Earthing System

Ensuring Electrical Safety

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Earthing System presentation Outlines

- **Introduction**
- **Purpose of Earthing System**
- **LV Earthing Classification**
- **General Principle of Designing Earthing System**
- **Grounding Fault Current**
    1. **Transformer**
    2. **RMU**
    3. **Generator**
    4. **Panels**

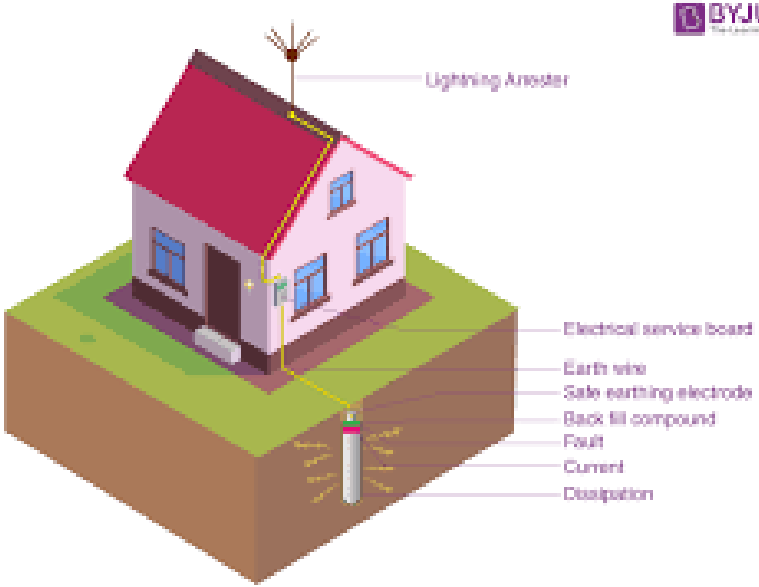
Earthing System presentation Outlines

- **Conductor Sizing**
  1. **General Equation**
  2. **Based on Earthing System Type (according to BS 7671)**

- **Soil Resistivity**
  1. **Important Factors**
  2. **Measurement Methods**
     - 2.1. **Wenner Method**
     - 2.2. **Driven Rod Method**

Introduction:

Why is it called earthing?



- **From The Defnation of Earthing System:**

➢ **Earthing is defined as “the process in which the instantaneous discharge of the electrical energy takes place by transferring charges directly to the earth through low resistance wire.**

Introduction:

Why we choose Earth to Discharge?

- **Depend on Two factors:**

1. **Human Resistence**

The “total body resistance” of the person is composed of the very low (approximately 300 Ω) internal body resistance plus the 2 skin contact resistances. The skin contact resistance will usually be between 1000 and 100,000 Ω, depending on contact area, moisture, condition of the skin, and other factors.

2- **Earth Resistance**

The specific resistance is mainly dependent on the type of soil. So, "good" soils with low resistance are clay, black soil (80 ohm * m), clay loam (100 ohm * m). The resistance of sand is highly dependent on the moisture content and ranges from 10 to 4000 Ohm * m.

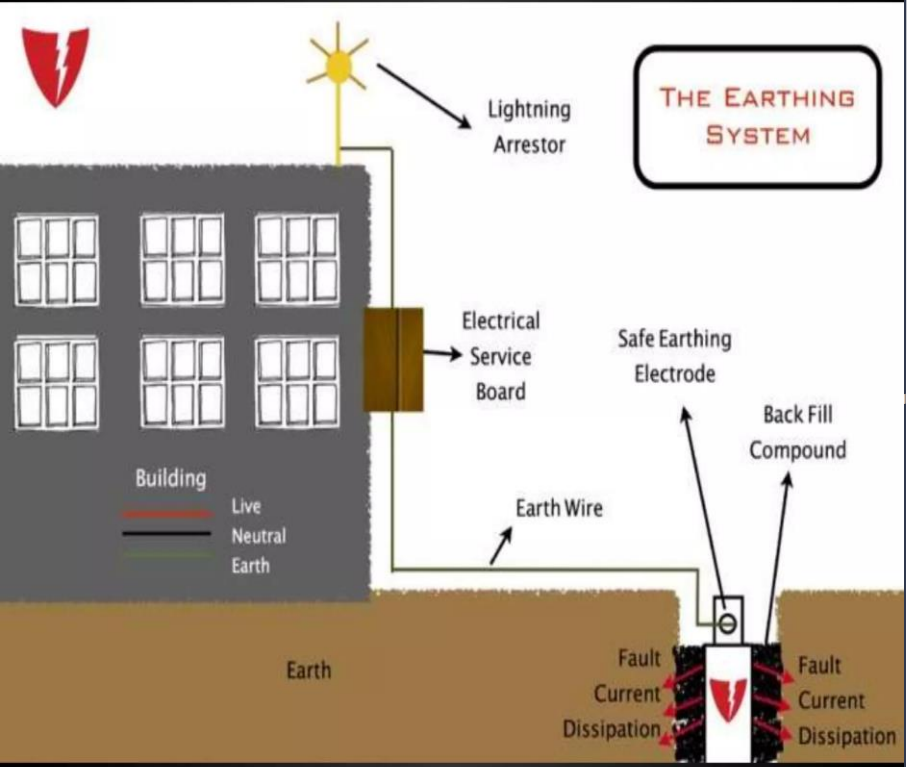
Introduction What is The Difference Betwen Earthing & Grounding..?

EARTHING VERSUS GROUNDING

Characteristics	Earthing	Grounding
Condition	The circuit part that does not carries current under normal condition	The circuit part that does carries current under normal condition
Protection	Protection of people and animals from an electric shock if touching	Protections of power system equipment
Wire	Generally green wire	Generally black wire
Path	Providing a path to a large surface of zero volt potential	Providing a return path to the current in case of faulty/abnormal conditions

DifferenceBetween.net

Introduction



- **Earthing systems are Essential component of electrical installations which provide a safe pathway for phase to ground to ground current to flow into Ground**

- **Importance Definitions**

Earth: the conductive mass of the earth, which electrical potential at any point is conventionally taken as zero.

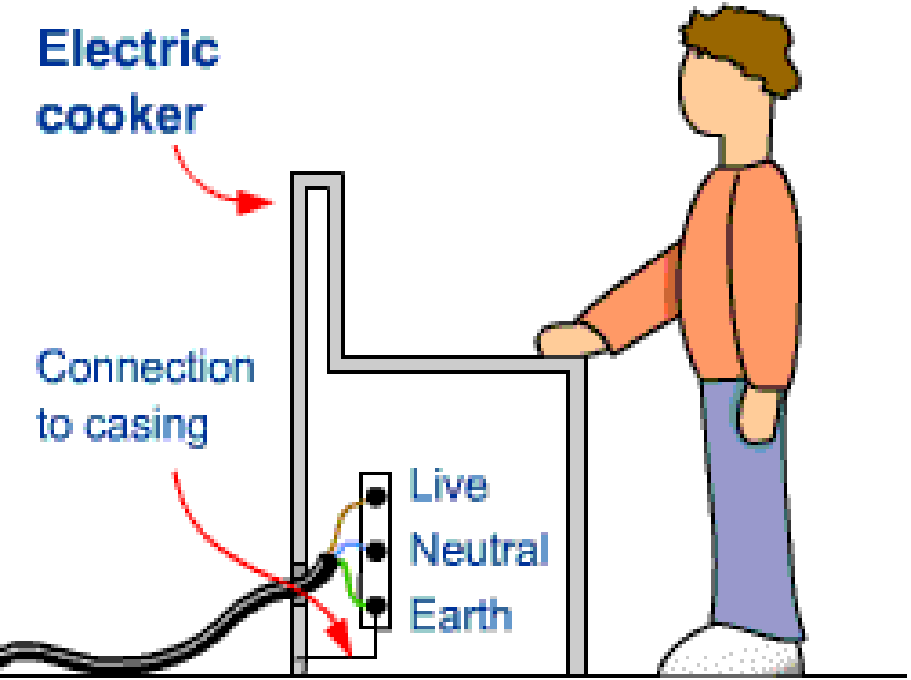
Earth Electrode: a conductor or a group of conductors in close contact with, and providing an electrical Connection with earth.

Equipotential Bonding: The practice of electrically connecting all metallic parts to form a single unified grounding system.

How Many Volts Or Amps Can Kill Humans?

BODILY EFFECT	MEN/WOMEN	DIRECT CURRENT (DC)	60 HZ AC	100 KHZ AC
Slight sensation felt at hand(s)				
	Men	1.0 mA	0.4 mA	7 mA
	Women	0.6 mA	0.3 mA	5 mA
Threshold of pain				
	Men	5.2 mA	1.1 mA	12 mA
	Women	3.5 mA	0.7 mA	8 mA
Painful, but voluntary muscle control maintained				
	Men	62 mA	9 mA	55 mA
	Women	41 mA	6 mA	37 mA
Painful, unable to let go of wires				
	Men	76 mA	16 mA	75 mA
	Women	60 mA	15 mA	63 mA
Sever pain, difficulty breathing				
	Men	90 mA	23 mA	94 mA
	Women	60 mA	15 mA	63 mA
Possible heart fibrillation after 3 seconds				
	Men and Women		500 mA	100 mA

Purpose of Earthing System



1. Safety (humans & Equipments)

Prevent Electric Shock: By providing a path for fault currents to flow directly to the ground, the earthing system minimizes the risk of electric shock to humans and animals.

Reduce Fire Hazards: Fault currents and electrical surges can cause overheating and fires. An earthing system helps dissipate these currents safely.

2.Voltage Stabilization

Reference Point: Provides a stable reference point for voltage measurements, ensuring the proper functioning of electrical systems.

Improved System Performance: By stabilizing voltage levels, an earthing system enhances the overall performance and reliability of electrical installations.

Earthing Accessors

- **Main Earthing Accessors**

- **Earth Rod**
- **Earth Plate**
- **Earthing Clamp**
- **Earthing Rod Coupling**
- **Earthing Rod Tip**
- **Earthing Rod Driving Head with driving sleeve**
- **Earth Access Pit**
- **Earth Pit Cover**
- **Earth Enhancement Materials**

Low willige lbeseessysting

	TN,	TT,	IT,
	TN		
Types	Thee earthing burtonce garrd of im eneysefole.	Tourdrrsmncs and aat accontiats updery intre pegrand out of system.	Custoverchgned forsmoed an actercteratial and recul endo lorking to dsen in the earking earthin, system.
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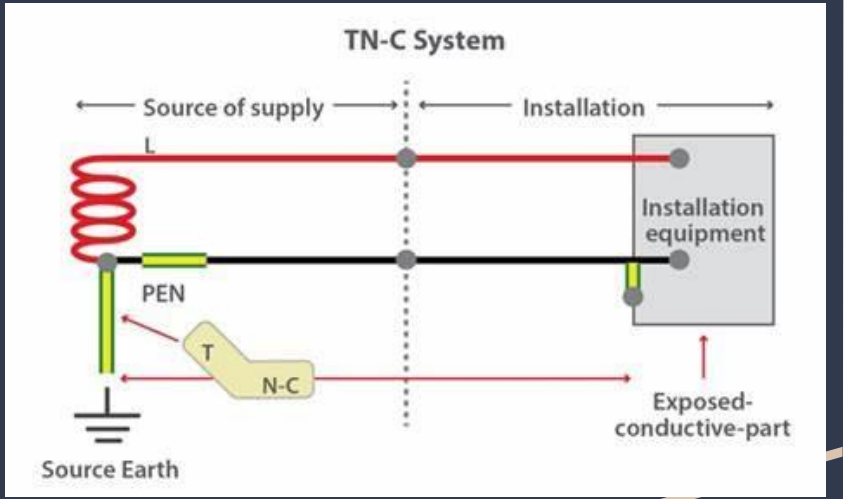
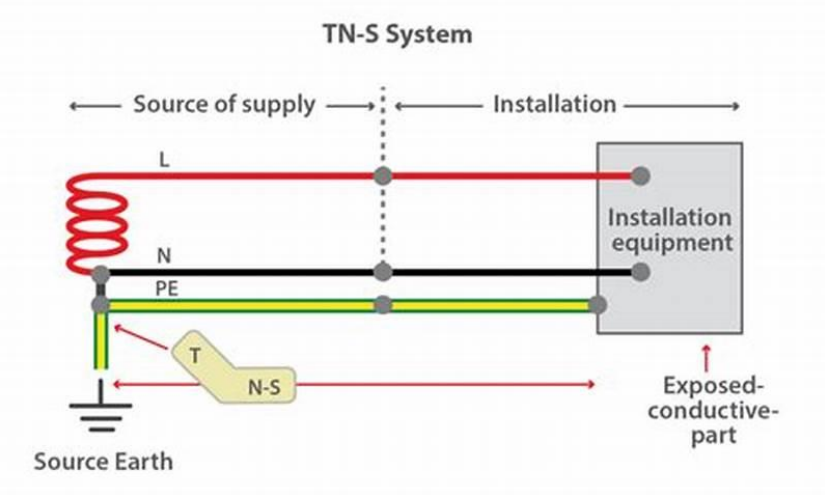
System	Description	Applications
TN-C-S	Combined PEN conductor for neutral and earth	Residential, commercial buildings
TN-S	Separate neutral and earth conductors	Industrial facilities, critical infrastructure
IT	Separate earth electrode connected to the equipment	Isolated systems, areas with high earth resistance
TT	the power supply source and the electrical installation are directly connected to the earth	Residential and Commercial Buildings and Rural Areas

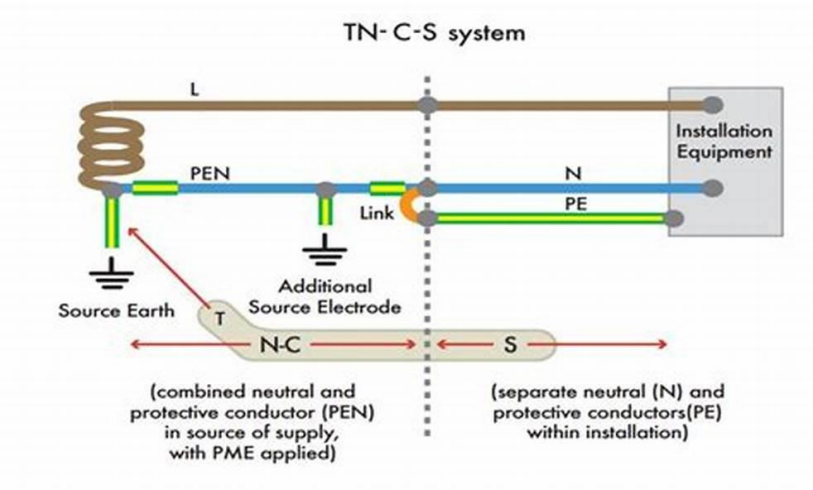
TN-C


TN-C System
Source of supply
Installation
L
PEN
T
N-C
Installation equipment
Exposed-conductive-part
Source Earth

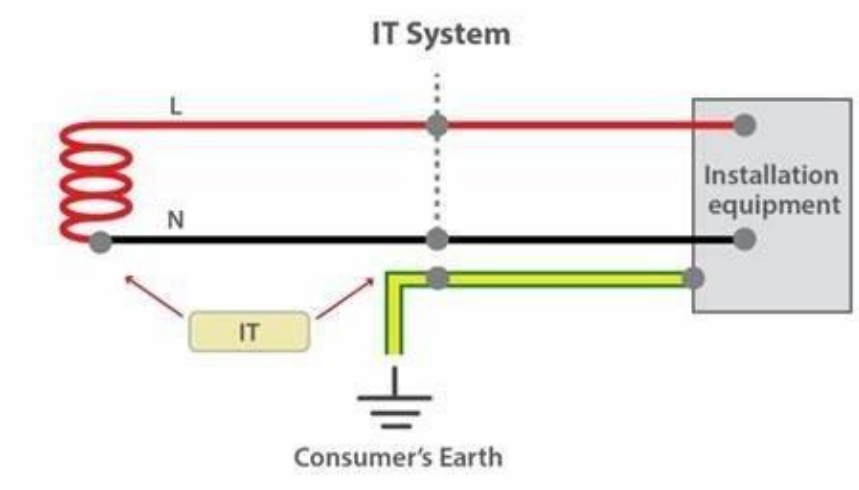
TN-S


TN-S System
Source of supply
Installation
L
N
PE
T
N-S
Installation equipment
Exposed-conductive-part
Source Earth

TN-C-S


TN- C-S system
L
PEN
Link
N
PE
Installation Equipment
Source Earth
Additional Source Electrode
T
N-C
S
(combined neutral and protective conductor (PEN) in source of supply, with PME applied)
(separate neutral (N) and protective conductors(PE) within installation)

IT


IT System
L
N
Installation equipment
IT
Consumer's Earth

General Principle of Earthing System Design

Designing an effective earthing system involves several critical principles that ensure safety, reliability, and efficiency. Here are the general principles to follow:

A- Reducing Earthing Resistance to small Value

B- Reducing step voltage and touch voltage between metal part and ground by equipotential bonding

To achieve this principles, we make

1- Increase length of rod

2- increase number of pits

3- Increase the distance between to pits

4- Increase the diameter of the rod

5- improve soil resistivity

Soil Resistivity :

Soil Resistivity Types:

Low Resistivity:

Soils with high moisture content and a large number of dissolved salts, like clay soils, generally have low resistivity. This allows for easy flow of electrical current

Medium Resistivity

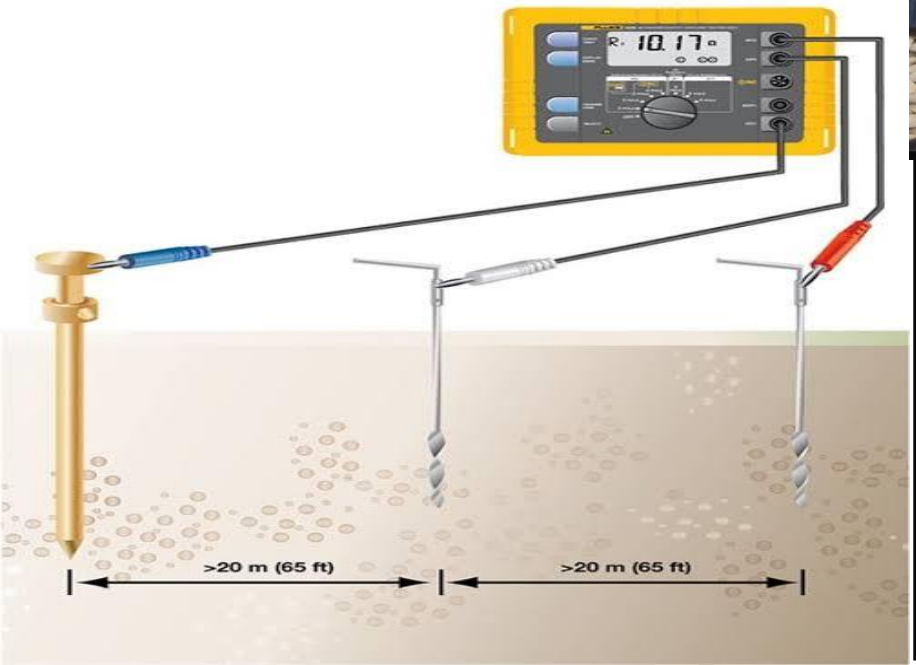
Soils with moderate moisture and dissolved salts, like sandy loam, fall into the medium resistivity category. They provide moderate resistance to electrical flow.

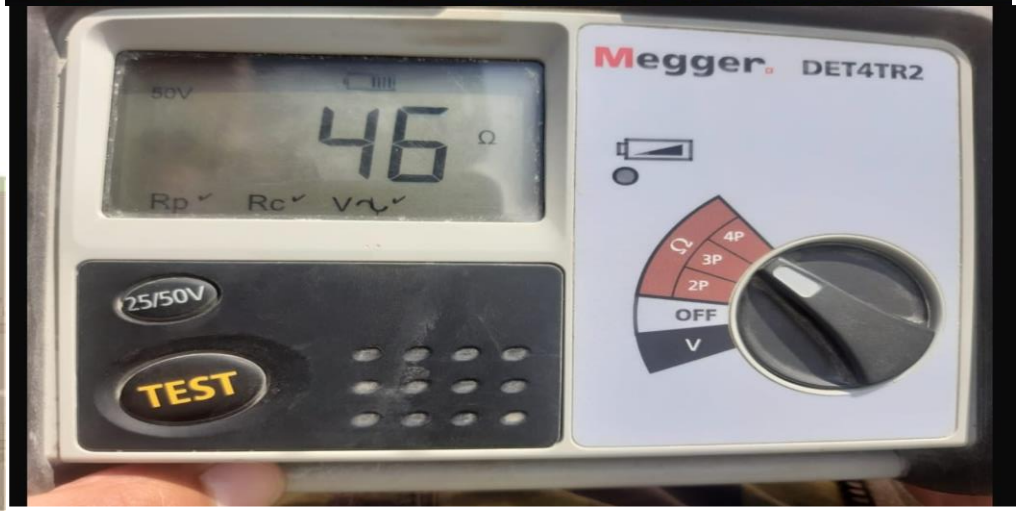
High Resistivity

Soils with low moisture content and limited dissolved salts, such as rocky soils or dry sand, typically have high resistivity. This limits the flow of electrical current.

Type of earth	Average resistivity ($\Omega \cdot m$)
Wet organic soil	10
Moist soil	10^2
Dry soil	10^3
Bedrock	10^4

Tools for Soil Resistivity Measurement





Types of Measurements of Soil Resistivity

Types of Measurements of Soil Resistivity

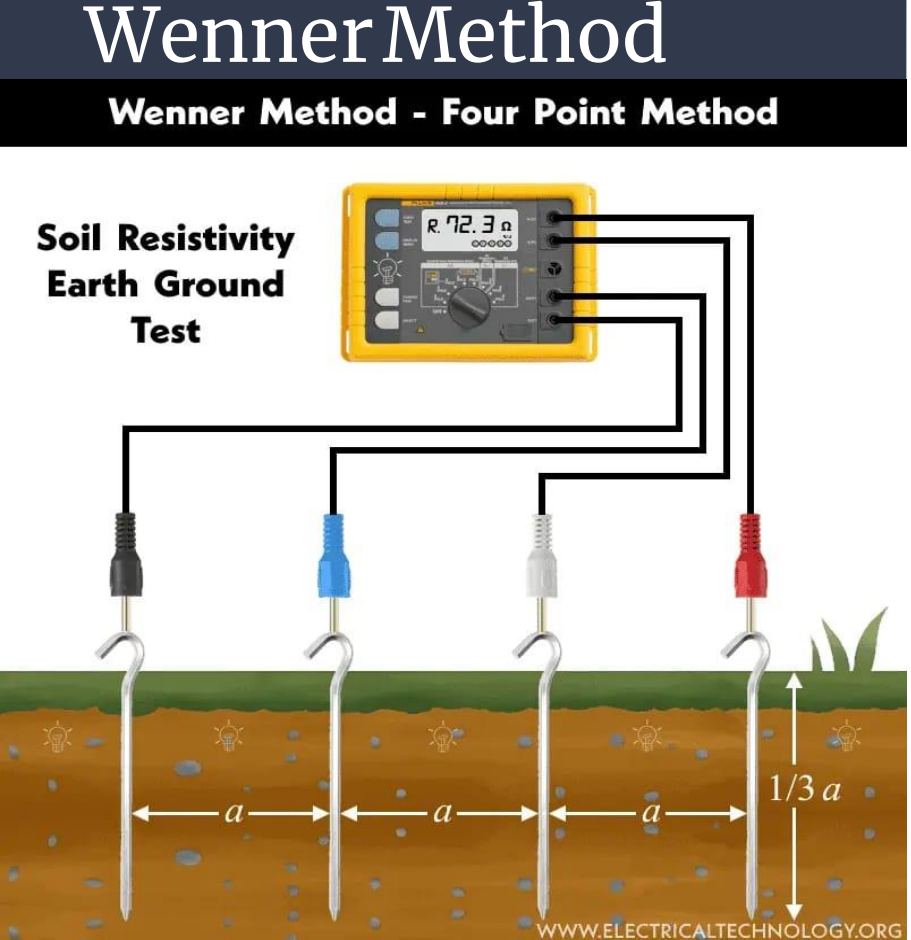
1- **Wenner Method**

This common method uses four electrodes in a straight line, and measures the resistance between the inner two electrodes.

2-**Driven Rod Method**

In this method, two driven rods are used to measure the resistance between them, allowing for a more localized measurement of soil resistivity.

Wenner Method



Wenner Method for Soil Resistivity

1- Electrode Placement

Four electrodes are placed in a straight line with equal spacing. The outer two electrodes are used to inject current, and the inner two electrodes are used to measure the potential difference.

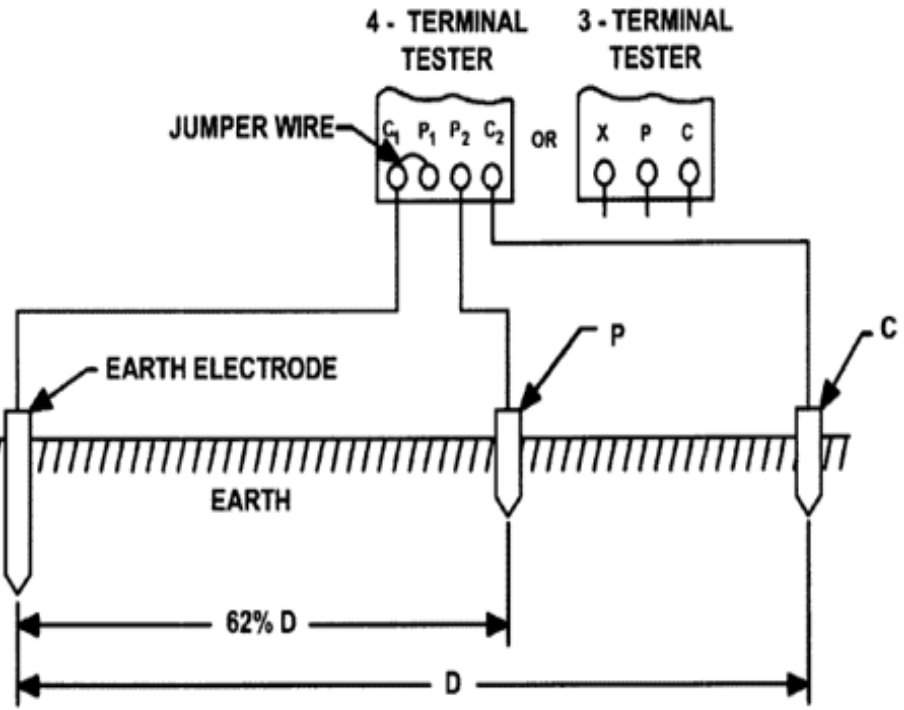
2- Current Injection

Current is injected into the ground through the outer electrodes. This creates a current flow through the soil, forming an electrical field.

3- Potential Measurement

The potential difference between the inner two electrodes is measured, providing a direct measurement of the resistance between those points in the soil.

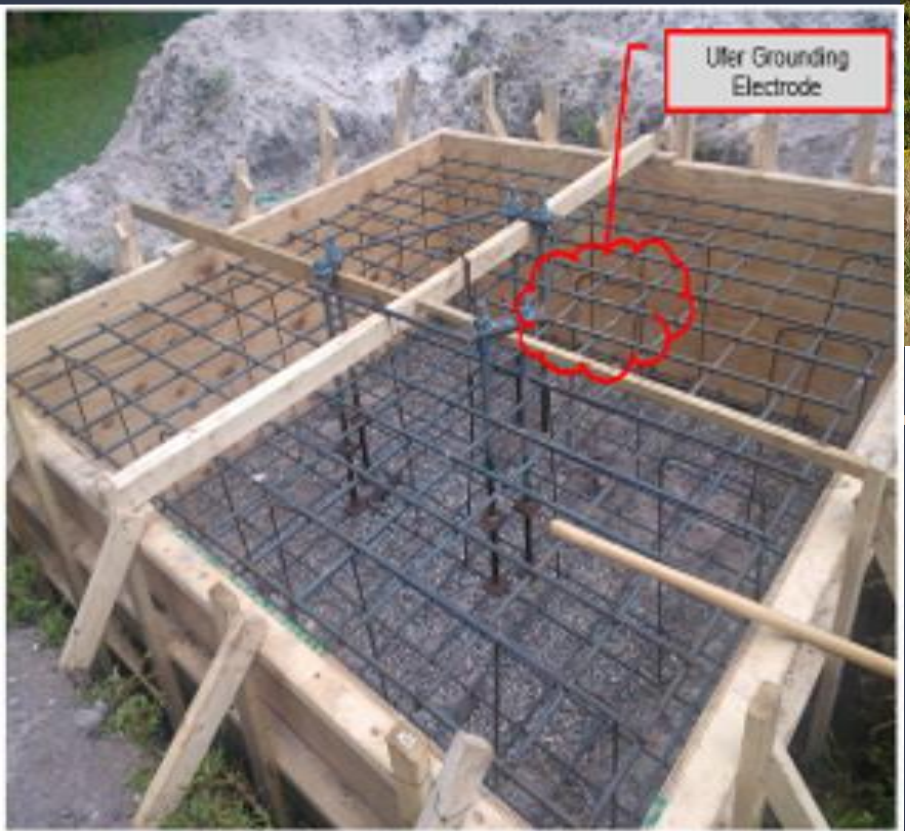
Driven Rod Method

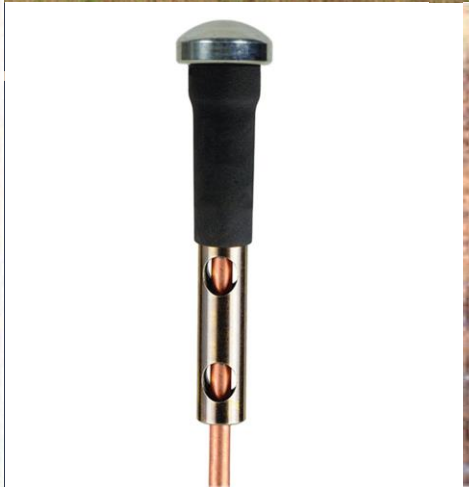


Fall-of-potential test method. Photo Credit: Megger

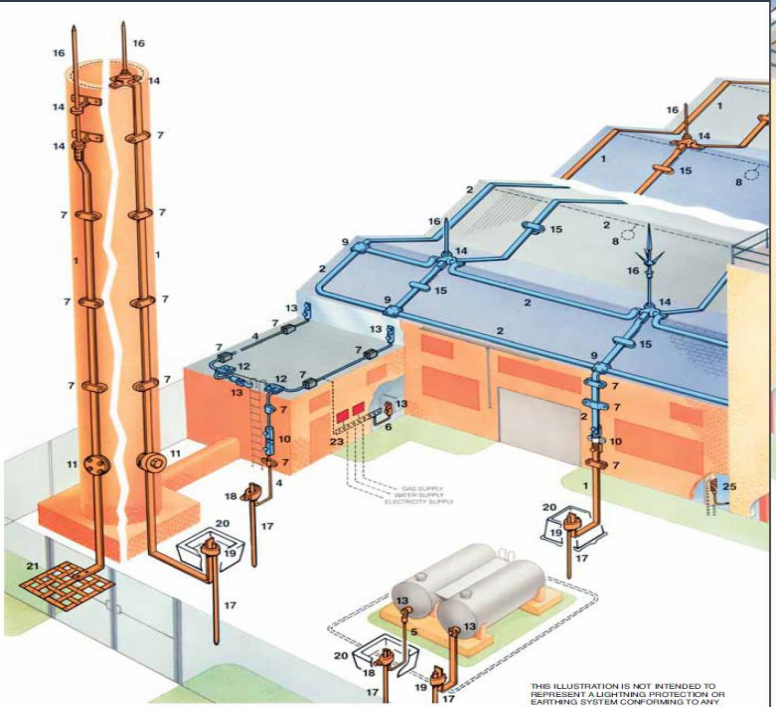
- In this method, the depth (Lr) of the driven-rod located in the soil to be tested is varied.
- The other two rods, known as reference rods, are driven to a shallow depth in a straight line.
- The location of the voltage rod is varied between the test rod and the current rod. - Alternately, the voltage rod may be placed on the side opposite the current rod.
- the voltage rod may be placed on the side opposite the current rod .

Picture from site

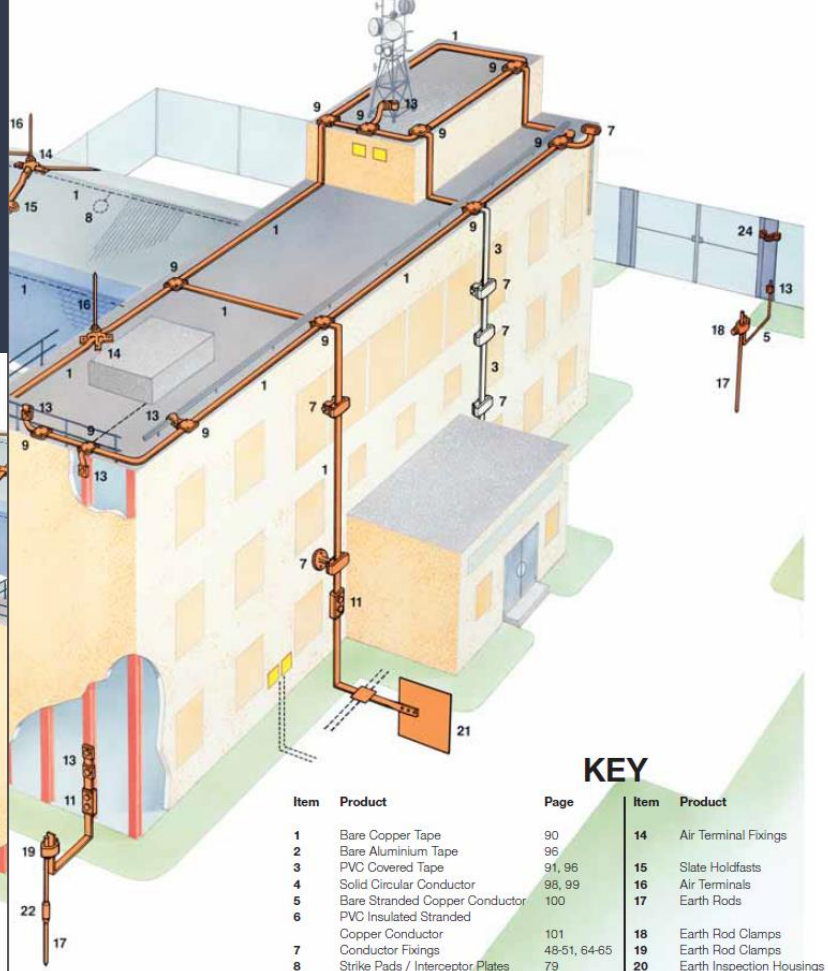




Earthing after Installation



THIS ILLUSTRATION IS NOT INTENDED TO REPRESENT A LIGHTNING PROTECTION OR EARTHING SYSTEM CONFORMING TO ANY RELEVANT SPECIFICATION, STANDARD OR CODE OF PRACTICE



KEY

Item	Product	Page	Item	Product	Page
1	Bare Copper Tape	90	14	Air Terminal Fixings	45-47, 62, 72-74
2	Bare Aluminium Tape	96			
3	PVC Covered Tape	91, 96	15	Slate Holdfasts	15
4	Solid Circular Conductor	98, 99	16	Air Terminals	44, 62, 72
5	Bare Stranded Copper Conductor	100	17	Earth Rods	12, 14, 16, 18-19
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10	Bi-Metallic Connectors	60, 68	22	Earth Rod Couplings	13, 15, 17
11	Test Clamps	58-59	23	Earth Bars & Disconnecting Link	32-33
12	'MV' Clamps	66	24	Flexible Copper Braid Bonds	36
13	Bonding Clamps	60-61, 68-71	25	Earth Bonding Points	31