DLW FLOORING

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Technical Information

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Electrostatic Behaviour of floor coverings

General

All materials consist of a great number of atoms. Atoms themselves consist of an atomic nucleus with positively charged and neutral particles and a shell made up of negative electrons. Depending on the material, atoms can bind their electrons with varying degrees of strength. If two different materials are brought into close mechanical contact with each other, the atoms with a greater electron affinity can adhere to a material with a lower electron binding strength at the periphery. If these materials are then separated, not all electrons are able to return to their original position.

The material deprived of electrons is positively charged, and the material with additional electrons negatively charged.

Shoe soles and clothing become charged, with this charge being transmitted to the wearer.

The static electrical charge depends on the type of materials coming into contact with each other and the humidity as well. With dry air / low humidity conditions materials and thus also people are more liable to become electrostatically charged than with high humidity levels.

Electronic components are especially susceptible and may cause switching errors or even become irreparably damaged by minor electrostatic discharges that are not even noticed by people.
Electrostatic charging can be reduced through the selection of suitable materials and by increasing humidity levels where too low, although it cannot be completely prevented.

1 Terms and definitions

1.1 Antistatic

Floor coverings are antistatic if they do not generally allow unpleasant electrostatic charges to occur.

- **Resilient and textile** floor coverings are antistatic according to EN 14041 if they result in a static electrical charge of ≤ 2.0 kV for body voltage in the walking test.

- **Resilient** floor coverings are antistatic if they are conductive according to section 1.2.

- **Textile** floor coverings are also antistatic if the charge is ≤ 2.7 kV using a test device according to section 4.2.3.

Antistatic DLW floor coverings are indicated by the following pictogram:

1.2 Static dissipative / Conductive

Floor coverings are static dissipative / conductive according to EN 14041 if their electrical resistance to ground is $\leq 10^9$ / $\leq 10^6\ \Omega$. However, other resistance values may also be specified.

Static dissipative / conductive DLW floor coverings are indicated by the following pictogram:

static dissipative

conductive

1.3 Insulating

A floor is insulating according to German VDE 0100-410 (offers shock protection from mains voltage) when the insulation resistance R_{ST} attains the following values:

50 kΩ =	$5 \times 10^4\ \Omega$ for installations with rated voltages under 500 V
100 kΩ =	$1 \times 10^5\ \Omega$ for installations with rated voltages up to 1000 V

Note:
Due to the variation in test conditions only an approximate insulation resistance can be calculated from the electrical resistance according to EN 1081. It is however known that conductive floor coverings with a resistance to ground of $< 10^6\ \Omega$ cannot attain the VDE limit values. Moisture in the floor system may also reduce the insulation resistance for all types of flooring.

1.4 Electrical resistance

The term electrical resistance is used when referring to the electrical voltage required to allow a specific current to pass along a conductor. The electrical resistance of a material describes its capability to impede the flow of current.

1.4.1 Vertical resistance

The electrical resistance of a floor covering when <u>un</u>laid, measured between the upper surface and the lower face opposite it. This vertical resistance characteristic is used to evaluate the capability of a floor covering to quickly discharge any electrostatic charge from its wear layer / usable surface underneath the covering.

1.4.2 Resistance to ground

The electrical resistance of a floor covering when <u>laid,</u> measured between the upper surface of the covering material and the ground. Like vertical resistance, this characteristic indicates the capability of a floor covering to quickly discharge any electrostatic charge from the wear layer to the ground.

1.4.3 Horizontal resistance

The electrical resistance of a floor covering when laid, measured on the surface of the covering between two electrodes. This characteristic is used to identify the transverse conductivity within the sheet of flooring, i.e. its capability to discharge electrostatic charges horizontally in the floor covering.

1.4.4 System resistance

The electrical resistance measured for the overall system "footwear-floor covering" in combination with a person. This characteristic is used to evaluate the conductivity of the overall system ("person-footwear-floor covering") for the protection of electronic components from any person-specific discharges that may occur.

FLOORING

1.4.5 Electrical insulation to ground

The electrical insulation to ground must be measured to evaluate the electrical insulating ability of the floor covering. One special requirement on the floor covering involves the so-called double stipulation - i.e. electrostatic insulating ability (electrical insulation to ground) in conjunction with simultaneous conductivity. These properties must be offered by a floor covering if it is to protect people who work with components at risk from electrostatic hazards while exposed to unprotected mains voltage.

2 Electrostatic Charging

Charging not only occurs in users while walking but also by rubbing their clothing against furniture, in particular when sitting down and standing up again, and also by rubbing up against other furniture surfaces (friction partner).

Such "secondary charging" cannot be dissipated by insulating footwear even when the floor covering is conductive. Such unpleasant electrostatic charging is thus not just due to the floor covering.

Acting as a "walking charge carrier", humans spontaneously release their charge as soon as they touch a conductive object. With low voltages this is imperceptible but at higher voltages this is accompanied by unpleasant spark discharges. A value of 3 kV is generally considered to be the level at which this becomes perceptible. Such voltages may reach 15 kV although they are not thought to be harmful to health according to current scientific knowledge.

Unpleasant discharges often occur when people work in a sedentary position. Here it can be seen that the low voltages measured when people rub their feet on the floor covering then increase two to five times this value as soon as they place their feet on the footrest of their chair or other insulating foot support. This rise in voltage may result in spark discharges. This is due to the reduction in capacity (see section 2.1.3). Such phenomena do not occur if office chairs and footrests are conductive.

2.1 Dependencies

2.1.1 Friction partners

The material making up the friction partner

has a major influence on the level of electrostatic charging. Plastic and dry leather soles for example against polyamide or wool result in high levels of charging, and some rubber soles to low levels. With polypropylene and polyacrylics only low levels of charging are generally observed.

2.1.2 Humidity

As the relative humidity of the air decreases, there is an increase in the tendency of insulating materials towards electrostatic charging. High levels of charging thus mainly occur in
rooms without air-conditioning when heated.

Overheated offices or similar workplaces without any source of humidity are unpleasant for staff alone in terms of health. A humidity level of at least 40% is advantageous in every respect.

2.1.3 Insulating subfloor

The type of subfloor is a decisive factor for electrostatic charging experienced by users. High levels of such charging are observed with highly insulating subfloors (e.g. mastic asphalt, wooden floors, old floor coverings and underlay for wall-to-wall carpeting) or insulating subfloors (e.g. anhydrite screed) and underfloor heating than for subfloors with lower insulation levels (e.g. cement screed). Insulating subfloors slow down dissipation of the charge, and the thicker the insulating subfloor, the lower the capacity of the system will be, i.e. its capability to carry a charge. The lower this capacity, the higher the voltage will be with an identical electrostatic charge.

3 Requirements

3.1 Standard workplaces, offices, PC workstations

There are no safety requirements in terms of electrostatic properties for these rooms. The use of anti-static floor coverings is thus sufficient.

3.2 Computer centres and control rooms

Electrostatic discharges may cause malfunctions in mainframe computers, control centres and other electronic equipment. The level of the elec-

trostatic charge at which such malfunctions occurs depends on the design of the equipment and shielding of the equipment / signal lines.

In the above-mentioned work areas a floor construction with a

- resistance to ground of $\leq 1 \times 10^8\ \Omega$ is specified to protect sensitive equipment.
  We however recommend clarifying the specific electrostatic requirements on the floor covering by consulting the manufacturer of the systems/equipment.

3.3 ESDS areas (Electrostatic sensitive devices)

EN 61340-5-1 is binding for areas in which components at risk from electrostatic discharge require protection. For this area a floor construction with a

- resistance to ground of $\leq 1 \times 10^9\ \Omega$ is specified to protect sensitive components.

  The test electrode is described in Annex A of EN 61340-4-1.

If primary earthing is to be ensured for personnel via the floor construction, values for system resistance according to IEC 61340-5-1 of

- $\leq 3.5 \times 10^7\ \Omega$ or alternative
- $\leq 1 \times 10^9\ \Omega$ and voltage of less than 100 V

are recommended. The measuring procedure for both requirements is described in DIN EN 61340-4-5.

Warning: EN 61340-5-1 makes no requirements in terms of personal shock protection against main voltage.

If there is a risk of touching main voltage at workplaces, e.g. in test-areas, section 6.3.3 of VDE 0100-410 specifies an insulating floor covering in order to protect personnel.

The requirements **insulating** according to VDE 0100 and **conductive** are at variance with each other. If these two requirements are made simultaneously, we speak of a double requirement.

3.4 Rooms for medical applications

In the case of rooms used for medical applications a German regulation, BGR 132, lists the binding requirements for floor coverings to avoid risks of

ignition due to electrostatic charging.
In areas at risk from explosion

- resistance to ground of ≤ 10^8 Ω is specified.

The method for testing resistance to ground is either EN 1081 or EN 61340-4-1.
The resistance must not be increased by cleaning products for floor coverings.

In rooms used for HF surgery a minimum resistance of ≥ 5 x 10^4 Ω is also specified.

3.5 Rooms with explosive materials

Spark discharges must be avoided in all cases in areas which are at risk from explosive materials (e.g. flammable liquids, explosives etc.). Section 3.6.3 of the German rule BGR 132 specifies a

- resistance to ground of ≤ 10^6 Ω in these areas.

4 Test method

4.1. Resistance measurements UNIT OF MEASUREMENT = Ω (OHM)

Most tests are carried out in a specified test environment that is not however uniform for the individual standards. The ambient temperature and relative humidity have to be recorded for measurements in practical situations.

4.1.1 Vertical resistance of textile floor coverings (ISO 10965)

The test measures the resistance of a textile floor covering with a 5 kg cylinder electrode ∅ 63mm.

test voltage 100 V with resistances ≤ 10^8 Ω,
test voltage 500 V with resistances > 10^8 Ω

4.1.2 Vertical resistance of resilient floor coverings (EN 1081)

The test measures the resistance using a tripod electrode with a total electrode contact area of 25.5 cm². The underside of the electrodes is made of conductive rubber.

test voltage 100 V with resistances ≤ 10^6 Ω,
test voltage 500 V with resistances > 10^6 Ω

4.1.3 Vertical resistance to earth of floor coverings in ESDS areas (EN 61340-4-1)

The test measures the resistance of a resilient floor covering with a 2.5 kg cylinder electrode ∅ 63 mm. The underside of the electrodes is made of conductive rubber.

Test voltage 10 V with resistances $\leq 10^5\ \Omega$ and
Test voltage 100 V with resistances $\geq 10^5\ \Omega$.

4.1.4 System resistance of floor coverings in ESDS areas (EN 61340-4-5)

The test measures the resistance between the test person holding an electrode while standing on the floor covering and the earth potential. The test person must wear (conductive) ESD footwear.

Test voltage 100 V.

4.1.5 Electrical insulation to ground (VDE 0100-610)

The test measures the resistance with a plate electrode between the surface of an installed resilient floor covering and the earth potential. This involves measuring the voltage type and level occurring during usage.

Test electrode 1 for **DC systems**
This electrode corresponds to the so-called tripod electrode according to EN 1081. Before measurement is carried out, the surface to be tested must be moistened or covered with a damp cloth. During measurement the electrode is subjected to a load of approx. 75 kg.

Test electrode 2 for **DC systems and AC voltage**
Electrode area: 625 cm² (footprint of ~2 shoes). A metal electrode measuring 25 x 25 cm is affixed to an insulating wooden board. A damp cloth measuring 27 x 27 cm is laid between the electrode and the floor covering. The electrode is then subjected to a load of approx. 75 kg.

Test voltage 500 V.

4.2 Static electrical charge measurements Unit kV (kilovolt)

4.2.1 Walking test

Testing is carried out in a climatic chamber at 23° C and a relative humidity of 25%.

The test measures the voltage U in volt of a test person walking over a textile or resilient floor covering with the footwear specified in each case:

- resilient floor coverings according to EN 1815 with material of sole made of rubber and PVC
- textile floor coverings according to ISO 6356 with material of sole made of Neolite.

The voltage between the floor covering and the material of the sole defines the level of electrostatic charging according to the standard.

4.2.2 Measurement of charging ability in ESDS areas (EN 61340-4-5)

The test measures the voltage in volt of a test person walking over a floor covering with the specified ESD footwear. The conductivity of the footwear must be tested beforehand.

4.2.3 Testing with a test device (DIN 54345-3)

The method using a test device only applies to textile floor coverings. The walking test is simulated here with a test device. The device can however only be used in a laboratory.

5 Installation

5.1 Installation in areas without special requirements

If there are no special requirements according to sections 3.2 to 3.5, standard installation is possible for all antistatic resilient and textile DLW floor coverings, i.e. stretch-laid or adhered with suitable adhesives.

In the case of insulating subfloors such as mastic asphalt or with underfloor heating (see section 2.1.3), we recommend even for antistatic floor

coverings using conductive adhesive. This cancels out the capacity-reducing effect of the subfloor.

5.2 Conductive installation

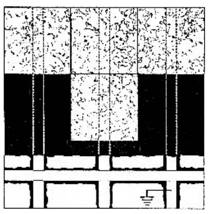
Where compliance with values for resistance to ground is specified in areas according to sections 3.2 to 3.5, this requirement can be satisfied by means of conductive installation:

This type of installation involves installing the conductive floor covering with conductive adhesive on a conducting system, which needs to be properly earthed.

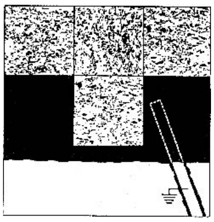
A suitable conductor made of copper (Cu) or equivalent material (cross-section > 4 mm²) must be provided for connection to the earthing system in the building. The conducting system of the floor covering must not be directly earthed or connected to the lightning protective system. Connection to the earthing system should be performed by an electrician, who must comply with the relevant regulations. It is advisable to agree the points of connection for earthing with an electrician in advance.

The following conducting systems are possible:

- **On copper tape / grids of copper tape**
  A continuous copper tape is laid under each row of tiles/sheet of floor covering. The copper tapes are then connected crosswise with two tapes, one at the beginning and one at the end of the sheet (grid of copper tape). Connection options for the earthing system should be provided at two points in the room, or in larger rooms (over 40 m²) at several points.



- **On a conductive primer / copper tape strip**
  A conductive primer is applied to the subfloor according to the manufacturer's instructions for use. At the connection points for the earthing system strips of copper tape should be arranged so that they are bonded to the floor in lengths of approx. 0.5 m. The connection points should be positioned so that the maximum distance from an earthing point does not exceed 10 m.



5.3 Conductive installation with double requirement

If conductive floor coverings are specified together with standing surface insulation according to VDE 0100-410, the copper tape grid and conductive precoating are omitted with ESD / LG1 floor coverings. Here a **semi**conductive adhesive must be used. With the double requirement the adhesive is earthed with strips of copper tape.

In case of further queries contact the Product-Information of DLW Flooring GmbH, Tel. +49 71 42 / 71 845, who will be pleased to provide detailed advice.

6 Floor coverings equipment

6.1 Resilient floor coverings

6.1.1 Addition of carbon

Conductive carbon (graphite, industrial carbon black) is added to the primary or secondary colour. The conductive constituents are distributed to ensure a permanent conductive effect in each case.

Conductive floor coverings with added carbon are indicated in the DLW range by "ESD / LG1" or "conductive / LG2".

6.1.2 Chemical equipment

The inclusion of chemical antistatic agents in the binder allows conductive resilient floor coverings to be manufactured without using black in the pattern. The antistatic agent is evenly distributed throughout the floor covering. This means that the resistance values have an especially limited variation range.

Conductive floor coverings with chemical finishes are indicated in the DLW range by "LCH".

6.2 Textile floor coverings

6.2.1 Addition of conductive textile fibres

High-quality textile floor coverings with excellent antistatic properties are manufactured by adding conductive textile fibres. The conductive fibres are distributed so that they are always in contact with users' feet when they walk on the floor covering.

The use characteristics of the wear layer are not affected by this equipment.