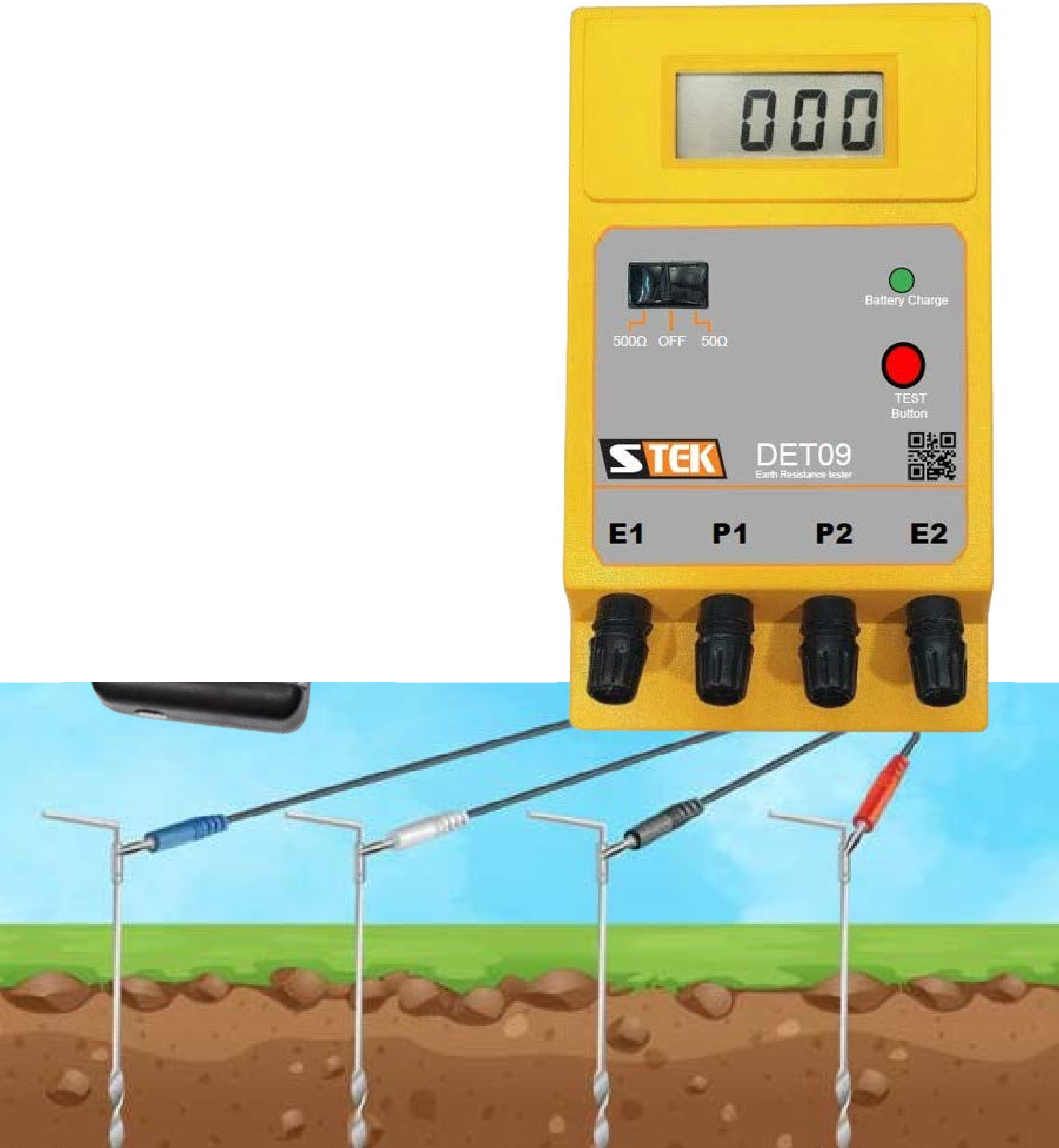
STEK Earth Resistance Testers DET09

DET09 4 Terminal Earth Resistance & Soil Resistivity Tester



STEK Earth Resistance DET09

Specifications:

Measuring Specifications For Soil Restivity & Electrode Earth Resistance Tester DET09			
Measurement Principle	3 Wire for Earth resistance and 4 Wire For Soil Resitivity		
Measurement Principle	Measuring Range	Resolution	Accuracy
Resistance Measurement	0.001Ω~500.0Ω	0.001Ω	±(5%rdg＋0.01Ω)
Voltage Generated	48V AC120Hz		
Display	3.5 Digit LCD		
Power	Ni-Cd Rechargeable Batteries		
Standards	Confirms to ISS : 9223/1979		
Dimensions	172 x 98 x 38		
Weight	575 Grams		
Accessories	Instruments, Re-chargeable Battery Installed, Mains Power cord for Charging, Earth Testing KIT Comprising of: 4 Spools of wire, 4 Spikes, Hammer and Carrying Case		

Earth/ground* resistance measurement

One of the basic prerequisites for guaranteeing safety on any residential or industrial electrical is to provide an earth electrode.
If there is no earth/ground electrode, people's lives may be endangered and electrical installations and other property may be damaged.
An earth/ground electrode alone, however, is not enough to guarantee total safety. Only regular inspections can prove that the electrical installation is operating correctly.
There are many earth resistance measurement methods available, depending on the type of neutral system, the type of installation (residential, industrial, urban environment, rural environment, etc), the possibility of cutting off the power supply, etc.

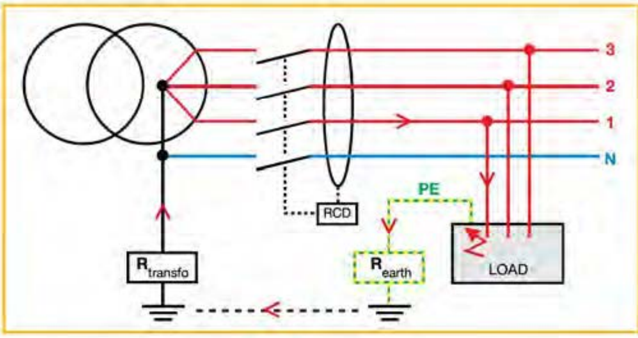
Why is earthing necessary?

Earthing means setting up an electrical bond between a given point in a network, installation or machine and an earth electrode. This earth electrode is a conductive part which may be inserted in the ground or in a conductive medium, in electrical contact with the Earth (see definition in NFC 15-100).

Earthing thus involves using a wire conductor to connect an earth electrode to the metal chassis earths which might accidentally come into contact with the electric current due to an insulation fault on an electrical device. In this way, there will be no danger for people because the fault current will have drained into the earth. If there is no earthing, any person involved will be subjected to an electric current which may kill them, depending on its level.

Earthing therefore enables leakage currents to flow away safely and, if it is linked to an automatic cut-off device, can ensure that the power supply to the electrical installation is switched off. So correct earthing keeps people safe while also protecting installations and property if there are fault currents or lightning strikes. It should always be linked to a cut-off system.

Example:
If the insulation on the load is faulty, the fault current is drained to earth via the protective conductor (PE).
Depending on its value, the fault current may cause the installation to be cut off when the residual current device (RCD) is tripped.



What should the value of the earth resistance be?

Before starting any earth resistance measurements, the first thing you need to find out is the acceptable maximum value for correct earthing.
The earth resistance requirements vary according to the country, the neutral systems used and the type of installation. For example, a power distributor such as EDF will require an extremely low earth resistance, often of only a few ohms. So it is important to check beforehand on the standards applicable to the installation to be tested.

As an example, let's take a TT residential installation in France:

To keep people safe, an installation must be equipped with protective devices which trip as soon as a "fault voltage" flowing in the installation exceeds the threshold voltage liable to harm the human body. Studies by a working party of doctors and safety experts have determined a permanent contact voltage accepted as safe for people: 50 V AC in dry premises (the limit may be lower for humid or immersed environments).

Furthermore, in residential installations in France, the residual current device (RCD) linked to the earth electrode usually allows a current up to 500 mA.

According to Ohm's Law: $U = RI$

In this case: $R = 50\ V / 0.5\ A = 100\ \Omega$

To make sure there is no danger for people or property, the resistance of the earth electrode must be less than 100 Ω.

The calculation above clearly shows that the value depends on the rated current of the RCD controlling the installation.

For example, the correlation between the earth resistance and the RCD rated current is specified by the NF C 15-100 standard, as shown in the following table:

Maximum resistance of earth electrode according to RCD rated current

Maximum rated current of RCD (IΔn)		Maximum resistance of earth electrode for chassis earths (Ohms)
Low sensitivity	20 A 10 A 5 A 3 A	2.5 5 10 17
Medium sensitivity	1 A 500 mA 300 mA 100 mA	50 100 167 500
High sensitivity	≤ 30 mA	> 500

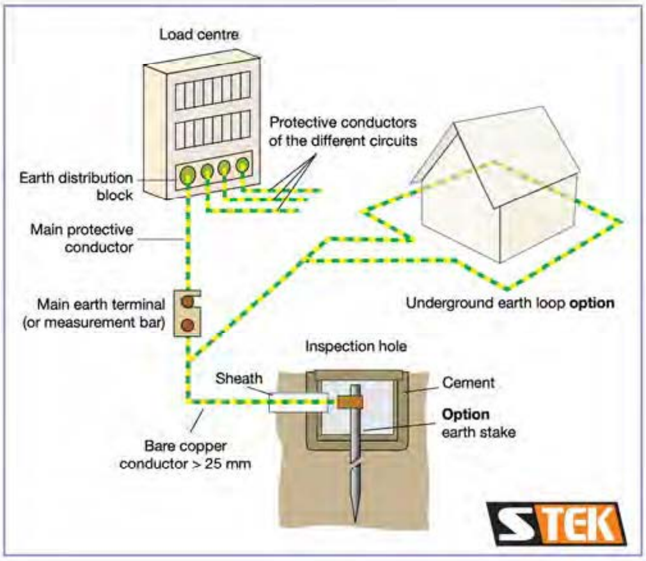
** To simplify, we will use the term "earth" in the text that follows.*

What is an earth electrode made up of?

The earth electrode

There are various methods for setting up an earth electrode, depending on the country, the building regulations and the applicable standards. In France, the following types are used:

- underground earth loop
- metal strip or cable sunk into the blinding concrete
- plates
- stakes or tubes
- ribbons or wires.
- etc.

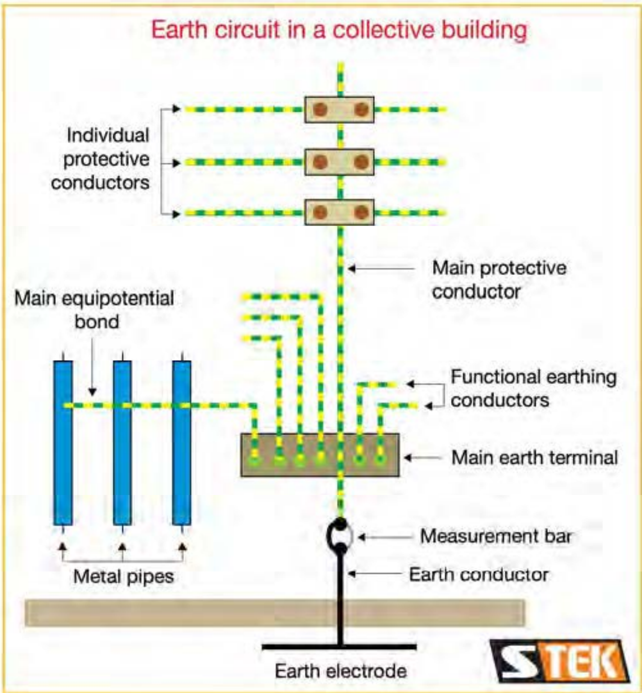


Whatever the type of earth electrode chosen, its purpose is to remain in close contact with the soil so that it can provide a connection with the earth to drain any leakage currents. The quality of an earth electrode depends on three key characteristics:

- the type of earth electrode
- the earth conductor
- the type and resistivity of the terrain, which is why it is important to measure the soil resistivity before installing new earth electrodes.

Other elements

The entire earthing system of the building is set up around the earth electrode. The earthing system usually comprises the following elements: the earth conductor, the main earth terminal, the measurement bar, the protective conductor, the main equipotential bond and the local equipotential bond.



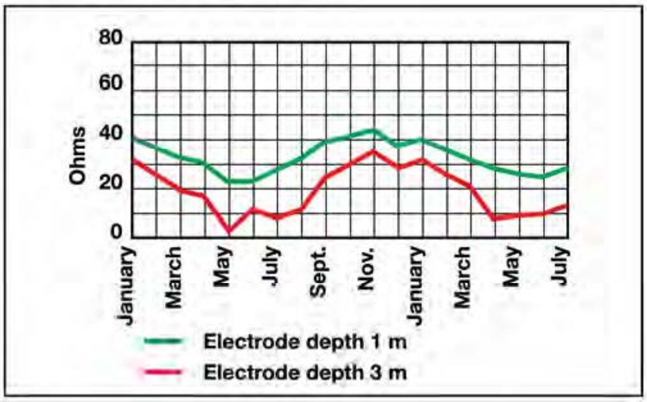
Soil resistivity

Soil resistivity (ρ) is expressed in Ohm metres (Ω.m). This corresponds to the theoretical resistance in Ohms of a cylinder of earth with a cross-section area of 1 m^2 and a length of 1 m. By measuring it, you can find out how well the soil conducts electric currents. So the lower the resistivity, the lower the earth electrode resistance required at that location.

Resistivity varies significantly according to the region and the type of soil because it depends on the level of humidity and the temperature (frost or drought increase it). This is why earth resistance may vary according to the season or the measurement conditions. As temperature and humidity levels become more stable the further you go from the ground surface, the deeper the earthing system, the less sensitive it is to environmental variations. **It is advisable to bury your earth electrode as deep as possible.**

Seasonal variation of earth resistance

(Earthing: electrode in clay soil)



Resistivity according to type of terrain

Type of terrain	Resistivity (in Ω.m)
Marshland	from a few units to 30
Loam	20 to 100
Humus	10 to 150
Jurassic marls	30 to 40
Clay sand	50 to 500
Silica sand	200 to 3,000
Bare stony ground	1,500 to 3,000
Grass-covered stony ground	300 to 500
Soft limestone	100 to 300
Fissured limestone	500 to 1,000
Mica schist	800
Decomposing granite and sandstone	1,500 to 10,000
Highly-decomposed granite and sandstone	100 to 600

Why soil resistivity measurements are useful

Soil resistivity measurements help you to:

- Choose the locations and types of the earth electrodes and earth networks before building them
- Define the electrical specifications of the earth electrodes and earth networks
- Optimize the construction costs for the earth electrodes and earth networks (the required earth resistance is obtained more quickly).

As a result, they are used on construction sites or for large-scale tertiary buildings (or power distribution substations) where it is important to choose the best positions for the earth electrodes.

Methods for measuring soil resistivity

Several processes are used to determine soil resistivity. The most widely used involves "4 electrodes", with two possible methods:

- **WENNER** method suitable for measurements at a single depth
- **SCHLUMBERGER** method suitable for measurements at different depths, as required for geological soil profiles.

Wenner method (most common)

Measurement principle

Four electrodes are set up in line in the ground, equally spaced at a distance "a" from one another.
A generator is used to inject a measurement current "I" between the two outer electrodes (E and H).
The potential ΔV is then measured with a voltmeter between the two central electrodes (S and ES).

The measurement instrument used is a traditional earth ohmmeter capable of injecting the current and measuring the ΔV value.

The resistance value R read on the ohmmeter can be used to calculate the resistivity by applying the following simplified formula:

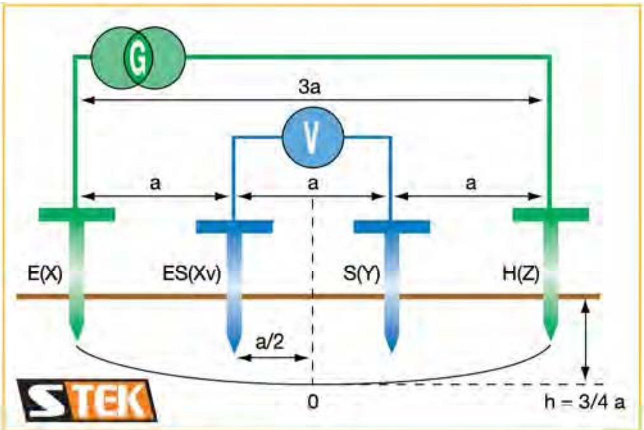
$$\rho = 2 \pi a R$$

Where ρ is the resistivity in Ω.m at the point located under point 0, at a depth of h = 3a/4

a is the measurement base in m

R is the value (in Ω) of the resistance read on the earth ohmmeter

For these measurements, EDF recommends that distance "a" should be at least 4 m.



Note: the terms X, Xv, Y and Z correspond to the former naming conventions used for the E, Es, S and H electrodes, respectively.

Schlumberger method

Measurement principle

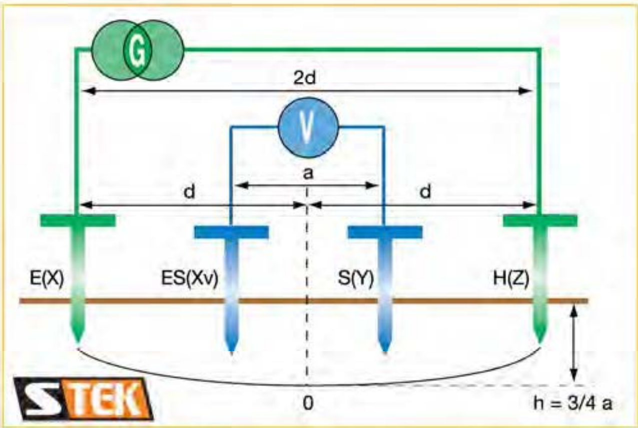
The Schlumberger method is based on the same measurement principle. The only difference concerns positioning of the electrodes:

- the distance between the 2 outer stakes is 2d
- the distance between the 2 inner stakes is A

and the resistance value R read on the ohmmeter can be used to calculate the resistivity with the formula:

$$\rho_S = (\pi.(d^2-A^2/4).R_{S-ES}) / 4$$

This method saves considerable time in the field, particularly when you want to carry out several soil resistivity measurements for a profile of the terrain. The extra time saved is due to the fact that only the 2 outer electrodes need to be moved, whereas all 4 electrodes need to be moved at the same time with the Wenner method.



Although the Schlumberger method saves time, the Wenner method is better known and more widely used. The mathematical formula necessary is also much simpler. Nevertheless, many Chauvin Arnoux measurement instruments include both formulae for instant calculation of the resistivity values with either method.

Methods for measuring earth resistance on an existing earth electrode

The different methods:

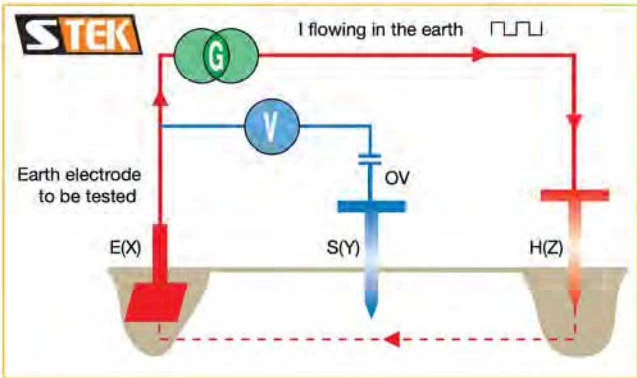
The soil resistivity measurement methods presented so far can only be used when installing a new earth electrode: they can be used to check the resistance value in advance and adjust the electrode according to the earth value required.
For existing earth electrodes, the method involves checking that they comply with the safety standards in terms of their construction and resistance value.
Various measurement methods may be used, however, depending on the installation's characteristics: whether it is possible to cut off the installation's power supply or disconnect the earth electrode, whether the electrode to be tested is the only one or is connected to others, what level of measurement accuracy is required, where the installation is located (urban or rural environment), etc.

Earth resistance measurements on installations with a single earth electrode

It is important to point out that the earth resistance measurement of reference is the 2-stake method. This method is referenced in all the electrical installation testing standards and can be used to measure the earth resistance both accurately and safely.
The measurement principle involves using an appropriate generator **G** to inject an alternating current (i) through the auxiliary electrode H and back through the earth electrode E.

The voltage **V** between the earth electrode E and the point in the earth where the potential is zero is measured using another auxiliary electrode S. The resistance can then be calculated by dividing the voltage measured by the constant current injected (i), thus:

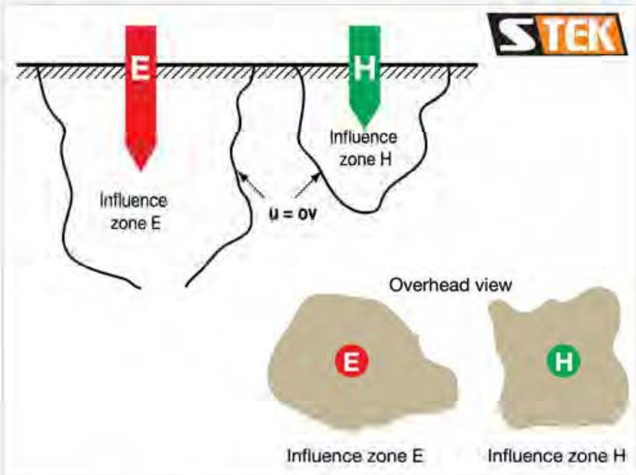
$$R_E = U_{ES} / I_{EH}$$



Important note:

A fault current is initially drained via the contact resistances of the earth electrode.
As you move further away from the earth electrode, the number of parallel contact resistances tends towards infinity, constituting an equivalent resistance close to zero. Beyond this limit, whatever the fault current, the potential is zero.
This means that around each earth electrode, there is a zone of influence whose shape and size are unknown.

When measuring, take care to set up the auxiliary electrode S (0 V potential electrode) outside the zones influenced by the auxiliary electrodes through which the current (i) is flowing.



As diffusion of an electric current depends on the soil resistivity, it is difficult to be sure that the zones of influence have been avoided. The best way of confirming the measurement is therefore to repeat it after moving the stake S so that you can make sure it is similar to the earlier measurement.