Lindner | Building New Solutions

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Electrostatics with system floors

1. General / Preliminary remarks

Static electricity as a natural phenomenon is familiar to the public, for example when getting an electric shock from door handles after walking across carpets. These electrical discharges are generally of no danger to the people themselves. People may however be startled and, as a result, make a mistake. In addition to this, however, there are consequences of static electricity that must be prevented.

These range from the destruction of electronic components to the explosion of complete factories!

Brief description

Static electricity builds up = electrical charge
Static electricity always occurs from the movement of fixed insulators or liquid substances, strictly speaking from their separation. An extreme example is when dusty air passes a wall.

The resulting voltage depends on the air humidity. Dry air will cause higher charges to develop than humid air.

Electronic components are extremely sensitive to such events. Discharges of just 30 V can destroy them and/or trigger switching errors.

This results in unpredictable risks and thus incalculable costs. A fact which defuses the problem is to ensure that generally all electronic elements are shielded.

Static electricity and conductivity
At best the occurrence of static electricity can be reduced by choosing appropriate materials but it cannot be prevented entirely. However, ensuring that all electric charges are discharged immediately and smoothly, prevents any danger to people or objects. If static electricity is continually discharged when it occurs, the charge cannot become large enough to cause an electrical discharge (electric shock).

Static and dynamic electricity
Dynamic electricity is the electric power that is supplied by a power station, via electricity lines and is available as a voltage. Static electricity, in contrast, is not supplied by a voltage source, but rather is a one-off event, which is not immediately available again after discharge and has to be built up again.

Test procedure for electrostatic properties

1) ***Resistance measurements; measurement parameter Ω (ohm)***
   Most tests are carried out in a prescribed test climate, which, however, is not uniform for the different standards.

Contact resistance
(R_1 - Procedure A - DIN EN 1081)
Electrical resistance is measured on a sample between the tripod electrode placed on the surface of the floor covering and an electrode placed directly on
the opposite underside.

Resistance to earth
(R_2 - Procedure B - DIN EN 1081)
Electrical resistance is measured on an installed floor covering between a tripod electrode pressed onto the top of the floor and the earth potential.

Surface resistance
(R_3 - Procedure C - DIN EN 1081)
Electrical resistance is measured on an installed floor covering between two tripod electrodes spaced 100 mm apart from one another.

Earth continuity
(R_{ST} DIN 57100 / VDE 0100 T-10)
Resistance is measured between the surface of the installed floor covering and the earth potential.

2) **Measurements of charge; measurement parameter kV (kilovolts)**

Walking test (DIN 54345, T2)
The charging voltage is measured by a test person shuffling across an installed floor covering wearing specific footwear.

Technical test (DIN 54345, T3)
The above mentioned walking test is simulated with a machine. This test can only be performed in a laboratory.

Terms

Antistatic
Elastic floor coverings are also antistatic if they are conductive.

Floor coverings are antistatic when they generally do not allow any disturbing electrostatic charges to develop; the charge needs to be less than or equal to 2.0 kV during the walking test.

Conductive

Floor coverings are conductive when their resistance to earth R_2 – Procedure B is less than or equal to 10^9 Ω. However, lower resistances are also required in many cases.

Insulation

A floor is insulating according to DIN 57100 / VDE 0100T410, Sec. 6.3.3 (against contact voltage from the mains) if the earth continuity R_{ST} is not less than the following values:
50 kΩ = 5 x 10^4 Ω for installations with nominal voltages under 500 V
100 kΩ = 1 x 10^5 Ω for installations with higher nominal voltages

Note

As a result of different test conditions, the earth continuity can only be calculated approximately from the contact resistance (R_1 – Procedure A – DIN EN 1081). However, from experience it is known that conductive floor coverings with less than 10^6 Ω do not meet the VDE requirements. Earth continuity for all types of floor coverings reduces where there is moisture in the flooring system.

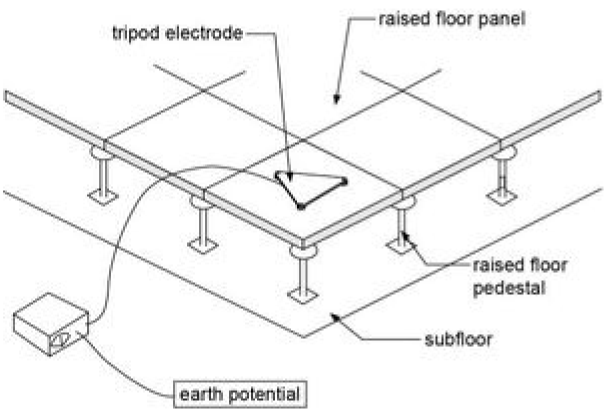
Resistance to earth

Resistance to earth R_2 – Procedure B – DIN EN 1081

Measurement of resistance to earth R_2 of the installed floor covering. The electrical resistance of an installed floor covering is measured between the earth potential and an electrode placed on the surface of the covering.
The tripod electrode is placed on the dry floor covering (48 hours after installation) and connected to the ohmmeter, just as is the earth connection. Load the tripod with at least 300 N before switching on the power.

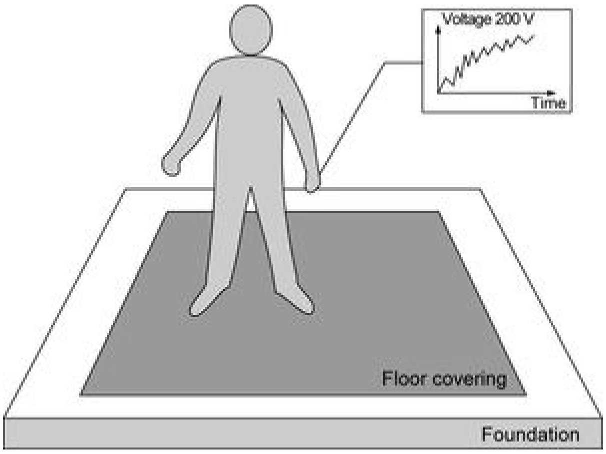
Note

For values of 10^2 Ω, static electricity can dissipate in about 1 second. Achieving less than 10^8 Ω, a floor covering is sufficiently conductive to prevent a potential fire hazard from flammable dusts or gases created from electrostatic loading resulting from walking on the covering. With less than 10^6 Ω, a covering is also suited for rooms for storage and production of explosives. The relevant requirements of the trade associations (e.g. ZH 1-200), electronics manufacturers and users have to be observed in each case.



Tripod electrode: Aluminium panel with rubber feet
Weight: Equal to or greater than 300 N

Test voltage: R less than or equal to 10^6 Ω with 100 V; R greater than 10^6 Ω with 500 V
Execution: At least three measurements



Charge measurements

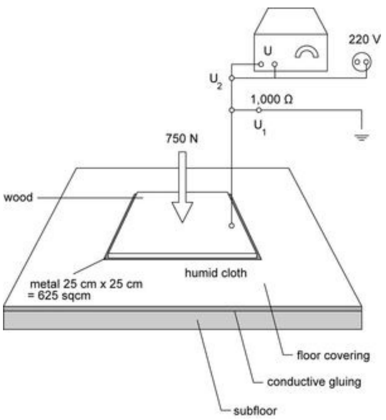
Charge measurements with the walking test, DIN 54345 / Part 2
- Measurements of the tendency to electrostatic charge during the walking test

Duration of the walking test:
The charging voltage is measured when the person stands on the floor covering with both feet.

Floor coverings are considered to be antistatic if the charge voltage does not rise above 2,000 V (definition acc. to data sheet EDV 1, Issue 7/84 from the TFI Aachen for carpet flooring).

1 minute (shuffling gait) at 23° C and at 25% relative air humidity.

A special rubber provided by the National Materials Testing Institute (BAM) is used for the sole material of the shoes. This material is slightly conductive and supplies a resistance of around 10^9 Ω between the person and a conductive floor.



Earth continuity

Earth continuity R_{ST}, DIN VDE 0100
- Measurement of the earth continuity between the surface of the installed floor covering and the earth potential

In workplaces handling components sensitive to static electricity and which regularly work with open voltage, e.g. in the test field, an electrically conductive floor covering must also be insulating acc. to DIN VDE 0100. The earth continuity measurement is used to assess the electrical insulating ability.

Note
VDE 0100 / Part 410 specifies a lower limit for the earth continuity R_{ST} as applicable to the workplaces mentioned above. In workplaces where the nominal voltage does not exceed 500 volts of alternating current, the earth continuity must be at least $5 \times 10^4\ \Omega$. If nominal voltages are between 500 and 1,000 volts of alternating current, the earth continuity must be at least $1 \times 50^5\ \Omega$. Electrode surface: 625 sqcm.

Examples of use

On the preceding pages we have clarified the meaning of the word electrostatic and the different measurements. What else must be taken into account where a raised floor is installed and what requirements are sensible?

The electrical resistance of individual areas are totalled which means in practice:

The resistance to earth R_2 can never be lower than the highest resistance of the individual element in the sequence: floor covering – adhesive – raised floor panels – gaskets – pedestals.

The flooring systems must fulfil the following requirements:

1. Office rooms with terminals, sale and exhibition rooms etc.

In these areas, an antistatic floor covering which is equal to or less than 2 kV tested to DIN 54345.

2. Rooms with electronic equipment, such as data centres, computer operation rooms, office rooms with special equipment: earth resistance R_2 less than or equal to $10^9\ \Omega$ or charging voltage U maximum 2 kV.

3. Unprotected electronic assemblies or components with operator protection requirements, e.g. test fields in the electronic production area: Earth resistance R_2 less than $1 \times 10^8\ \Omega$, earth continuity acc. to VDE 0100, R_{ST} operator $5 \times 10^4\ \Omega$ or R_{ST} greater $1 \times 10^5\ \Omega$ (depending on nominal voltage).

4. Unprotected electronic assemblies or components, e.g. fabrication or laboratory rooms for the production, repair and testing of electronic equipment, assemblies or components: Earth resistance R_2 less than 1×10^8 Ω.

5. Explosive atmospheres in general, e.g. laboratories with risk of explosion, gas pressure regulating facilities, accumulator rooms: Earth resistance R_2 less than 10^8 Ω.

6. In newly built rooms used for medical purposes, R_2 less than 10^7 Ω, after four years R_2 less than 10^8 Ω, HF surgery R_2 greater 5×10^4 Ω.

7. Explosive substances, e.g. where explosives are produced and stored, munitions or pyrotechnical items: Earth resistance R_2 less than 10^6 Ω.

Summary:
For most raised floor applications, a covering not exceeding the 2 kV charge limit is usually sufficient. There is no requirement for earth resistance for the whole structure. Requirements for earth resistance as per the above list is usually only necessary in subareas e.g. central computer rooms.

Seen as a whole, the subject of static electricity is difficult to understand because of the many tests and requirements, a situation arising from excessive earth resistance requirements which were specified in the past.

Low conductivity of less than 10^8 Ω can only be achieved by raised floor manufacturers when using highly conductive coverings, panel materials and adhesives. With regard to construction costs, unnecessary excessive requirements should, therefore, be avoided. It should be mentioned here that corresponding user clothing (conductive footwear) is absolutely crucial. A technically perfect electrostatic floor construction is useless against non-conductive footwear. Damages due to electrostatic discharge in this instance are inevitable.

Source
Safety Guideline for Raised floors, AGI Worksheet, manufacturer´s recommendations, Carpet Research Institute.

2. Estimation of the resistances

As these figures are a little bit unclear it has been agreed that only the first number is named and then the number of zeros.

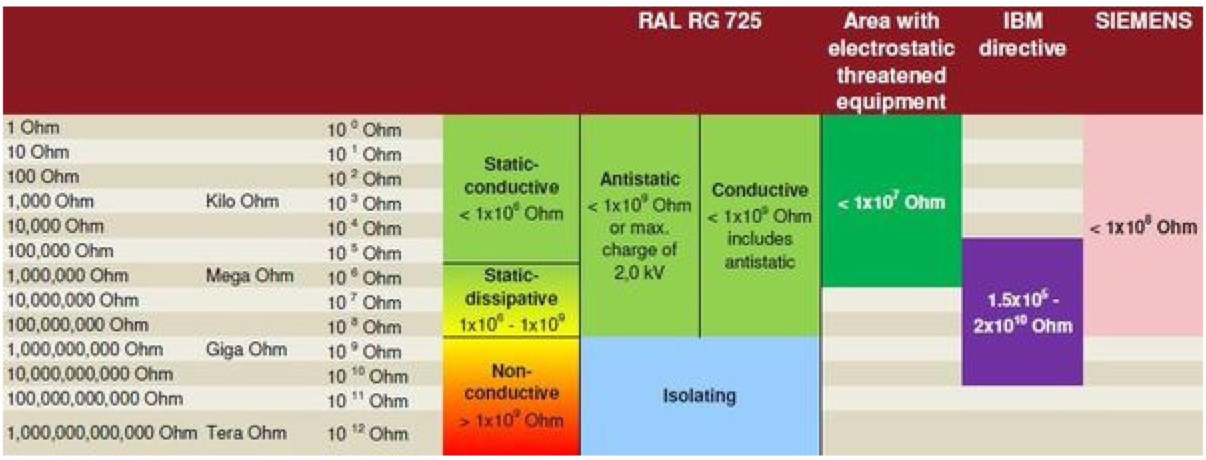
So the figure	1 million	gets	1 multiplied by 10 to the power of 6
So the figure	2 billions	gets	2 multiplied by 10 to the power of 9
So the figure	25,000,000,000	gets	2.5 multiplied by 10 to the power of 10

The expression "10 to the power of" is the mathematical code for the simplified way of representing of the large figures. The special requirements to the floor have to be defined as close as possible by the specialist engineers of the trades which are going to be applied on the floor.

1 x 10 to the power of 0 Ω	1 Ω		1 Ohm
1 x 10 to the power of 1 Ω	10 Ω		10 Ohm
1 x 10 to the power of 2 Ω	100 Ω		100 Ohm
1 x 10 to the power of 3 Ω	1 kΩ	Kilo Ohm	1,000 Ohm
1 x 10 to the power of 4 Ω	10 kΩ		10,000 Ohm
1 x 10 to the power of 5 Ω	100 kΩ		100,000 Ohm
1 x 10 to the power of 6 Ω	1 MΩ	Mega Ohm	1,000,000 Ohm
1 x 10 to the power of 7 Ω	10 MΩ		10,000,000 Ohm
1 x 10 to the power of 8 Ω	100 MΩ		100,000,000 Ohm
1 x 10 to the power of 9 Ω	1 GΩ	Giga Ohm	1,000,000,000 Ohm
1 x 10 to the power of 10 Ω	10 GΩ		10,000,000,000 Ohm
1 x 10 to the power of 11 Ω	100 GΩ		100,000,000,000 Ohm
1 x 10 to the power of 12 Ω	1 TΩ	Tera Ohm	1,000,000,000,000 Ohm

An earthing is only necessary with required conductivity values of $<10^8$ Ohm. The electrostatic values of the systems are shown in the data sheets of the systems.

3. Overview of electrostatic requirements



4. Earthing

We recommend from experience that a earthing clamp should be installed every 20 - 30 m² or at least once per room for the conducting of charges into the earth potential. Up to now, there is no valid standard or guideline existing for these requirement.