Recommendations for the test of ESD garments

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ESTAT-Garments partners

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Main results have been published in

- Evaluation of existing test methods for ESD garments, VTT Research report No BTUO45-041224, 2004
- ESTAT-Garments interlaboratory tests, VTT Research report No BTUO45-051337, 2005
- Recommendations for the use and test of ESD protective garments in electronics industry, VTT Research report No BTUO45-051338, 2005
- All available at http://estat.vtt.fi

- In this presentation we focus to the ESTAT-Garments recommendations for the test methods

ESTAT-Garments recommendations for test methods

Different levels of tests

- **Evaluation tests** for new products to enter the market, which should be done in laboratories under controlled conditions
- **Approval test(s)** for first article or incoming material to determine if the measured values specified by the inspection order are within limits
- **Periodic** field/audit **test(s)** done for garments already in use, which test(s) would be done in production sites or in laundries after washing

Proposal for the classification of garments

Class A

1. Class A garments must be grounded in use.
2. Class A garments are electrically countinues, low-charging[1] and either static dissipative or conductive.
3. Class A garments are recommended for the handling of very ESD sensitive devices.

Class B

1. Class B garments are recommended, but not required to be grounded in use.
2. Class B garments are low-charging[1], but need not have measurable electrical continuity.

[1] Low charging material is a material with low tendency for charge separation by contact or by rubbing against other materials

Recommendations for the evaluation test

Evaluation tests - *Valid for both Class A and Class B garments:*

Required tests

- IEC 61340-5-1 / ESD STM 2.1 point-to-point resistance test method or alternatively, ESTAT-Garments test method "Measurement of the charge decay time of ESD-protective garment"
- EN 1149-3 Method 1 (tribocharging) for fabric level chargeability test
- EN 1149-3 Method 2 (induction charging) for the electrostatic shielding test

Optional test

- ESTAT-Garments test method "Measurement of a direct discharge from an ESD protective material, such as an ESD garment/fabric"

Recommendations for the approval test

Approval test

Required test for Class A garments

- IEC 61340-5-1 / ESD STM 2.1 point-to-point resistance test method or alternatively, ESTAT-Garments test method "Measurement of the charge decay time of ESD-protective garment"

Required test for Class B garments

- EN 1149-3 Method 2 (induction charging)

Optional test for Class A garments

- EN 1149-3 Method 2 (induction charging)

Recommendations for the periodic test

Periodic test

Required only for Class A garments

- IEC 61340-5-1 / ESD STM 2.1 point-to-point resistance test method or alternatively, ESTAT-Garments test method "Measurement of the charge decay time of ESD-protective garment"

Required limits of acceptance

Required limits

Class A garments

- Point-to-point resistance $R_p < 1x10^{10}\ \Omega$
- Charge decay time of full garment $t_g < 20$ s
- Chargeability $V_0 < 500$ V (or $E_0 < 10$ kV/m)

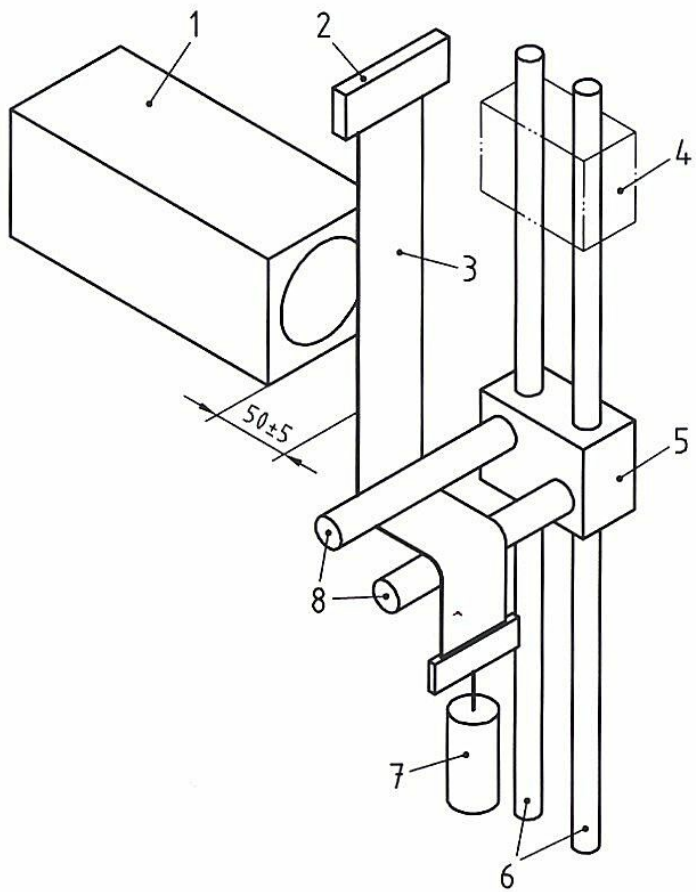
Class B garments

- Chargeability $V_0 < 2000$ V (or $E_0 < 40$ kV/m)

Test method descriptions

EN 1149-3 Method 1

- Chargeability test method



EN 1149-3 Method 1

- For needs of electronic industry the focus should be in the chargeability of garment fabrics due to triboelectric charging (the maximum E_0 or V_0)
- Some improvements for the EN 1149-3 description are proposed
  - PA rods should be used instead of Al
  - Free falling of the charging rods should not be allowed
  - Use of DC non-contact electrostatic voltmeters should be allowed

EN 1149-3 Method 1

- *Table 37 Means of maximum surface potentials for HDPE- and PA-charging rods in Volts for vertical fabric direction.*

Means of V0 vertical: HDPE [V]

	Sample code							
Laboratory	**SCF**	**SCG**	**SSG**	**HCG**	**CCF**	**CCG**	**PCG**	**PEG**
VTT	-24,60	71,10	128,10	162,90	56,70	379,80	2991,30	3462,90
Nokia	0,00	8,33	-10,00	21,67	3,33	100,00	316,67	366,67
TUT	80,00	126,67	150,00	213,33	113,33	490,00	3716,67	2226,67

Means of V0 vertical: Polyamide [V]

	Sample code							
Laboratory	**SCF**	**SCG**	**SSG**	**HCG**	**CCF**	**CCG**	**PCG**	**PEG**
VTT	-20,10	-21,90	-47,70	-256,20	-154,20	-1134,00	-4804,80	-11303,10
Nokia	-10,00	-141,67	-175,00	-341,67	-175,00	-1500,00	-2583,33	-6333,33
TUT	-86,67	-93,33	-123,33	-186,67	-86,67	-310,00	-4366,67	-6050,00

EN 1149-3 Method 1

- *Table 41 Means of surface potentials after 30 s for HDPE- and PA-charging rods in Volts for vertical fabric direction.*

Means of V30 vertical: HDPE [V]

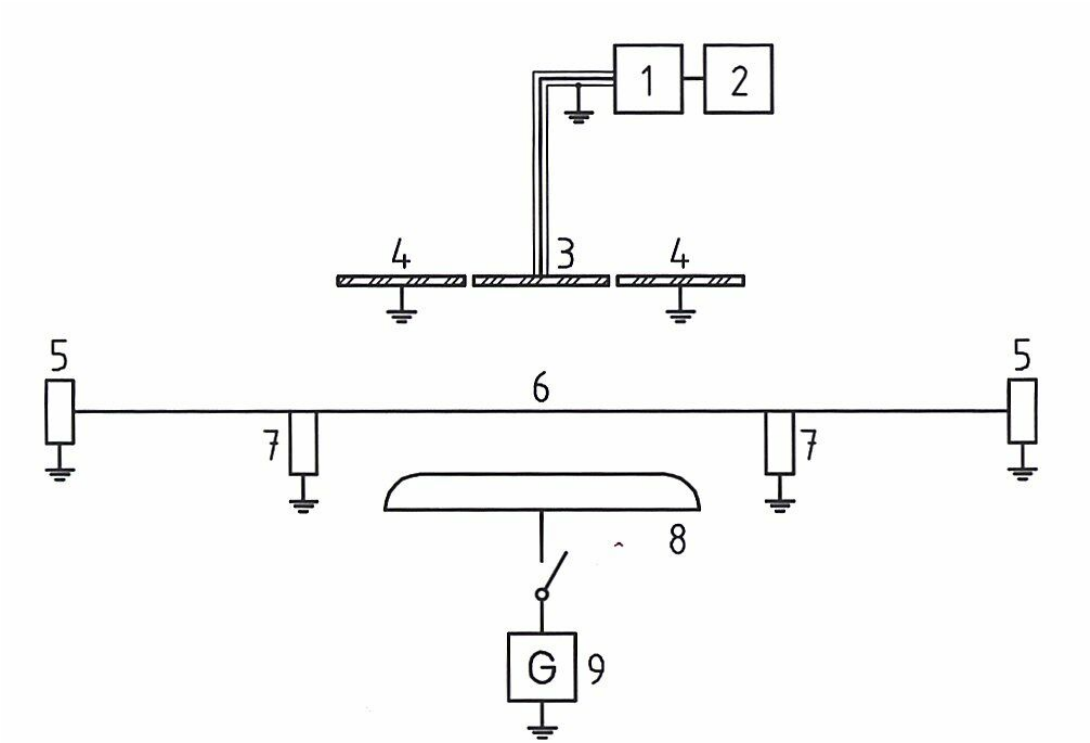
	Sample code							
Laboratory	**SCF**	**SCG**	**SSG**	**HCG**	**CCF**	**CCG**	**PCG**	**PEG**
VTT	-8,70	4,80	15,90	157,20	50,10	364,50	2127,30	3161,10
Nokia	0,00	0,00	-7,50	19,17	3,33	100,00	283,33	366,67
TUT	0,00	33,33	26,67	186,67	63,33	426,67	3273,33	3023,33

Means of V30 vertical: Polyamide [V]

	Sample code							
Laboratory	**SCF**	**SCG**	**SSG**	**HCG**	**CCF**	**CCG**	**PCG**	**PEG**
VTT	-7,20	-12,60	-15,00	-250,50	-150,60	-1056,90	-3492,00	-10863,30
Nokia	0,00	-50,00	-50,00	-341,67	-133,33	-1500,00	-2250,00	-6333,33
TUT	0,00	10,00	20,00	140,00	-36,67	-273,33	3656,67	4293,33

EN 1149-3 Method 2

- Electrostatic shielding test method



EN 1149-3 Method 2

Table 45 Half decay time due to induction charging.

Decay time t50% [s]

	Sample code							
Laboratory	**SCF**	**SCG**	**SSG**	**HCG**	**CCF**	**CCG**	**PCG**	**PEG**
VTT	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	7,94	>10
Nokia	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	16,00	>10
STFI	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	12,82	>10

Table 46 Means of shielding factor.

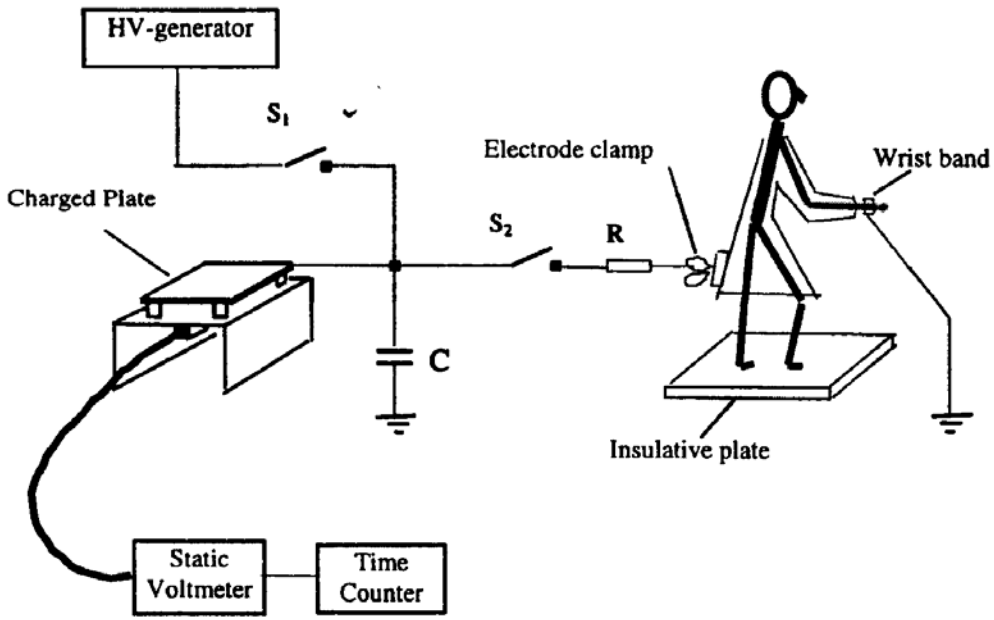
Means of shielding factor

	Sample code							
Laboratory	**SCF**	**SCG**	**SSG**	**HCG**	**CCF**	**CCG**	**PCG**	**PEG**
VTT	0,97	0,89	0,89	0,80	0,92	0,69	0,01	0,01
Nokia	0,95	0,86	0,87	0,77	0,91	0,72	0,00	0,00
STFI	0,95	0,86	0,86	0,75	0,90	0,65	0,00	0,00

ESTAT-Garments system test method

Measurement of the charge decay time of ESD protective garments

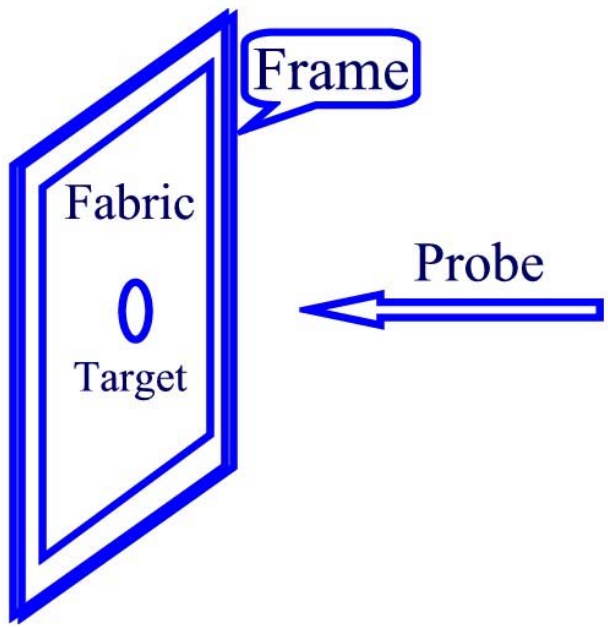
- Continuity of groundable garment
- Garment level charge decay
- Voltage suppression



ESTAT-Garments test method

Measurement of a direct discharge from an ESD protective material, such as an ESD garment/fabric

- Direct ESD from fabrics
- Peak ESD current
- Charge transferred



Why not IEC 61340-2-1 charge decay test?

- The IEC 61340-2-1 charge decay test failed in the ESTAT-Garments round robin test to reliably distinguish good and bad ESD protective fabric materials

Means of charge decay time from max. to 100 V [s]

	Sample code							
Laboratory	**SCF**	**SCG**	**SSG**	**HCG**	**CCF**	**CCG**	**PCG**	**PEG**
VTT	0,04	10,50	2,22	>30	>30	>30	>30	>30
Centexbel	0,50	53,07	21,27	>60	>60	>60	>60	>60
Celestica	0,09		0,04	>20	>20	>20		>20

Fabric potential at 2 s [V]

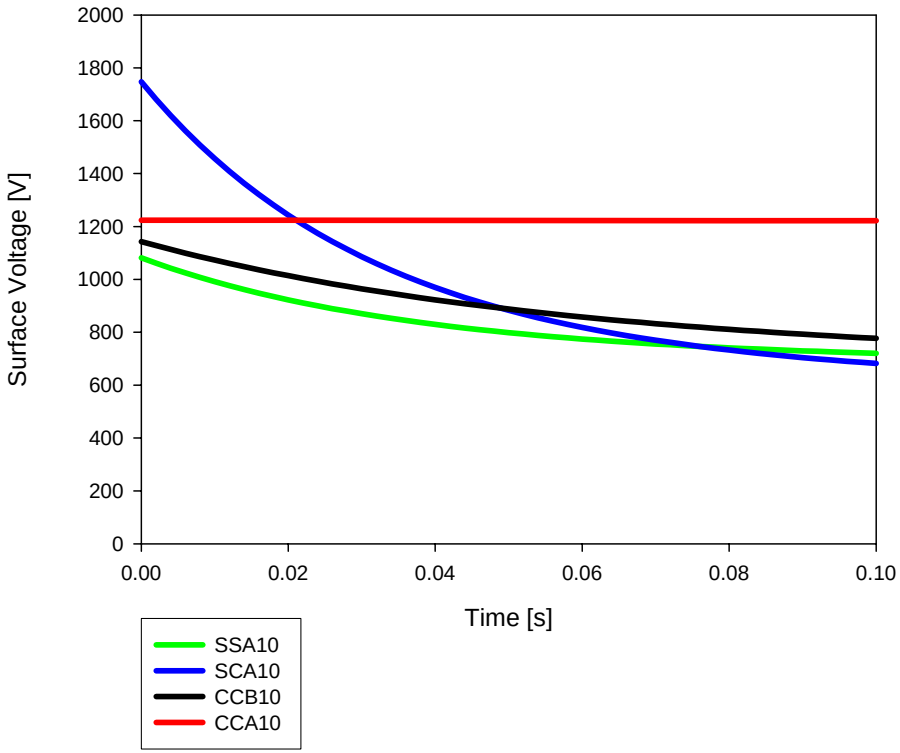
	Sample code							
Laboratory	**SCF**	**SCG**	**SSG**	**HCG**	**CCF**	**CCG**	**PCG**	**PEG**
VTT	20	190	110	220	280	320	350	370
Centexbel	20	400	300	480	680	740	1100	1200
Celestica	10	10	10	550	600	600	500	1000
JCI	20	250	180	340	300	500	740	1100

Why not IEC 61340-2-1 charge decay test?

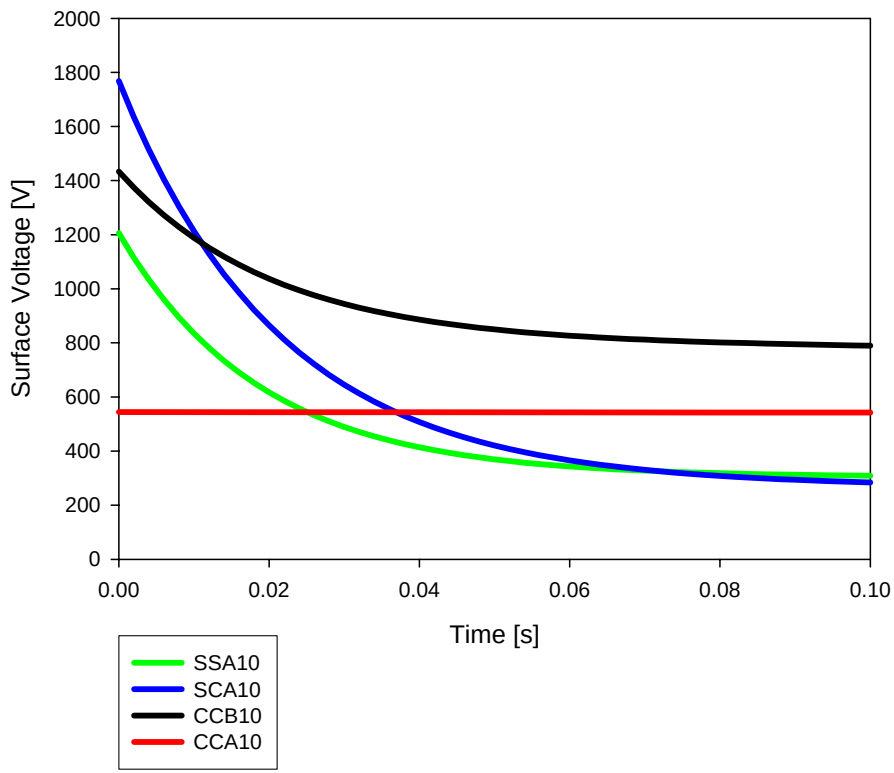
- The test method works well for materials having single time constant of charge decay, such as ESD packaging material
- If the material under the test is electrostatically very heterogeneous having several characteristics time constant, a balanced, true charge decay behaviour of the material may not be measured by the material
- That is what happened for the most state-of-the-art ESD fabrics in the RRT-tests.
- The state-of-the-art ESD fabrics are composites with conductive and insulating elements, each having very different characteristics time constant of charge decay

Charge decay of ESD fabrics after tribocharging

Center 12%



Cross 12%



- Measured at University of Genova (G. Coletti et al.) by a special set-up for scientific purposes: center = response of fabric; cross = response of conductive threads

Conclusions

- The ESTAT-Garments project team recommends the following test methods for consideration by TC101 experts:

- The conventional point-to-point test method.
- ESTAT-Garments system level test method:

  Measurement of the charge decay time of ESD protective garments
- EN 1149-3 Method 1 (chargeability test for fabrics).
- EN 1149-3 Method 2 (electrostatic shielding test).
- ESTAT-Garments direct ESD test method:

  Measurement of a direct discharge from an ESD protective material, such as an ESD garment/fabric