• Earthing / Grounding

What is Earth?

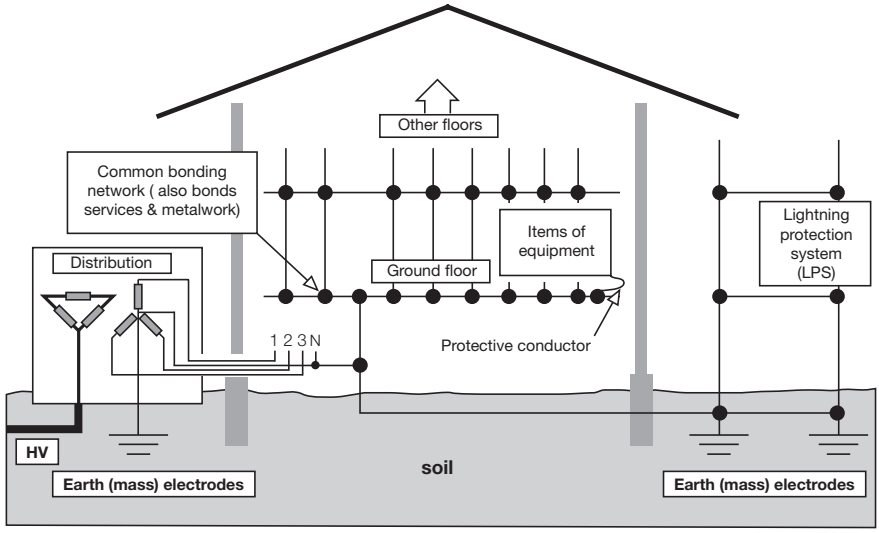
Earth can mean different things to different people. In this context it means a place of zero potential, a place where fault currents can be directed of sufficient capacity to enable fuses to rupture. In reality it is usually the substance beneath our feet and we connect to this in a number of different ways.

Buildings are connected to the ground and therefore the floors on which we stand are at the same potential.

The electrical connections that come into our homes and offices need to be safe. This is why the earth connection in a domestic location is usually made to a metal pipe (generally the mains water supply) somewhere close to where it enters the ground.

It will also be found that the distribution transformer will have an earth connection, usually in the form of a copper rod anchored in the ground.

Lightning conductors that are found on tall buildings will also be rooted in the ground, so that in the event of a lightning strike the current passes harmlessly to ground and not into the structure of the building, thus saving the building from damage.



Earthing overview

Ground Resistivity

The wetter the ground, the less resistance it will have. This is the reason buildings have their own earth connection and do not rely on the earth point at the distribution transformer.

Type of ground	Ground resistivity *p* (Ωm)	
	Range of values	Typical value
Boggy ground	2 - 50	30
Adobe clay	2 - 200	40
Silt & sand-clay ground, humus	20 - 260	100
Sand and sandy ground	50 - 3,000	200 (moist)
Peat	200+	200
Gravel (moist)	50 - 3,000	1,000 (moist)
Stony and rocky ground	100 - 8,000	2,000
Concrete: 1 part cement + 3 parts sand	50 - 300	150
Concrete: 1 part cement + 5 parts gravel	100 - 8,000	400

Earthing for Safety

For an electrical system to be safe, a sufficient level of protection must be provided. This can be achieved by the use of insulation and earthing. The table below details the level of protection (LOP) provided by different types of insulation and earth.

Abbr.	Earth Type	Level of Protection (LOP)
FE	Functional Earth	0
PE	Protective Earth	1

Abbr.	Insulation Type	Level of Protection (LOP)
OP	Operational (Functional)	0
B	Basic	1
S	Supplementary	1
D	Double	2
R	Reinforced	2

For a system to be safe a total LOP of 2 must be provided.

The next table specifies the distance required between two conductors for the different types of insulation for IT and industrial applications. Basic insulation does not require such a large gap as double or reinforced and therefore provides a lower level of protection.

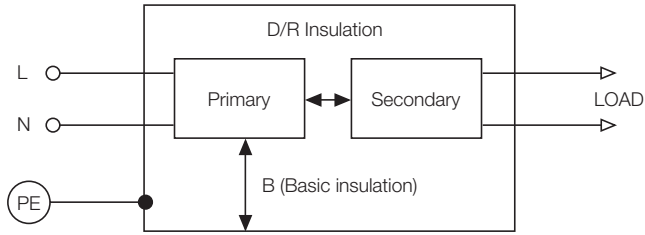
Insulation Type	Clearance	Creepage
Functional	1.5mm	3.2mm
Basic/Supplementary	2.0mm	3.2mm
Double/Reinforced	4.0mm	6.4mm

The distances above are based on a 300 VAC working voltage. The working voltage is the voltage between the two circuits to be isolated. The lower the working voltage, the lower the creepage and clearance distances required.

To ensure that the insulation is correct and not damaged or manufactured incorrectly a test voltage must be applied. The table below shows the test voltages for a 300 VAC working voltage.

Insulation Type	Test Voltage
Functional	1500VAC
Basic/Supplementary	1500VAC
Double/Reinforced	3000VAC

Two types of earth can be present in a system:
FE – Functional Earth – This does not provide a safety function.
PE – Protective Earth – This provides protection against electric shock in a class 1 system.



The diagram above represents a complete class 1 power supply. Primary to earth protection is provided by basic insulation and protective earth (LOP 2). Primary to secondary protection (240VAC to 12VDC) is provided by double/reinforced insulation (Total LOP 2).

Earthing for EMC

Full details of earthing for EMC can be found in the legislation section (page 90).