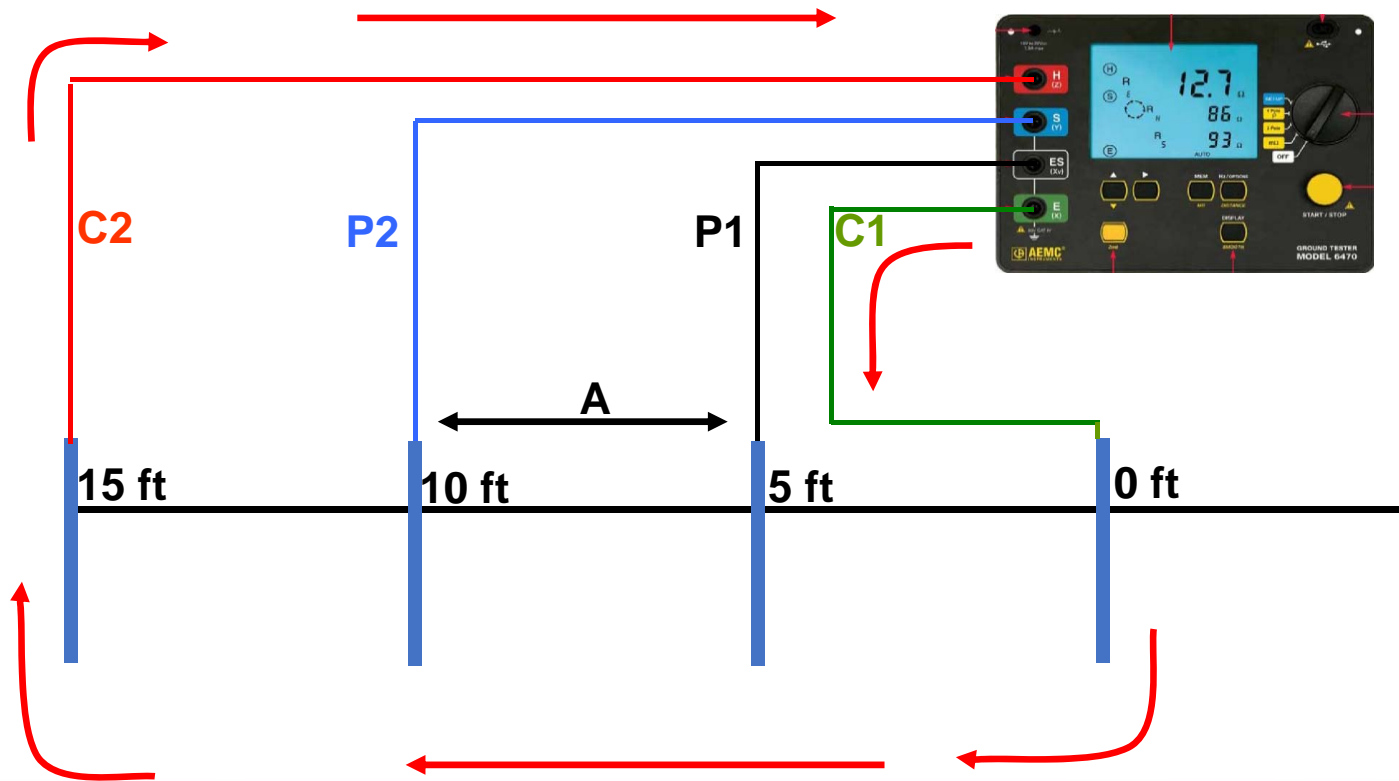


# Soil Resistivity Testing

## 4-Pt. Wenner Method

- Visually Survey Lease Area to Determine Location and Direction For Test
  - Not parallel to buried metallic objects
  - Not parallel overhead power lines
  - Sufficient straight line distance to allow for test
  - **Minimal distance 300 feet**

# 4-Pt. Wenner Method



## 4-Pt. Wenner Method

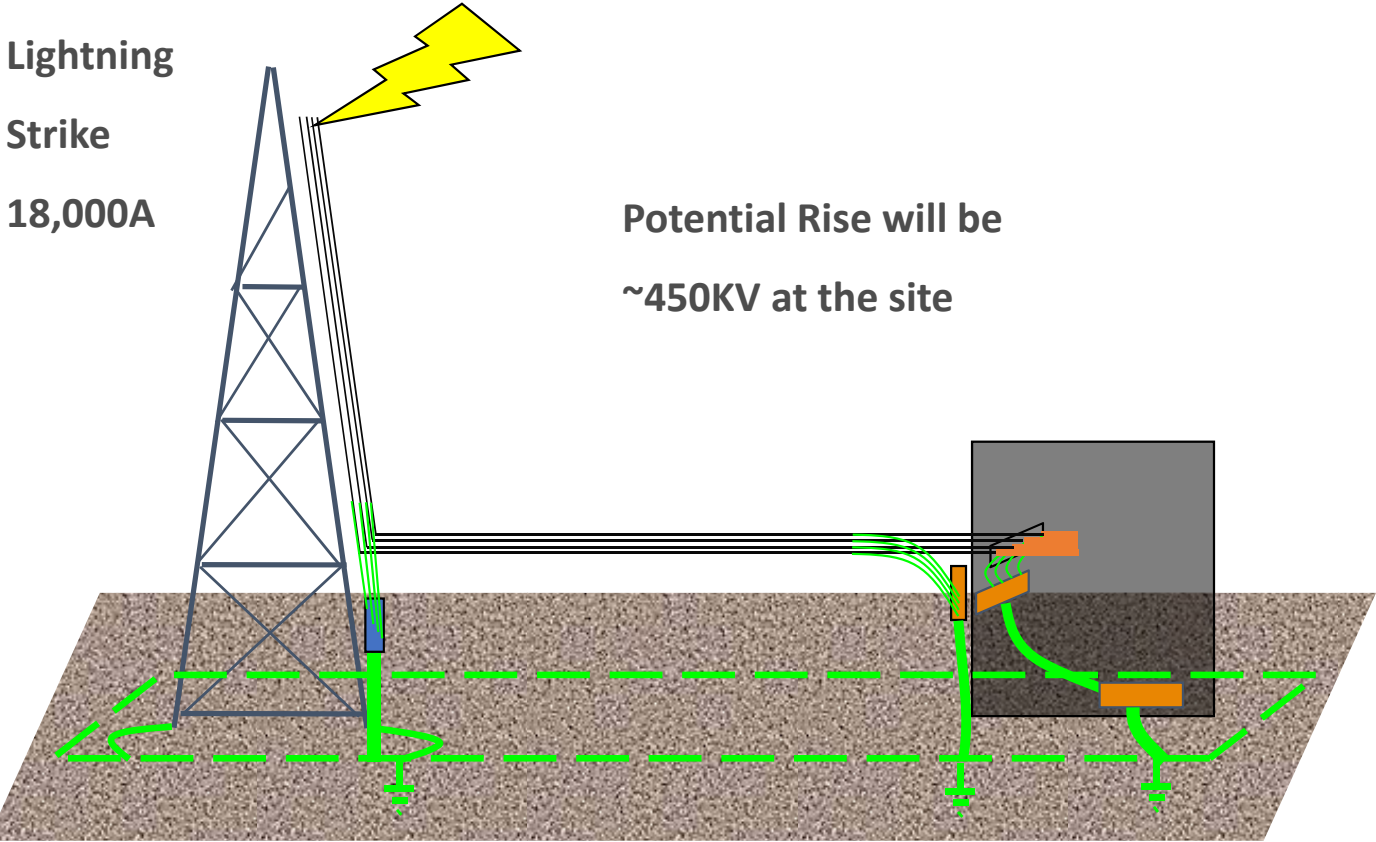
<u>Probe Spacing (Feet)</u>	<u>Meter Reading (Ohms)</u>	$\rho = 1.915 AR$ <u>Calculated Resistivity (Ohm-Meter)</u>
5	52.00	497.90
10	19.68	370.87
15	10.16	292.00
20	6.53	250.10
30	4.30	247.04
40	10.80	827.28
60	7.40	850.26
80	5.58	855.60
100	4.44	850.26

# Typical Grounding Electrode System Resistance Requirements

# Typical Resistance Requirements

- NFPA 70 NEC 25 OHMS or Two Rods
- IEEE Standard 142 & 1100 Equipment Dependent
- Motorola Standard R-56 10 OHMS (Design Goal)
- Telecommunications 5 to 10 OHMS
- Emerson DeltaV 3 OHMS
- Essilor 3 OHMS
- GE Medical Systems 2 OHMS

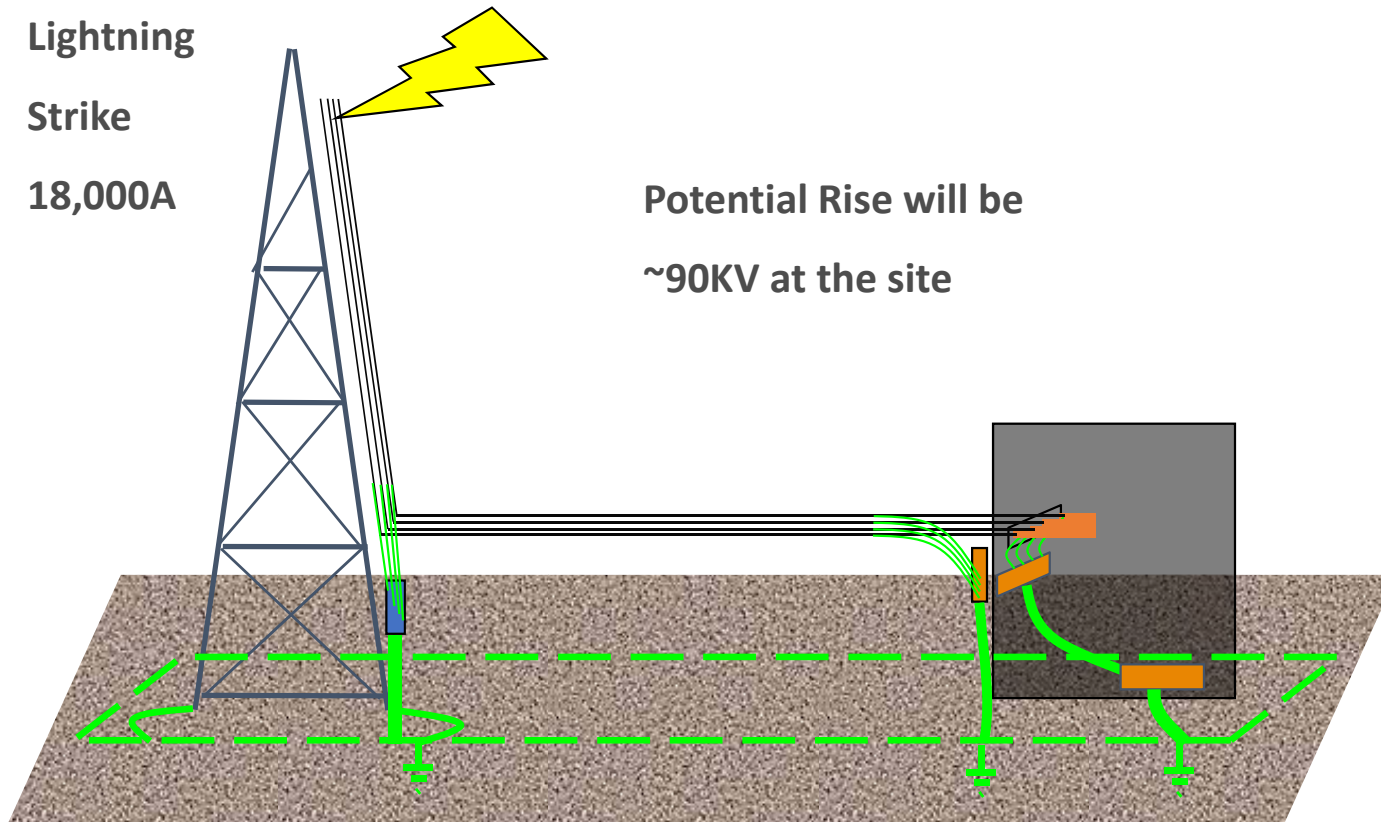
# 25 Ohm Grounding System



# 5 Ohm Grounding System

Lightning  
Strike  
18,000A

Potential Rise will be  
~90KV at the site





# Grounding System Resistance Testing

# Grounding System Testing

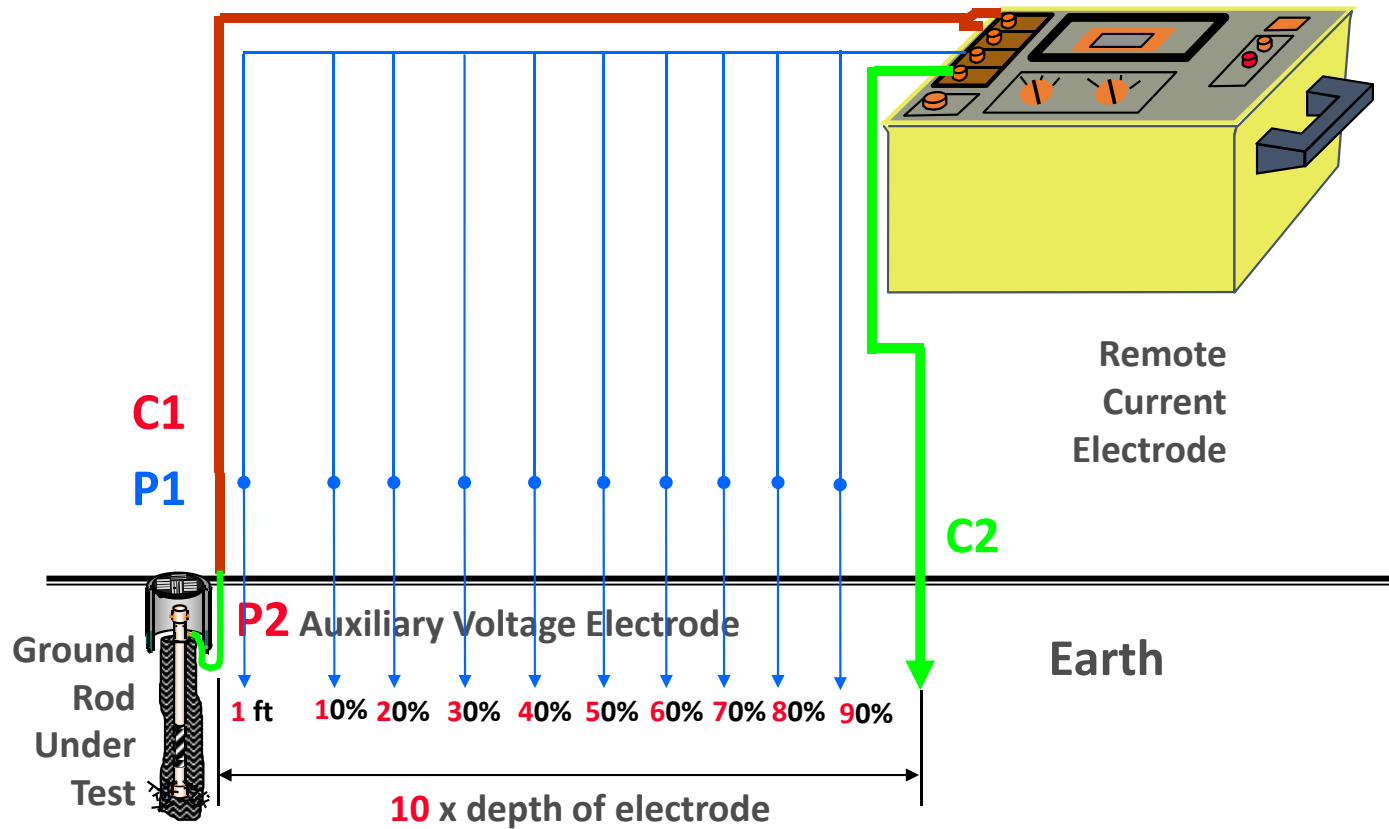
- **Why Test Grounds?**
  - Determine Baseline
  - Validate Construction
  - Confirm Design Spec Satisfied
  - Satisfy Warranty Reqs
  - Ensure Equip Protection & Performance



# Testing Methods

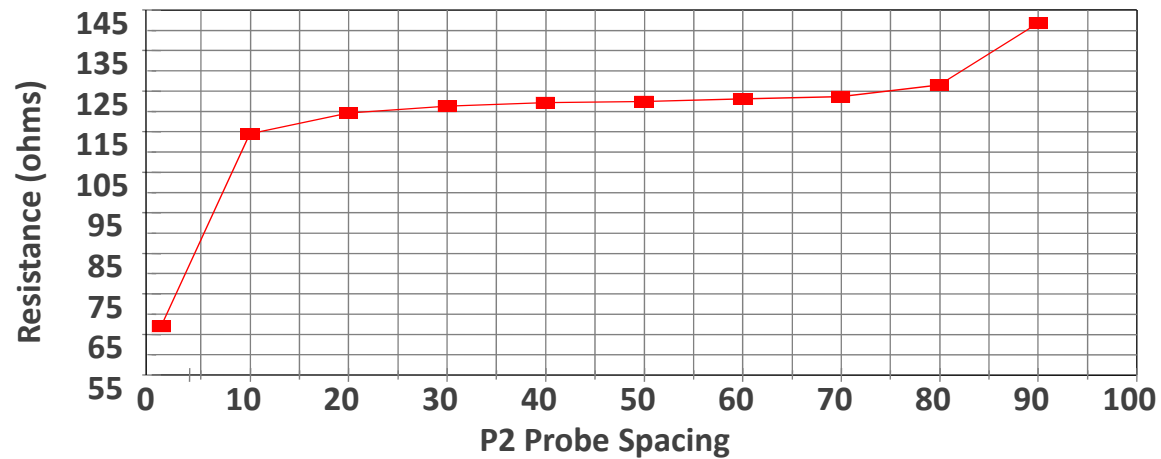
- Two Test Methods
  - Fall of Potential (Three Point) Test
  - Clamp-on Test

# Fall-of-Potential Method



# Fall of Potential

- Why 10+ Samples?
  - Single Point Could Be Misinterpreted
  - Data Must Be Plotted
    - Visual Plateau
    - Confirms Test Validity



# Fall Of Potential Test

## Why Invalid?

- #1 Reason
  - Not Isolating System Under Test
    - Meter is a constant amperage meter
    - Part of the current travels through the connection
    - The ground system is part of a parallel network
  - Test Is Invalid Unless Disconnected

# Fall Of Potential Test

## Why Invalid?

- #2 Reason
  - Insufficient Probe Spacing
    - Req'd to Avoid the Spheres of Influence

## Fall of Potential Test

- Spacing For Current Probe?
  - Single Electrode
    - Minimum 5X Length of Rod
    - Ideal, 10X Length of Rod
      - 10 Foot Rod, 50-100 Feet Away
      - 200 Foot Well, 1000-2000 Feet Away

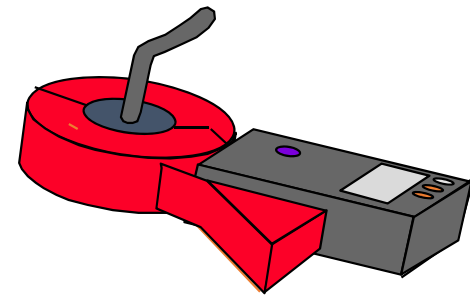


# Clamp-on Ground Resistance Testing

## Clamp-on Resistance Testing

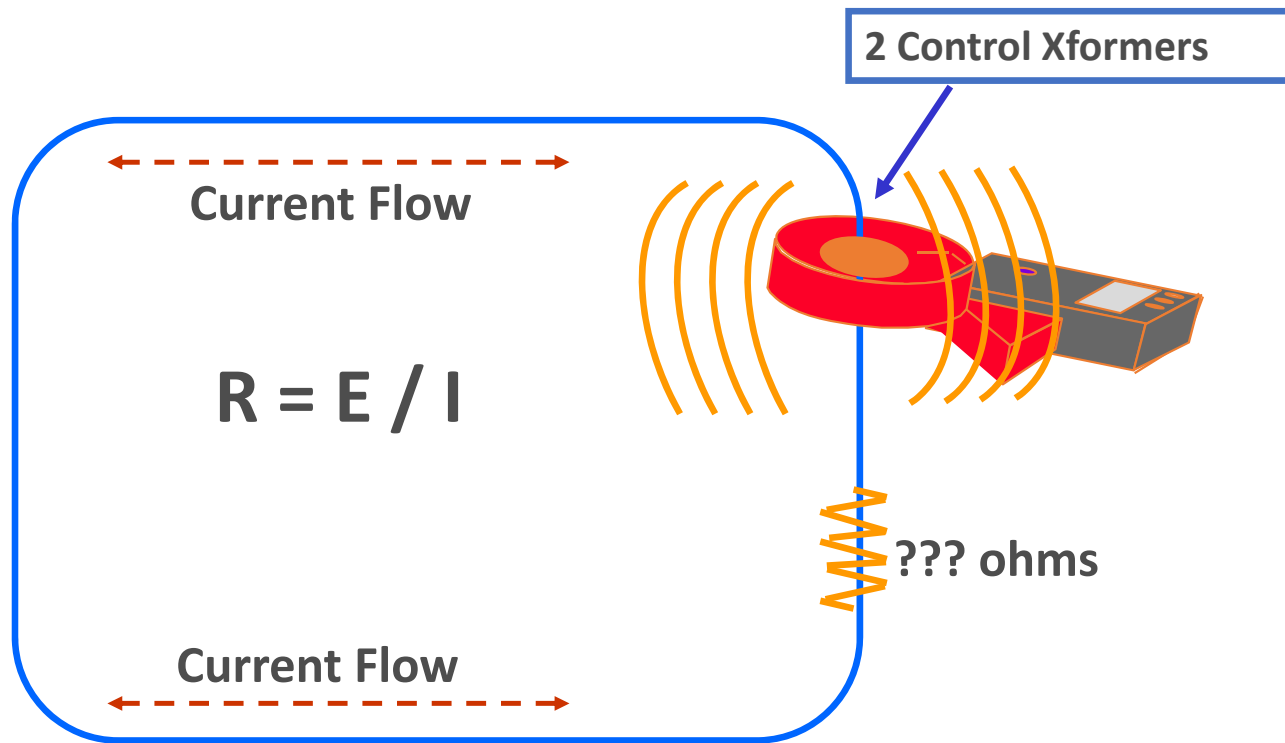
### Clamp-on Ground Resistance Meter

- Convenient, Quick, Easy
- Does Not Require Disconnecting Equipment
- Measures Current on the Ground

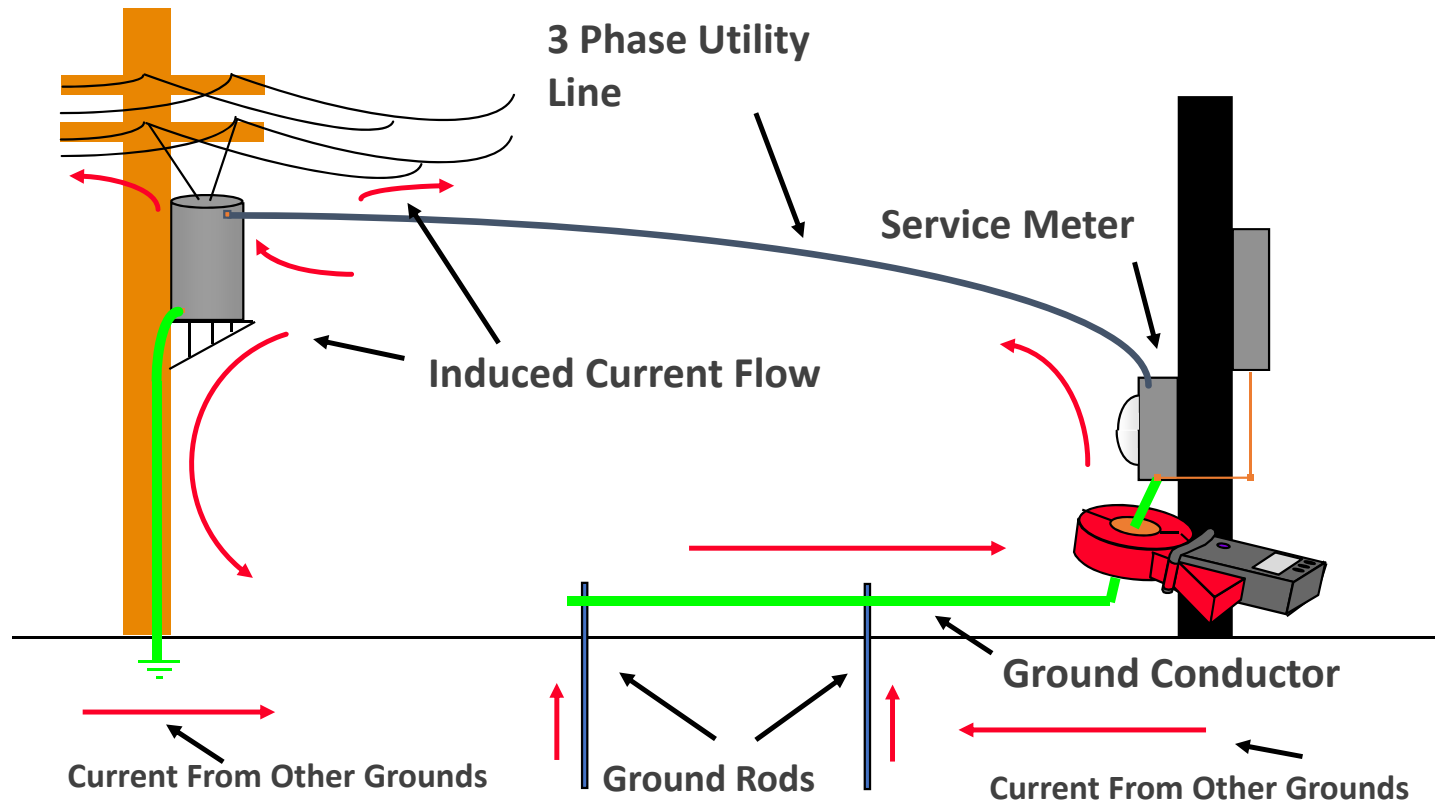


May Read Ground Loops vs. Ground Resistance

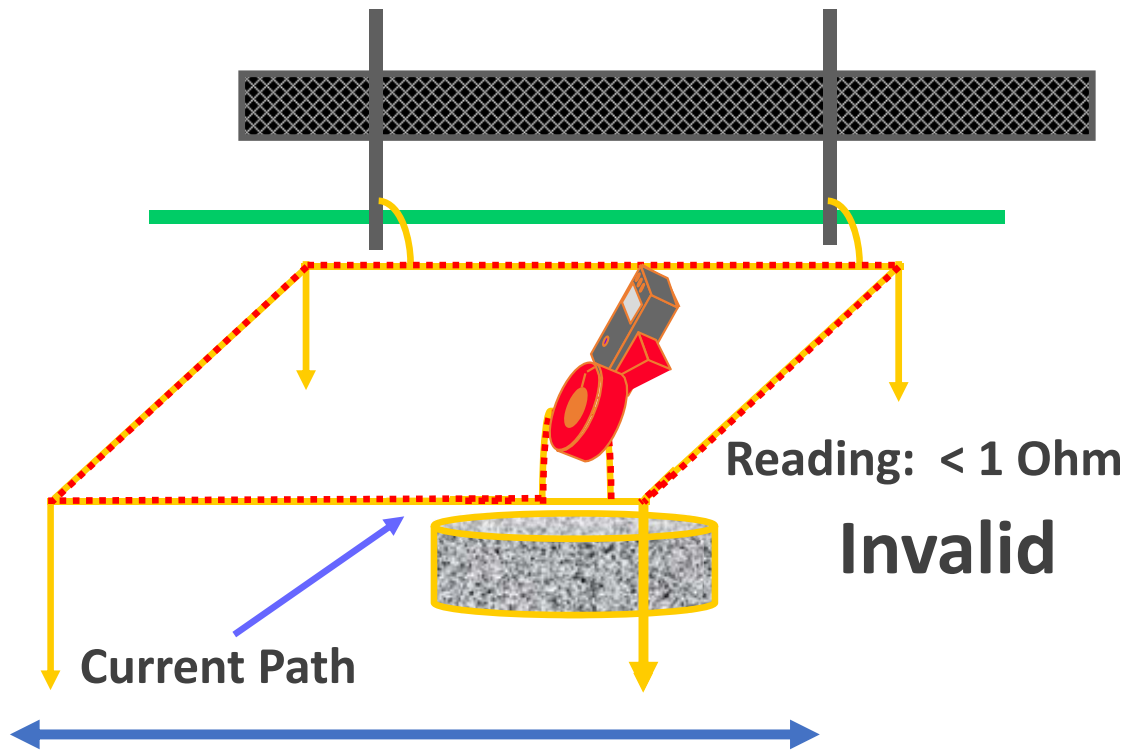
# Clamp -on Meter Operation



# Clamp-On Resistance Testing Example



# Invalid Clamp-on Reading



# Bonding

# Bonding

Do the words bonding and grounding mean the same thing?

- **Bonding** - The permanent joining of two metallic parts to form an electrically conductive path that ensures electrical continuity and the capacity to safely conduct any current likely to be imposed.



**Grounding** - An electrical connection , whether intentional or accidental between an electrical circuit or equipment and the earth, or to some conducting body that serves in place of the earth.

# Bonding

## Why is Bonding More Important Now than Ever Before?

### Grounding Processes/Grounding Electrode Systems -V- Technological Advances

- Except for the advent of electrolytic electrodes and different grounding enhancement materials, grounding processes and grounding electrode systems have changes little in the past 100 years.
- Are we using the same technology that our grandparents did?
  - Personal Computers
  - Television
  - Microwave
  - Radar
  - Solar Panels
  - Electronic Points of Sale Systems
  - Electronic Cash Registers
  - Voice Over Internet Protocol
  - Cellular Telephone
  - Ground Positioning Systems
  - Photovoltaic Cells
  - Radio Communications
  - Computer controlled manufacturing
  - Medical Equipment
  - Fiber Optic Voice/Data Transfer
  - Digital Networking

# THANK YOU FOR YOUR ATTENTION

## BICSI Fall Conference & Exhibition

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