



Conductive floor coating systems

Protection against
electrostatic discharge

It should be noted that the following details, illustrations, general technical information, and drawings contained in this brochure are only general proposals and details which merely describe the basic functions schematically. No precise dimensions are included. The applicator/client is independently responsible for determining the suitability and completeness for the product in question. Neighbouring works are described only schematically. All specifications and information must be adjusted or agreed in the light of local conditions and do not constitute work, detail or installation plans. The technical specifications and product information in the Technical Data Sheets and in system descriptions/certificates must be observed.



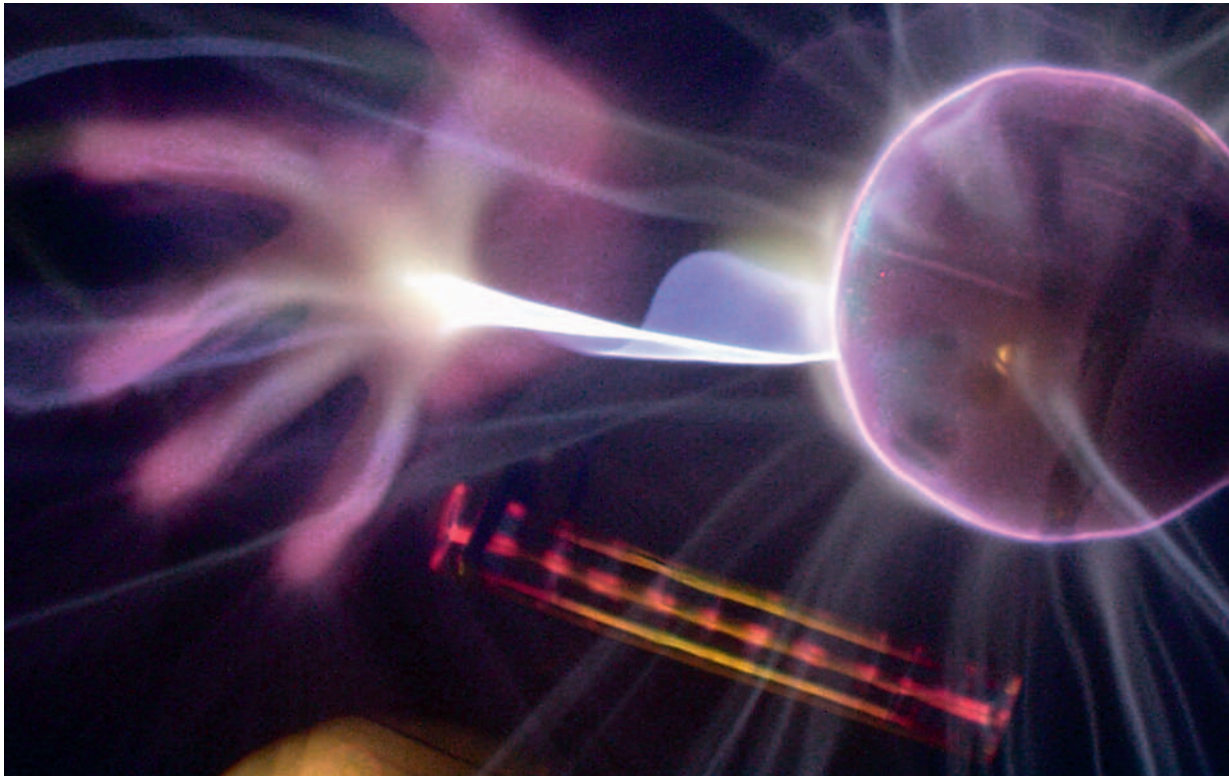
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The danger of electrostatic discharge

Electrostatic discharge – expensive and dangerous



Static electricity is an electrical charge at rest. It usually arises as a result of friction followed by separation. Friction causes heat, which sets the molecules of a material in motion. If two materials are then separated, electron migration from one material to the other is possible.

When electrons migrate, the excess or deficiency of electrons results in the formation of an electric field – static electricity. Simply separating two materials, e.g. by pulling adhesive tape from a roll, can induce this electron exchange, thus generating electrostatic fields.

The quantity of static electricity depends on the materials which are subject to friction and separation, the intensity of friction and separation and the relative humidity. Common plastic usually generates the largest static charges. Low humidity, such as frequently applies in winter, is also conducive to the generation of vast electrostatic charges.

ESD: ElectroStatic Discharge

Materials which readily exchange electrons (or charges) between atoms are referred to as conductors. They possess mobile electrons. Examples of conductors are metals, carbon and the layer of sweat on the human body. Materials which do not exchange electrons so readily are known to as insulators. Familiar insulators are plastic, glass and air. Both conductors and insulators can become charged with static electricity. When a conductor is charged, the free electrons provide a fast means of discharge as soon as it comes into contact with another conductor or is grounded.

Typical forms of electrostatic potential

Many daily activities can result in charges accumulating on the human body which can be harmful to sensitive components:

- walking over a carpet
= 1,500 to 35,000 volts
- walking over an untreated vinyl floor = 250 to 12,000 volts
- working at a work bench
= 700 to 6,000 volts
- picking up an ordinary plastic bag from a work bench = 1,200 to 20,000 volts

Possible effects of electrostatic discharges

Electrostatic potentials attract small particles (dust) – this can lead to difficulties in clean rooms. The greatest risk lies in the discharge of electrostatic potentials, causing sparks.

This entails a risk of explosion in atmospheres containing solvents or dust, such as may apply in food or fertilizer storage facilities or corn mills, for example. In purely financial terms, electrostatic discharge causes the greatest damage to production processes for electronic equipment – meltdown or scorching of sensitive components constitutes a major problem.

Cost effects

A static shock noticeable to humans involves a voltage of at least 3,000 V. The discharge is often responsible for a very high rejection rate in the manufacturing of electronic components (e.g. microchips). Humans are not able to perceive lower electrostatic potentials.

Microchips and ICs (integrated circuits) which are used or manufactured at electronics factories can incur damage as a result of voltages well below 1,000 V. Some of the more sensitive parts may suffer damage even from voltages below 10 V.

As microelectronic engineering progresses at a rapid pace, electronic components are becoming ever smaller. When the size of equipment is reduced, so is the microscopically small spacing between insulators and electric circuits, thus increasing the susceptibility to electrostatic discharge.



The manufacturing of electronic components such as microchips or micromechanical elements is highly susceptible to electrostatic discharge.

Electrostatic infection

ESD damage resulting from invisible and undiscovered events is comparable to infection of the human body with viruses or bacteria. Although they are invisible, these pathogens may cause serious harm before their presence is noticed. Inoculation against this invisible danger in the form of ESD protection is crucial.

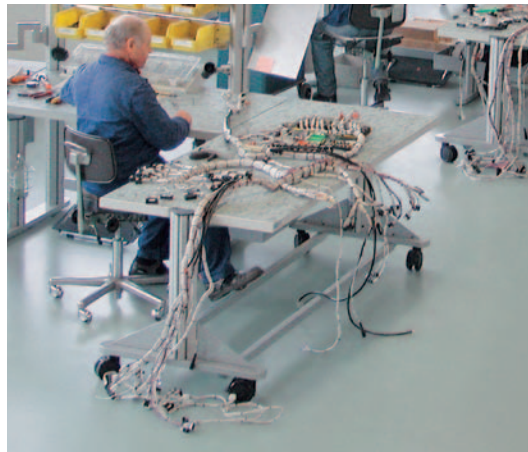
When a component is infected in the described manner, two different failure models may arise.

The catastrophic failure:

The device is physically damaged and no longer works. These failures occur immediately after an ESD event. They are generally easy to detect and eradicate.

The latent failure:

A latent failure applies when the component has been exposed to electrostatic discharge but no catastrophic damage has occurred. The component or product will then continue to meet all the required quality standards, but after a certain time its performance will deteriorate or complete failure may even occur. Latent failures are extremely difficult to detect and are usually extremely costly. The electronics industry estimates the annual costs resulting from these failures to be more than EUR 60 billion



Floors in ESD areas

ESD areas – e.g. in microchip production – can only perform their task effectively if all the materials and equipment in the areas concerned meet the given requirements. Typical items of equipment in ESD areas include tables, chairs, footwear, clothing, wrist straps, ionisers – and conductive floor coatings. The latter play a particularly important role, as they are required to discharge all the charges generated in ESD areas into the ground.

Static losses caused by ESD

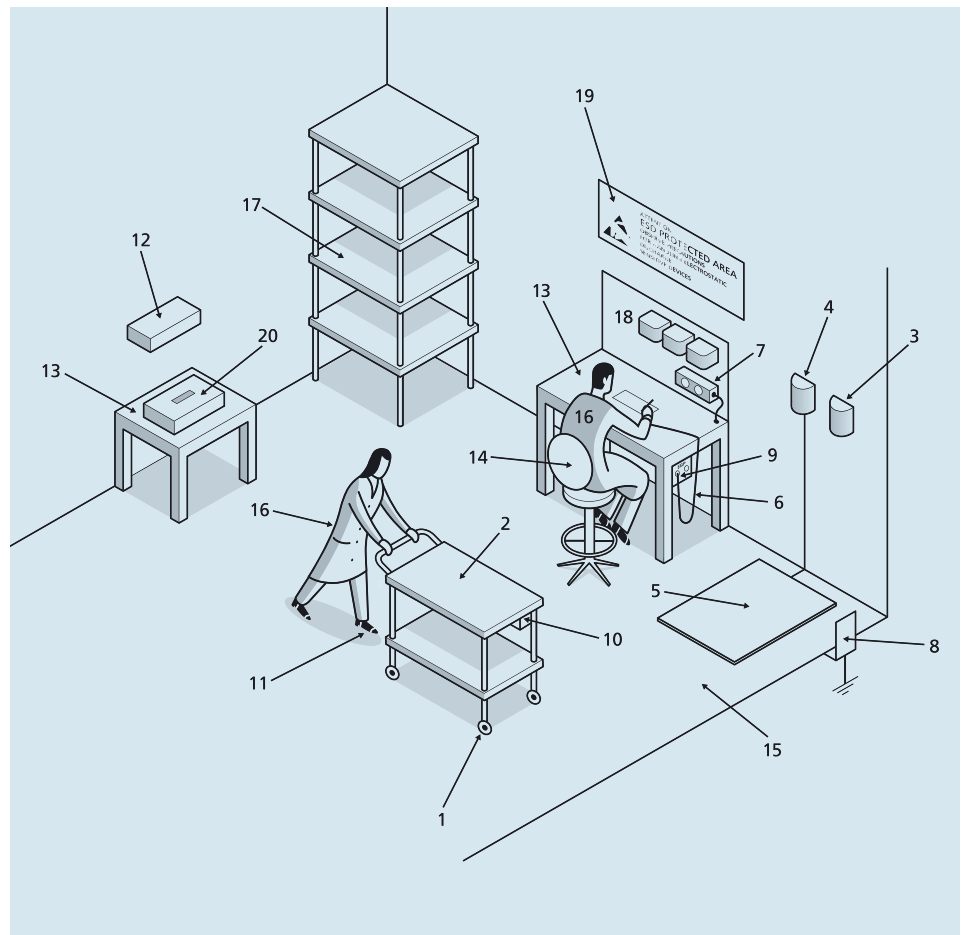
	Minimum loss	Maximum loss	Estimated average loss
Component manufacturers	4 %	97 %	16-22 %
Subcontractors	3 %	70 %	9-15 %
Dealers	2 %	35 %	8-14 %
Consumers	5 %	70 %	27-33 %

Source: Stephen Halperin, "Guidelines for Static Control Management"

The ESD-protected area

Complex and yet reliable

In order to ensure the reliability and quality of modern-day electronic products, components which are sensitive to electrostatic discharge have to be produced at ESD-protected areas (EPA). As the figure shows, an ESD-protected area represents a complex facility. A particularly important role is played here by conductive flooring, which is required to dissipate the generated charges to the ground.



- | | | | |
|---|--------------------------------------------------------|----|------------------------------------------------------|
| 1 | Groundable wheels | 10 | Earth bonding point of trolley |
| 2 | Groundable surface | 11 | ESD-protective footwear |
| 3 | Wrist strap tester, shall be displayed outside the EPA | 12 | Ioniser |
| 4 | Footwear tester, shall be displayed outside the EPA | 13 | Work surfaces |
| 5 | Footwear tester foot plate, wrist strap and cord | 14 | Seating with feet and pads with grounding properties |
| 6 | Wrist cord and wrist band (wrist strap) | 15 | Floor |
| 7 | EPA grounding cord | 16 | Clothing |
| 8 | EPA ground | 17 | Shelving with grounded surface |
| 9 | Earth bonding point (EBP) | 18 | Shelving with grounding properties |
| | | 19 | EPA sign |
| | | 20 | Machine |

Extract from EN 61340-5-1 (VDE 0300 Part 5-1): 2001-08, reproduced from registered, limited circulation authorised by licence 012.002 from the DIN German Institute for Standardisation e.V. and VDE Association for Electrical, Electronic & Information Technologies e.V.

A separate licence is required for further reproduction or circulation. In applying the standards, it is important to observe the versions with the latest issue date.

Standard sheets are available from VDE VERLAG GmbH, Bismarckstrasse 33, D-10625 Berlin and Beuth Verlag GmbH, Burggrafenstrasse 6, D-10787 Berlin.

Standards and guidelines

The principles of ESD protection



Conductive floor coatings are used in two different areas:

- Explosion prevention
- ESD protection

In both cases, the conductive floor coating prevents people from accumulating high charges. The explosion of combustible media is prevented by storing them in ex protection rooms. In ESD areas the focus is on protecting sensitive electronic components from electrostatic discharge. Both areas are regulated by different standards and must thus be considered separately.

Measuring device for determining resistance to ground.



Explosion prevention applications: ESD protection applications:

TRBS [Technical Rules for Operating Safety] 2153

Avoidance of dangers of ignition resulting from electrostatic charges (published in GMBI [Joint Ministerial Gazette] no. 15/16 dated 9 April 2009, page 278)

The document valid for explosion protection up until then, BGR 132 (03.2003), was integrated into TRBS 2153. Both aforementioned regulations are only valid throughout Germany.

This Technical Rule applies to the assessment and avoidance of dangers of ignition resulting from electrostatic discharge in areas at risk of explosions, and to the selection and implementation of the corresponding safety measures. These rules are applied, for example,

- at storage facilities for solvents
- at munitions factories and depots
- in producing and handling combustible dust
- at storage facilities for combustible materials

Required resistance to ground for floors $< 10^8 \Omega$. A measurement standard is not indicated. Usually, EN 1081 (04.1998) or EN 61340-4-1 (12.2004) is applied here.

EN 1081 (04.1998)

Resilient floor coverings – Determination of the electrical resistance

This is the usual measuring standard for TRBS 2153. A so-called three-point electrode is employed as the measuring electrode. The measuring voltage is 100 volts.

ANSI/ESD S20.20-2007 EN 61340-5-1 (07.2008)

Protection of electronic devices from electrostatic phenomena – General requirements

This is essentially the master standard for ESD areas. It defines the requirements for all relevant components in ESD-protected areas.

For floors, the standard stipulates a resistance to ground of $< 10^9 \Omega$. When the floor is primary means of grounding personnel either one of the two following requirements must be met:

- The combination resistance of the system – from the person via the footwear and the floor to the grounding – must be less than $3.5 \times 10^7 \Omega$
- The maximum voltage generated on a human body must be less than 100 volts and the combination resistance less $1 \times 10^9 \Omega$.

The methods for measuring resistance and voltage generation are described in the following standards:

EN 61340-4-1
EN 61340-4-5
ANSI/ESD S7.1-2005
ANSI/ESD STM 97.1-2006
ANSI/ESD STM 97.2-2006

ANSI/ESD S7.1-2005 EN 61340-4-1 (12.2004)

Electrical resistance of floor coverings and installed floors

These are measuring standards for EN 61340-5-1 and ANSI/ESD S20.20-2007.

The measurement covers only the floor, and not the overall system (person/footwear/floor).

Voltage: Volt (V)
Resistance: Ohm (Ω)

ANSI/ESD STM 97.1-2006

ANSI/ESD STM 97.2-2006

EN 61340-4-5 (03.2005)

Electrostatics – Part 4-5: Standard test methods for specific applications – Methods for characterising the electrostatic protection of footwear and flooring in combination with a person

These are the second floor measuring standards for EN 61340-5-1 / ANSI/ESD S 20.20. Rather than considering the flooring by itself, this method covers the overall system (person/footwear/floor). The following quantities are measured:

- resistance to ground in ohms (system test),
ANSI/ESD STM 97.1-2006
- charging of persons in volts (walking test)
ANSI/ESD STM 97.2-2006



VDE 0100-410 (06.2007)

Erection of Low-Voltage Installations – Part 4-41: Protective Measures – Protection against electrical shocks

This German standard focuses on the protection of people with regard to the danger of coming into contact with live parts. Whilst the standards cited above are concerned primarily with the upper limits for resistance levels, this standard defines the lower limits:

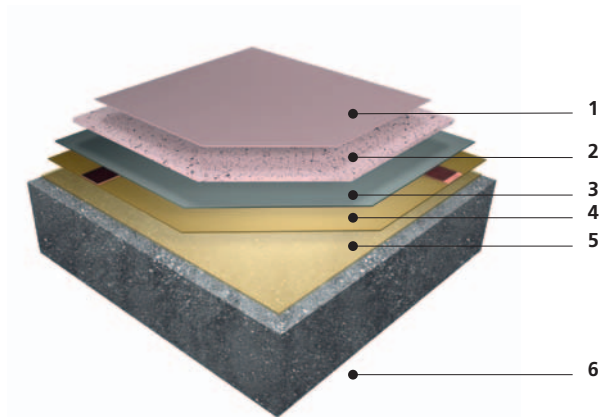
- Insulation resistance $\geq 5 \times 10^4 \Omega$, if the nominal voltage of the installation does not exceed 500 V
- Insulation resistance $\geq 10 \times 10^4 \Omega$, if the nominal voltage of the installation does exceed 500 V

The measurement is carried out according to VDE 0100-600 (06.2008) Appendix A. This measuring method differs fundamentally from those of the previously mentioned standards. Therefore, the measured values are not comparable.



The system structure of a conductive floor coating

The components and their function



- 1 Sealing/
possible care agent
- 2 Finishing coat
- 3 Conductive intermediate
with conductive strip
- 4 Filling and levelling coat
- 5 Priming coat
- 6 Subfloor

Subfloor

Cement-bound substrates such as cement screeds or concrete are generally coated, as are magnesia and anhydrite screeds, to a less common extent. If there is a danger of rising moisture, a water vapour permeable system must be chosen. Thermoplastic substrates, such as mastic asphalt, require a viscoplastic coating.

Primer

As with all reaction resin bound systems, the primer promotes adhesion between the subfloor and the coating. The primer usually consists of a solvent-free, low-viscosity, transparent epoxy resin. The resin primer can be filled with fire-dried quartz sands to produce a levelling layer. Diffusion-open systems are primed with water emulsified epoxy resins.

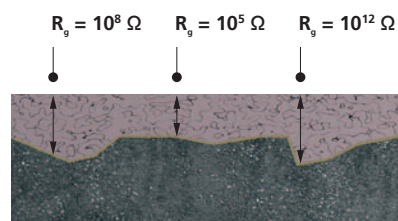
Filling and levelling

The discharge resistance of a conductive coating system results primarily from the thickness of the finishing coat. In order to attain a uniform level of resistance over the entire surface the finishing coat must be of uniform thickness. After priming rough and uneven subfloors, it is thus advisable to apply a levelling filler coating of resin primers and quartz sands.

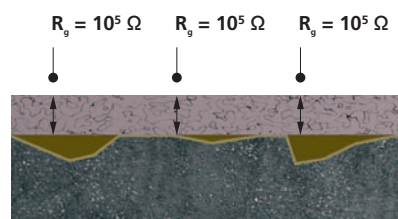
Conductive layer/ grounding

As the electrostatic discharge capability of concrete declines in the course of time as a result of drying processes, in addition to which the primer acts as an isolating layer, a so-called conductive layer must be applied. This intermediate layer enables the discharge of electrostatic charges to be channeled to the ground via a conductive layer with a constant level of resistance. The conductive layer generally consists of a soot-filled, water-based epoxy resin dispersion.

StoCretec offers two versions: a highly-conductive (StoPox WL 110) and a moderately conductive (StoPox WL 118) product. The latter product is used when the conductive coating needs to additionally meet the requirements on operator protection in accordance with DIN VDE 0100-410.



Dissipative coating on uneven substrate without a levelling layer.



A levelling layer ensures uniform thickness of the finishing coat, resulting in uniform discharge resistance.



These consist of dowels which are fixed to the substrate. A cable lug enables very simple connection to the grounding system. The black conductive intermediate which is rolled over the strips possesses a much higher conductivity in horizontal direction than the coating material.



Finishing coat

The conductive properties of the finishing coat are generally attained by adding carbon fibres. Modern, so-called volume-conductive coatings do not contain any carbon fibres, but special conductive filler materials which provide the systems with a significantly more homogeneous conductivity.

Numerous different coating systems are available for different applications:

- water vapour permeable thin and thick coatings on a water emulsified epoxy resin base
- systems based on solvent-free epoxy resins with high resistance to mechanical stress and chemicals
- tough to viscoplastic systems based on solvent-free polyurethane resins

Coatings with electrostatic discharging capability can be additionally be gritted to enhance slip resistance. Special silicon carbides or coated quartz sands with conductive properties are used for this purpose.



Sealing

Systems incorporating finishing coats which have been rendered conductive by means of carbon fibres possess adequate conductivity to meet the requirements for explosion prevention applications. They do not, however, meet the current requirements pertaining to ESD protection. To solve this problem, the finishing coats are additionally provided with pigmented conductive sealing. Such a sealing is highly abrasion resistant and possesses a certain horizontal conductivity. They are thus able to homogenise the conductivity of the overall system and to discharge arising charges not only vertically, but also horizontally. This capacity ensures compliance with all the relevant ESD standards. A conductive sealing generally consists of water-based two-component polyurethane or epoxy resin dispersions.



The conductive intermediate generally consists of a soot-filled, water-based epoxy resin dispersion.



The conductive strips may only be connected to the ring circuit by a qualified electrician!



Applying the finishing coat



The conducting set in the practical box



Ground connection of the conducting set

StoCretec ESD floor coatings

Always the right system

StoCretec ESD floor coating systems

	Water-based EP thin-layer system	Water-based EP thick-layer system	Water-based EP thick-layer system	Solvent-free EP thin-layer system
Properties	<ul style="list-style-type: none"> Water vapour permeable thin-layer coating Complies with TRBS 2153 Complies with EN 61340-5-1 / ANSI/ESD S20.20-2007 – both only in combination with StoPox WL 113 Complies with DIN VDE 0100-410 – only in combination with StoPox WL 118 Low-cost system Very good light resistance 	<ul style="list-style-type: none"> Water vapour permeable thick-layer coating Complies with TRBS 2153 Complies with EN 61340-5-1 / ANSI/ESD S20.20-2007 – both only in combination with StoPox WL 113 Complies with DIN VDE 0100-410 – only in combination with StoPox WL 118 Very good light resistance 	<ul style="list-style-type: none"> Water vapour permeable, volume conductive thick-layer coating Free of carbon fibres Complies with TRBS 2153 Complies with EN 61340-5-1 / ANSI/ESD S20.20-2007 Conductivity is independent of the relative air humidity Conductivity largely independent of the ESD footwear Very good light resistance 	<ul style="list-style-type: none"> Textured thin-layer coating Complies with TRBS 2153 Complies with EN 61340-5-1 / ANSI/ESD S20.20-2007 – both only in combination with StoPur KV/StoPur WV 210 Complies with DIN VDE 0100-410 – only in combination with StoPox WL 118 Low-cost system
Area of application	<ul style="list-style-type: none"> Rooms used for storing and/or charging batteries Storage facilities for combustible materials Rooms containing highly sensitive electronic equipment Server rooms Production shops for precision electronic equipment (ESD facilities) 	<ul style="list-style-type: none"> Laboratories Storage facilities for combustible materials Rooms containing highly sensitive electronic equipment Server rooms Production shops for precision electronic equipment (ESD facilities) 	<ul style="list-style-type: none"> Laboratories Rooms containing highly sensitive electronic equipment Server rooms Production shops for precision electronic equipment (ESD facilities) 	<ul style="list-style-type: none"> Rooms used for storing and/or charging batteries Industrial factories and warehouses subject to a risk of explosion Production shops in the automobile industry
Primer	StoPox WG 100 unfilled StoPox WG 100 levelling layer, filled with quartz sand	StoPox WG 100 unfilled StoPox WG 100 levelling layer, filled with quartz sand	StoPox WG 100 unfilled StoPox WG 100 levelling layer, filled with quartz sand	StoPox GH 205 unfilled StoPox GH 205 levelling layer, filled with quartz sand
Conductive layer	StoPox WL 110 or StoPox WL 118	StoPox WL 110 or StoPox WL 118		StoPox WL 110 or StoPox WL 118
Finishing coat	StoPox WL 111	StoPox WB 110	StoPox WB 113	StoPox KU 411
Sealing	Optional: StoPox WL 113	Optional: StoPox WL 113		Optional: StoPur KV/StoPur WV 210
Care agent		Optional: StoDivers P 110	StoDivers P 110	
Layer thickness	approx. 0.5 mm	approx. 2-3 mm	approx. 2 mm	approx. 1 mm
Substrates	<ul style="list-style-type: none"> Rising moisture Magnesia screed Calcium sulfate screed Cement-based subfloors 	<ul style="list-style-type: none"> Rising moisture Magnesia screed Calcium sulfate screed Cement-based subfloors 	<ul style="list-style-type: none"> Rising moisture Magnesia screed Calcium sulfate screed Cement-based subfloors 	<ul style="list-style-type: none"> Cement-based subfloors



Solvent-free EP thick-layer system	Solvent-free EP thick-layer system	Solvent-free EP thick-layer system	Solvent-free PUR thick-layer system
<ul style="list-style-type: none"> Thick-layer coating Very high resistance to chemicals and mechanical stress Complies with TRBS 2153 Complies with EN 61340-5-1/ANSI/ESD S20.20-2007 <ul style="list-style-type: none"> – both only in combination with StoPur KV/StoPur WV 210 Complies with DIN VDE 0100-410 <ul style="list-style-type: none"> – only in combination with StoPox WL 118 	<ul style="list-style-type: none"> Volume-conductive thick-layer coating Free of carbon fibres Homogeneous surface appearance Complies with TRBS 2153 Complies with EN 61340-5-1/ANSI/ESD S20.20-2007 Complies with DIN VDE 0100-410 <ul style="list-style-type: none"> – only in combination with StoPox WL 118 Minimal dependence of the conductivity on the relative air humidity 	<ul style="list-style-type: none"> Volume-conductive thick-layer coating Complies with TRBS 2153 Complies with EN 61340-5-1/ANSI/ESD S20.20-2007 Complies with DIN VDE 0100-410 <ul style="list-style-type: none"> – only in combination with StoPox WL 118 	<ul style="list-style-type: none"> Viscoplastic thick-layer coating with crack-bridging properties Complies with TRBS 2153 Complies with EN 61340-5-1/ANSI/ESD S20.20-2007 <ul style="list-style-type: none"> – both only in combination with StoPur KV/StoPur WV 210 Complies with DIN VDE 0100-410 <ul style="list-style-type: none"> – only in combination with StoPox WL 118
<ul style="list-style-type: none"> Industrial factories and warehouses subject to a risk of explosion Facilities for the production, handling and use of water-endangering substances in accordance with Section 62 of the German water management act (WHG) Laboratories Clean rooms Rooms containing highly sensitive electronic equipment ESD facilities 	<ul style="list-style-type: none"> Rooms containing highly sensitive electronic equipment Production shops for precision electronic equipment (ESD facilities) Packaging rooms for microelectronic parts Computer rooms 	<ul style="list-style-type: none"> Rooms containing highly sensitive electronic equipment Production shops for precision electronic equipment (ESD facilities) Packaging rooms for microelectronic parts Computer rooms 	<ul style="list-style-type: none"> Rooms containing highly sensitive electronic equipment Production shops for precision electronic equipment (ESD facilities) Packaging rooms for microelectronic parts Computer rooms
StoPox GH 205 unfilled	StoPox GH 205 unfilled	StoPox GH 205 unfilled	StoPox GH 205 or StoPur IB 500 each unfilled
StoPox GH 205 levelling layer, filled with quartz sand	StoPox GH 205 levelling layer, filled with quartz sand	StoPox GH 205 levelling layer, filled with quartz sand	StoPox GH 205 or StoPur IB 500 levelling layer, each filled with quartz sand
StoPox WL 110 or StoPox WL 118	StoPox WL 110 or StoPox WL 118	StoPox WL 110 or StoPox WL 118	StoPox WL 110 or StoPox WL 118
StoPox KU 611	StoPox KU 613	StoPox KU 615	StoPur IB 510
Optional: StoPur KV/StoPur WV 210			Optional: StoPur KV/StoPur WV 210
approx. 2 mm	approx. 1.5 mm	approx. 2 mm	approx. 2 mm
<ul style="list-style-type: none"> Cement-based subfloors 	<ul style="list-style-type: none"> Cement-based subfloors 	<ul style="list-style-type: none"> Cement-based subfloors 	<ul style="list-style-type: none"> Cement-based subfloors Mastic asphalt subfloors

StoCretec ESD floor coatings

Products and measured values

The available range of conductive floor coatings has become highly complex. The following table provides an overview of the valid standards as well as the StoCretec coatings which comply with the required measured values in each case.

Requirements for conductive floor coatings

TRBS 2153	Required resistance to ground of the coating: < 10 ⁸ Ω, measurements in accordance with EN 1081 or EN 61340-4-1
EN 61340-5-1 / ANSI/ESD S.20.20	Protection of electronic devices from electrostatic phenomena: Resistance to ground: R _g < 1 x 10 ⁹ Ω Grounding of personnel: R _g < 3.5 x 10 ⁷ Ω or charge < 100 V and R _g < 10 ⁹ Ω (primary grounding of staff via floor), measurements in accordance with EN 61340-4-1 / ANSI/ESD S7.1 and EN 61340-4-5 / ANSI/ESD STM 97.1 / ANSI/ESD STM 97.2

Systems and standards

Standard	with conductive intermediate StoPox WL 110			with conductive intermediate StoPox WL 118		
	TRBS 2153 R _g < 10 ⁸ Ω	EN 61340-5-1 / ANSI/ESD S20.20	DIN VDE 0100-410 (2007) R _g > 10 ⁵ Ω	TRBS 2153 R _g < 10 ⁸ Ω	EN 61340-5-1 / ANSI/ESD S20.20	DIN VDE 0100-410 (2007) R _g > 10 ⁵ Ω
System						
StoPox WL 111	●			●		●
with StoPox WL 113	●	●		●	●	●
StoPox WB 110	●			●		●
with StoPox WL 113	●	●		●	●	●
StoPox WB 113	●	●				
StoPox KU 411	●			●		●
with StoPur KV	●	●		●	●	●
with StoPur WV 210	●	●		●	●	●
StoPox KU 611	●			●		●
with StoPur KV	●	●		●	●	●
with StoPur WV 210	●	●		●	●	●
StoPox KU 613	●	●		●	●	●
StoPox KU 615	●	●		●	●	●
StoPur IB 510	●			●		●
with StoPur KV	●	●		●	●	●
with StoPur WV 210	●	●		●	●	●

● complies with standard



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Quality management system
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