



WE CREATE BETTER ENVIRONMENTS
BY KEEPING THEM UNDER CONTROL

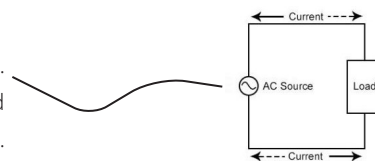
Controlled environment key terms

TERMINOLOGY OF **CONTROLLED ENVIRONMENT** KEY TERMS

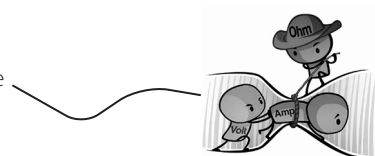
In this whitepaper the key terms related to controlled environments are explained by giving short definitions, examples and visualizations. The terms are sorted in alphabetical order.

A

Alternating current (AC) – Current from the electricity network, which periodically reverses direction. There will be a change in polarity after a period of time. AC is most commonly found in mains-wired buildings such as homes and offices. It is the form of electricity that consumers use when plugging in i.e. kitchen appliances or computers into a wall socket.



Ampère / amperage – The standard unit of electrical current, in which the flow of electrons can be measured. Amperage is the strength of a current of electricity.

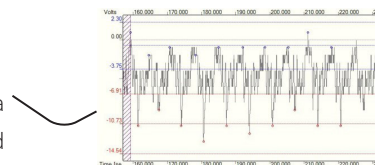


Antistatic – Materials which reduce or eliminate build-up of static electricity. The limit value is 2.0 kV (2000 V) for the body voltage in the walking test, as indicated in EN 14041 (CE mark). 'Regular' Forbo Flooring Systems floor coverings have antistatic properties, such as Tessera, Eternal, Sphera Element and Marmoleum Marbled.



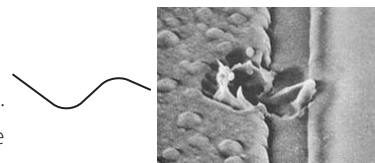
B

Body Voltage Generation (BVG) – The static electricity created by the friction between a body and a surface. For example when a person walks across a floor, the friction between the surface of the floor and the soles of their shoes creates static charge. BVG is expressed in Volts.



C

Catastrophic failure – A catastrophic failure is a visible and noticeable defect to a component. The electronic component is severely damaged and fails to work directly. This type of defect can be detected by testing the electronic component.



Charged Device Model – A failure model where another material or device is involved in an ESD event; static charge flows from the material or device through another device to ground.

Cleanroom – Areas or facilities where the cleanliness of the air and/or surfaces is controlled. It concerns environments where critical processes take place.

Conductive – An electroconductive material has a low resistance value. Static charges can flow efficiently and easily through the surface of the conductive material to earth. Typically a floor is called conductive when the electrical resistance to ground is $<10^6 \Omega$. In practice a lower limit of $5.4 \times 10^4 \Omega$ is often used, because lower values can be dangerous for human beings. Norm values are indicated in EN14041 (CE mark) and ESD specific standard.



Conductor – A material with a good ability to transport electrical current. Most metals are conductors; copper, aluminum, carbon and gold are often used to serve as a conductor. Typically, conductors have a resistance of $<10^{-2} \Omega$ (if used in their pure form).

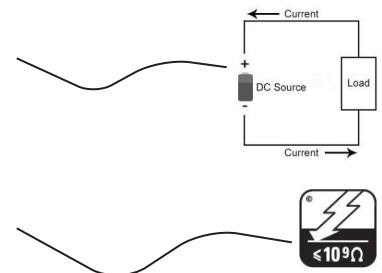
Controlled environment – A collective term for most sensitive environments where critical processes take place. These areas require certain measures, such as electrostatics, air pressure, volume and size of airborne particles and gas emissions.

D

Decay time – The time it takes for static charges to flow from one surface to another, to a given percentage (10%) of its original value.

Direct Current (DC) – Current which always flows in the same direction, for example in batteries or power banks. The polarity remains the same. It is the opposite of an alternating current.

Dissipative – A (static) dissipative material has a low resistance value, but not as low as a conductive material. However, static charges can still flow efficiently and easily through the dissipative material to earth. Typically a floor is called dissipative when the electrical resistance to ground is between $1 \times 10^6 \Omega$ and $1 \times 10^9 \Omega$. In practice an upper value of $10^8 \Omega$ is preferred. Norm values are indicated in EN14041 (CE mark) and ESD specific standards.



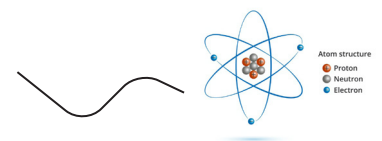
E

Earth – Earth or ground is the reference point in an electrical circuit from which voltages are measured. It can also mean a common return path for electric current, or a direct physical connection to the earth, by for example copper or aluminum. The voltage is 0V.

(Electrical) current – The continuous flow of static electricity in an electric circuit.

(Electrical) resistance – The electrical voltage required to allow an electrical current of a certain strength to pass through a conductor. The higher the electrical resistance, the higher the voltage needed to get the current through the conductor.

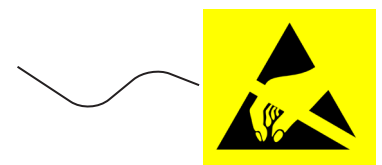
Electrons – Negatively charged particles. Electrons can be bonded to atoms (the tiny particles of substances or materials) or can be floating freely in the air.



(Electro)static charge – The buildup of charge between two surfaces, caused by the exchange of electrons from one surface to the other. This is most commonly created by the contact and separation of two surfaces. This can be expressed in Volts.

Electrostatic discharge (ESD) – ESD events take place when static charged surfaces return to their neutral, uncharged state. It is the sudden flow of electrons from one surface or human being to another surface or human being.

Electrostatic sensitive device – A device which may be damaged by electrostatic discharges, even below 10V. Electrostatic sensitive devices should not be touched without ESD protection (shielding by ESD bag, EPA, ESD grounding). The international symbol to indicate electrostatic sensitive devices is a black triangle with a hand and yellow bar.



ESD protected area (EPA) – An environment where measures are taken to ensure the control of static electricity. Requirements for EPA's are recorded in IEC 61340-5-1. Control measures can include e.g. working surfaces, storage racks, trolleys, furniture, flooring, ionization and garments.



G

Ground – Ground or earth is the reference point in an electrical circuit from which voltages are measured, a common return path for electric current, or a direct physical connection to the earth, The voltage is 0V.

Grounding point / groundable point – A device or location where conductors (e.g. copper strips underneath ESD floors) are connected to the earth. To ensure a functioning ESD system, charges must be able to flow from the place where they are created, to a grounding point.



H

Horizontal resistance – The electrical resistance of a floor measured with two electrodes on the surface side. When measured on a isolating material, it tells something about the ability of a floor to transfer electrostatic charge across the floor itself.

Human Body Model – A failure model where a person is involved in an ESD event. People can carry a charge too; charges can flow from the human body through a device to ground. The model can be used to test the ESD robustness of the integrated circuit of a device.

Humidity – Humidity/moisture has an effect on conductivity and charging. Higher relative humidity (RH) levels, lead to higher conductivity and less charging. A hygrometer can be used to determine the RH level. A RH above 40% is recommended for human health. When the humidity level decreases, materials charge quicker and ESD events happen with a higher Voltage. Especially in dry winters in heated areas the risk of ESD events increase. This is the reason that ESD compliance testing for flooring needs to be done at 12% RH and moisture values have to be documented.

I

Induction – Can be a cause of electrostatic charge. In this case, a charged source influences the electrons in another object without physical contact. The object becomes electrically charged. A daily life example is wireless charging of a mobile phone. An ESD event may occur when this surface comes in contact with an object which is a conductor (e.g. metal).

Insulator – A material with no ability to transport static electricity. Insulators cannot be grounded. Most plastics and glass are insulators. Typically, insulators have a resistance $>10^{11} \Omega$.

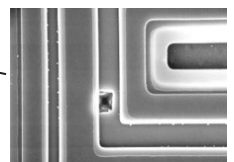
Insulating floor – A floor is insulating when it offers shock protection from mains voltage. IEC 60364-6 is the basis for various local standards (VDE0100, NEN 1010). The conductivity shall be $>50 \text{ k}\Omega$ when measured with $\leq 500 \text{ V}$ and $>100 \text{ k}\Omega$ when measured with higher voltages up to 1000 V .

Ionization – A technique used to neutralize electrical charges on objects. A large amount of electrically charged particles are transported through the air to an object where they restore the imbalance in protons and electrons.



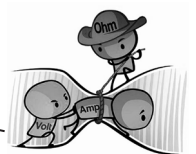
L

Latent defect – Damage to an electronic component which is not immediately detectable. The component still functions, but is more sensitive and electrical overstress can cause a catastrophic failure over time. The component stops functioning in a later stage.



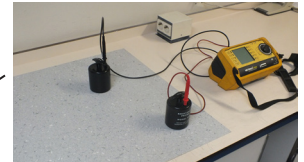
O

Ohm – The standard unit in which electrical resistance is expressed. An Ohm can be explained as an unit of electrical resistance located between two points across a resistor, conductor, device or circuit.



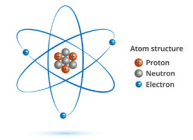
P

Point-to-point resistance (PtP) – Electrical resistance measured from the surface of a material to the back of the material. This measurement method is also known as vertical resistance.



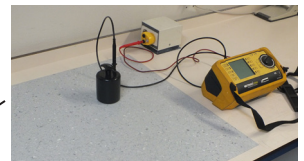
Polarity (tribo-electric) – Materials can have a positive (+, more protons) or negative (-, more electrons) polarity. Electrons flow from negative to positive materials. They can also flow from positive to more positive and from negative to less negative materials.

Protons – Positive (+) charged particles. Protons can be bonded to atoms (the tiny particles of substances or materials) or can be floating freely in the air, just like electrons.



R

Resistance to ground – Electrical resistance measured between the surface of a material and ground. This can be done on uninstalled and installed flooring and indicates the ability of a floor to discharge electrostatic charges. This measurement is also known as point-to-ground (PtG) resistance.



S

Shielding – Protection of an electrostatic sensitive device against ESD events. This can be done by putting the device in a shielded bag. A multi layered bag with metal in, insulative material (moisture vapour barrier) and metal out. A shielded bag does not charge and does not distribute charge. If the bag is closed it can be used outside an EPA. This is not the case for antistatic and dissipative bags which are to be used within EPA's.



System resistance – The electrical resistance to ground of a combination of a person, footwear and an installed floor. An ESD floor will only function properly if it is part of an ESD system. The charges must be able to flow from the place where they are created to a grounding point.



Surface resistance – The surface resistance expresses the ability of a material to conduct static electricity. It is the ratio of voltage and current between two electrodes and can be determined by the following formula: $R = U / I$.

- R is the resistance (in Ohm Ω),
- U is the voltage (in Volt)
- I is the current (in Ampere).

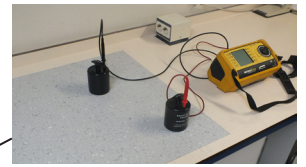
T

Tribo-electric charging – When materials become electrically charged due to friction, or by contact and separation. It arises when two surfaces rub together. During contact, charged electrons (-) flow from one surface to the other. When the surfaces are being separated, electrons will be extracted from one surface and remain to the other surface. The surfaces now have a potential difference: an opposite electrostatic charge.

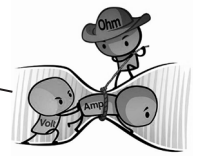
Tribo series – A list of materials ordered on their polarity when separated from another material. The farther away two materials are from each other, the greater the charge transferred. Materials near to each other on the series may not exchange any charge, or may even exchange the opposite of what is implied by the list.

V

Vertical resistance – Electrical resistance measured from the surface of a material to the back of the material, which is only possible with uninstalled flooring. Used to evaluate the ability of a floor to discharge electrostatic charge. This measurement method is also known as PtP resistance.

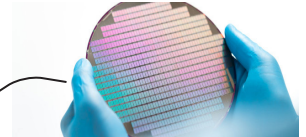


Volt / Voltage – Volt is the standard unit of voltage or potential difference. Voltage describes the amount of energy associated with electric charge as it moves around in a circuit. Voltage simply is what makes electric charges move. It is the 'push' that causes charges to move in a wire or other electrical conductor.



W

Wafer – A thin slice of semiconductor material, used in the electronics industry.



Walking body voltage – A test method for characterizing the electrostatic protection of footwear and flooring in combination with a person walking. Can be determined by body voltage generation (BVG) testing. Upper limit for ESD flooring is <100 V, preferably <30 V, in practice the lower the value the better.

Wrist strap – A bracelet device connected to ground, to prevent static discharge on sensitive electrical components.

