
Appendix 8

Trolleys, carts, wagons, trucks

1 Scope

This appendix defines test methods for ESD protective properties of carts and similar items (in the following referred to as “carts”) for use (transportation, storage or as a portable work surface) in an EPA. It also defines the requirements of the same parameters for the “ESD-approval”.

The requirements for an “ESD-approval” correspond to requirements specified in IEC 61340-5-1.

The test method corresponds to IEC 61340-2-3.

2 References

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| [1] | IEC 61340-5-1, edition 1.0, 2007 | Electrostatics – Protection of Electronic devices from electrostatic phenomena – General requirements |
| [2] | IEC 61340-2-3, first edition | Method of test for determining the resistance and resistivity of solid planar materials used to avoid electrostatic accumulation. |

3 Definitions

The definitions in this document follow the definitions in ref [1] and IEC 61340-1-2.

4 Sampling

At least three test samples are required. If the product is supplied in many variants with small deviations, the test samples are chosen so that they represent all the variants.

5 Test method

5.1 Principle

The test method corresponds to IEC 61340-2-3.

Surface resistance: IEC 61340-2-3, section 8.6.1.

Resistance to ground: IEC 61340-2-3, section 8.6.3.1.

Point-to-point resistance: IEC 61340-2-3, section 8.6.4.

5.2 Equipment

- V/A-meter with uncertainty less than $\pm 1\%$. Keithley 487 or two Fluke 187 multimeters for current and voltage measurements.
- One concentric ring electrode (2,5 kg) according to IEC 61340-2-3, figure 1. The electrode shall be provided with conductive rubber as contact material between the electrode and the test object.
- Two conductive electrodes (2,5 kg; $\varnothing 63.5$) according to IEC 61340-2-3, figure 4. Both electrodes shall be provided with conductive rubber pads as contact material between the electrode and the test object.
- Stainless steel plate.
- Insulating support plate larger than the base of the chart (vertical resistance higher than $10^{14} \Omega$).
- Stop watch (SP inv. No.: 501336) with uncertainty less than 0,2 s (including manual operation).

5.3 Preparation

If it is needed, the test samples shall be cleaned according to the manufacturers' recommendations.

The test samples shall be conditioned at least 48 h in $23\text{ °C} \pm 2\text{ °C}$ and $12\text{ \%RH} \pm 3\text{ \%RH}$.

Measurements are performed in $23\text{ °C} \pm 2\text{ °C}$ and $12\text{ \%RH} \pm 3\text{ \%RH}$.

The concentric ring electrode shall before it is used, be verified according to IEC 61340-2-3, section 8.4.1.

The conductive electrode shall have a resistance less than $10^3 \Omega$ measured at 10 V according to IEC 61340-2-3, section 8.2.3.

5.4 Procedure

All surfaces considered as work and storage surfaces, which unprotected ESDS may come in intimate contact with, are measured.

5.4.1 Surface resistance

The concentric ring electrode is placed on the test sample with a distance of at least 10 mm from the edge.

The electrode is energized at 10 VDC. If the indicated resistance is less than $10^6 \Omega$ the value is recorded after $15 \text{ s} \pm 2 \text{ s}$.

If the indicated resistance is higher or equal to $10^6 \Omega$ the electrode assemblies are deenergized and again energized but now at 100 VDC. The resistance value is recorded after $15 \text{ s} \pm 2 \text{ s}$.

The measurement is performed at six different positions on each test sample.

5.4.2 Point-to-point resistance

Two conductive electrodes (2.5 kg; \varnothing 63.5 mm) are placed on the test object with the centre of each test point 250 mm from each other and at least 50 mm from the edge.

The electrode is energized at 10 VDC. If the indicated resistance is less than $10^6 \Omega$ the value is recorded after $15 \text{ s} \pm 2 \text{ s}$.

If the indicated resistance is higher or equal to $10^6 \Omega$ the electrode assemblies are deenergized and again energized but now at 100 VDC. The resistance value is recorded after $15 \text{ s} \pm 2 \text{ s}$.

The measurement is performed at six different positions on each test sample.

5.4.3 Resistance to groundable point

The stainless steel plate is placed on the insulating support plate and the chart is placed so that one wheel contacts the steel plate and the others contact the insulating support plate. The steel plate forms one electrode for the measurement.

One conductive electrode (2.5 kg; \varnothing 63.5 mm) is placed on the test object at least 50 mm from the edge of the test object.

The electrode is energized at 10 VDC. If the indicated resistance is less than $10^6 \Omega$ the value is recorded after $15 \text{ s} \pm 2 \text{ s}$.

If the indicated resistance is higher or equal to $10^6 \Omega$ the electrode assemblies are deenergized and again energized but now at 100 VDC. The resistance value is recorded after $15 \text{ s} \pm 2 \text{ s}$.

The measurement is repeated at different test points. Between each individual measurement the chart is moved so that different contact points on the same wheel are used. Six measurements shall be performed on each test item.

Keeping the conductive electrode (2,5 kg; \varnothing 63.5) in one position, all the other wheels (or feet), one at a time, are measured as described above.

5.5 Results

For each type of measurement the average value of all measured values is stated, as well as all individual values.

5.6 Uncertainty

In the calculation only the uncertainty of the instrument is presented. The uncertainty of the method depends on the test sample, which can be inhomogeneous.

5.6.1 Picoamperemeter Keithley type 487, inv. No. 501419 or 502589.

	Voltage	Current	Total instrument uncertainty (at k=2): $\pm 2 \times \sqrt{\sum(\frac{fel\%}{\sqrt{3}})^2}$
4 k Ω at 10 V	± 0.14 %	± 0.108 %	± 0.31 %
100 k Ω at 10 V	± 0.14 %	± 0.3 %	± 0.45 %
40 k Ω at 100 V	± 0.19 %	± 0.108 %	± 0.34 %
1T Ω at 100 V	± 0.19 %	± 0.8 %	± 0.98 %

5.6.2 Multimeter Fluke type 187, inv. No. 503380 or 503381

	Voltage	Current	Total instrument uncertainty (at k=2): $\pm 2 \times \sqrt{\sum(\frac{fel\%}{\sqrt{3}})^2}$
25 Ω at 10 V	± 0.06 %	± 0.16 %	± 0.31 %
4 k Ω at 10 V	± 0.06 %	± 0.258 %	± 0.38 %
250 Ω at 100 V	± 0.12 %	± 0.16 %	± 0.33 %
40 k Ω at 100 V	± 0.12 %	± 0.258 %	± 0.40 %

5.6.3 Monroe 244 (SP inv. No. 501 781)

Voltage	Instrument uncertainty
Electrostatic potential	± 3 V in the range 0-100 V ± 3 % in the range 100-3500 V

5.7 Report

Test report according to IEC 61340-2-3, section 11.

5.8 ESD approval

ESD-approval certificate shall as an additional information state:

The ESD-approval does not include any requirements regarding electrical safety properties. If work will be performed close to live voltages, requirements according to national regulations shall be fulfilled.

6 Requirements

To be "ESD-approved" the test items shall fulfil all of the following requirements:

- Either surface resistance or point-to-point resistance requirements must be fulfilled. All measured resistance values must be in the range $10^4 \Omega$ to $10^{10} \Omega$.
- Resistance to groundable point must be less than $10^9 \Omega$.
- compliance of requirement in IEC 61340-5-1 regarding electrostatic field of maximum 10000 V/m measured as a potential of maximum 100 V according to SP-Method 2472, section 7.3.
- Compliance of requirement in SP-Method 2472, section 6.3.
- Surfaces considered as work and storage surfaces must not be designed in such a way that the requirements are achieved by use of cover paint (which may be damaged by scratches etc.). That means that the base material exposed when the paint is damaged, must not be insulating or conductive to such an extent that the requirements are not fulfilled.