



2<sup>nd</sup> Nordic ESD Conference  
on September 5-6, 2006, Karlskoga, Sweden

Session: 1b:4 on September 5<sup>th</sup> 15:30

**Title:**

**Correlation between walking test and resistance values for the verification of the System-functionality Person / Footwear / Flooring for personnel grounding regarding IEC 61340-4-5:2004 and IEC 61340-5-1 Ed.2.0 (IEC-101/218/CDV).**

Abstract:

This report shows that in some cases the charging of a person, measured with the walking test equipment regarding ESD Standard EN 61340-4-5:2004, is not in direct correlation with the surface resistance or resistance to ground values. The new ESD Standard IEC 61340-5-1 Ed.2.0 (Project IEC-101/218/CDV) describes for personnel grounding the system Person / Footwear / Flooring (resistance measured from person to footwear to floor to ground). The limit of this system should be at a maximum of  $3,5 \times 10^7 \Omega$ . Nevertheless, this walking test study shows that the person is charged to more than 100 Volts during the test although the person is connected to a grounded wrist strap. This means that the movement of a person can charge the person although the wrist strap is worn. Although the decay time of the charge is very short, it may be critical in cases of low humidity or very dry skin of the person. This study could be important for all EPA's (Electrostatic Discharge Protected Areas).

Referent:

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Brief:

09/2002 – now:	KEINATH Electronic, Gomaringen, Germany
Since 2005:	Member of the German National Standard Committee
2000 – 2002:	Robert Bosch Pty.Ltd, Clayton, Australia Process Engineer, Semiconductor Facility, Final Testing
1995 – 2000:	Robert Bosch GmbH, Reutlingen, Germany Process Engineer, Semiconductor Facility
1990 – 1995:	Technical Highschool (Fachhochschule), Reutlingen, Germany Electronics / Semiconductor Technology

System Person / Footwear / Flooring for personnel grounding normative issue

ESD Flooring has to be guarantee the diversion electrostatic charge of personnel, seats, racks, carriers, trolleys and all other equipment inside an EPA.

If the system Person / Footwear / Flooring for personnel grounding regarding IEC 61340-4-5:2004 and IEC 61340-5-1 Ed.2.0 (IEC-101/218/CDV) is the only provision to avoid personnel charging to more than 100V the resistance values of the system has to be:

1)  $R_S < 3,5 \times 10^7 \text{ Ohm}$  (35M $\Omega$  ;  $35 \times 10^6 \text{ Ohm}$ )

or

2)  $R_S < 1,0 \times 10^9 \text{ Ohm}$  (1G $\Omega$ )  
and personnel charge < 100Volts

$R_S$ : Resistance value of the System Person / Footwear / Flooring to ground (PE).

Measuring  $R_S$  regarding EN 61340-4-5:

61340-4-5/CD © IEC - 9 - 101/149/CD

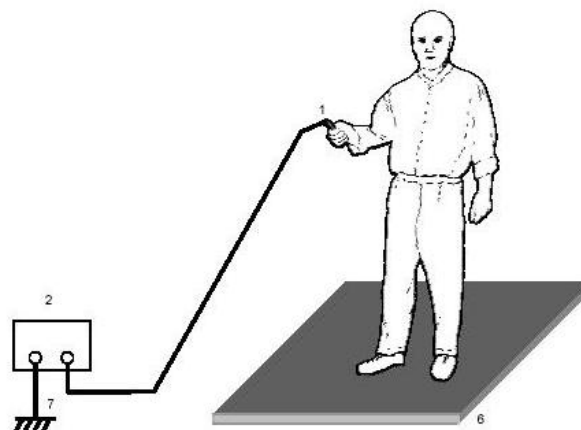


Figure 1b. Test set-up for measuring electrical resistance of footwear and installed flooring in combination with a person

Key to figure 1:

- 1 - Hand-held electrode (6.3.1.2)
- 2 - Resistance measuring apparatus (6.3.1.1)
- 3 - Groundable point (6.1)
- 4 - Floor covering under test
- 5 - Support material (6.1)
- 6 - Installed flooring
- 7 - Building ground

During a customer ESD Audit in January 2005 there was following situation:

On the working place pre-assembly the system Person / Footwear / Flooring for personnel grounding was the only provision for personnel grounding

The resistance values to ground ( $R_G$ ) for the flooring were between  $3,5 \times 10^5$  Ohm and  $8,0 \times 10^5$  Ohm.

Climate:

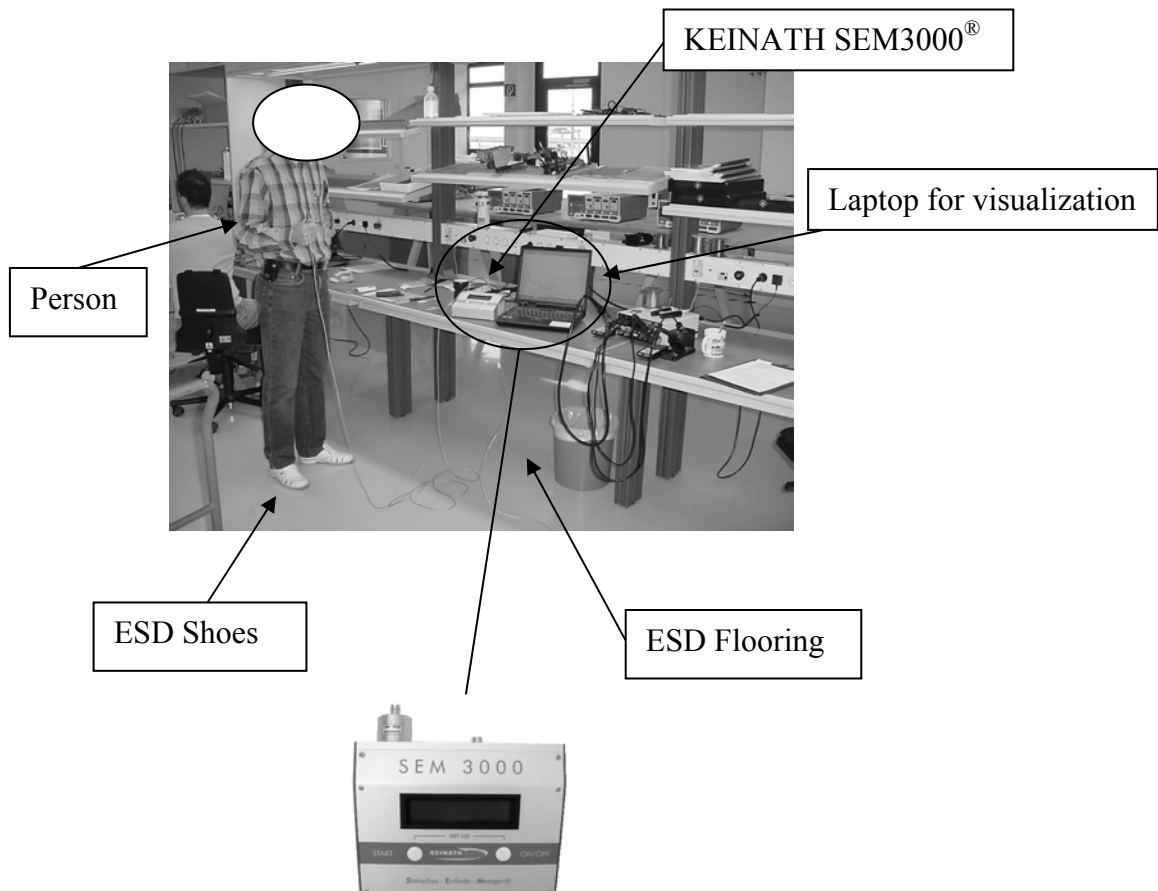
Humidity approx. 25% rh; Temperature approx. 22°C

To check if the system functionality for the system Person / Footwear / Flooring is given the resistance values of the whole system were measured.

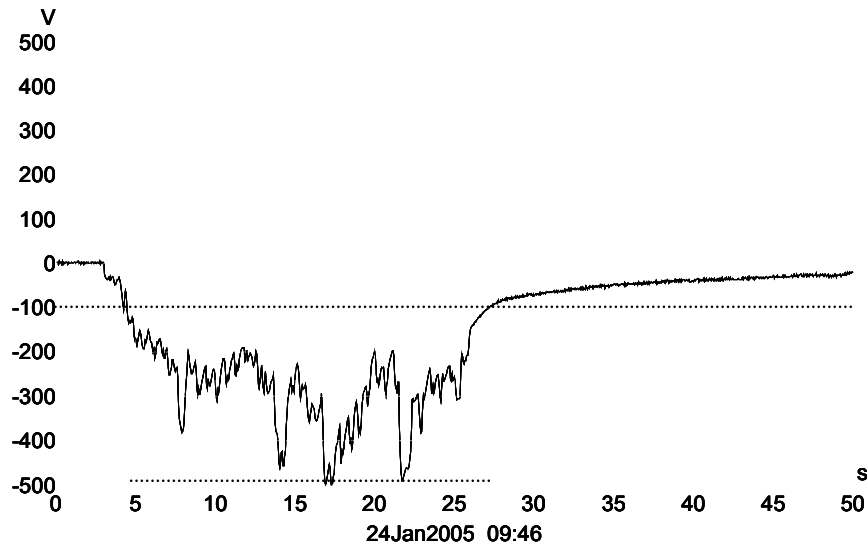
The values of the system drifted between  $7,5 \times 10^9$  up to  $7,5 \times 10^{10}$  Ohm.

The limit for the resistance values for the system is  $R_S < 1,0 \times 10^9$  Ohm.

The walking test study done afterwards confirmed the malfunction of the system.

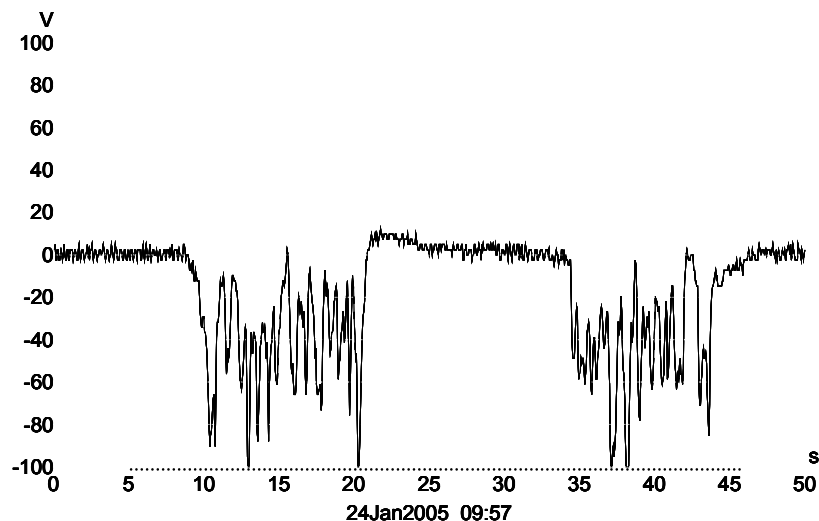


Personnel charge of up to 500 Volts on the working place pre assembly:



The result has shown that the charge of a person up to 500 volts is to high. The recommendation in this situation was, to wear wrist straps. The next graphic shows that although the **wrist strap is worn and grounded** the personnel charge is to high. The limit regarding IEC 61349-5-1 is about 100 Volt. Normally a person is not chargeable during the wrist strap is worn and grounded.

Personnel charge of nearly more than 100 Volts with the worn and grounded wrist strap:



Although the resistance values of the floor to ground were with  $10^5$  Ohm in a very low range the walking test showed the personnel charge of 500 Volts is to high. The reason may cause that through cleaners and polishers a small isolating layer on the surface of the ESD Flooring isolate the derivability of the person to ground. The very unnormal effect is that although the wrist strap is worn the charge of the person is nearly 100Volts.

Corrective action:

Main cleaning of the ESD floor with a special ESD cleaner (KEINATH KBR 151)

Cleaning on Saturday, March, 26<sup>th</sup> 2005

Qualification of the floor on Wednesday, March 30<sup>th</sup> 2005

Climate:

Humidity approx. 35% rh; Temperature approx. 21°C

Measurement of the resistance values on the floor of the working place pre-assembly:

Nr.:	Measuring point	Surface Resistance R <sub>O</sub>	Resistance to ground R <sub>G</sub>	Walkingtest
1	Difference between Electrodes: 1m	3,0 x 10 <sup>9</sup> Ohm	2,0 x 10 <sup>5</sup> Ohm to 2,0 x 10 <sup>10</sup> Ohm	< 100V
2	Difference between Electrodes: 5m	3,0 x 10 <sup>10</sup> Ohm	2,0 x 10 <sup>5</sup> Ohm to 2,0 x 10 <sup>10</sup> Ohm	< 100V
3	Difference between Electrodes: 10m	3,0 x 10 <sup>10</sup> Ohm	2,0 x 10 <sup>5</sup> Ohm to 2,0 x 10 <sup>10</sup> Ohm	< 100V
	Resistance of the system Person / Footwear / Flooring		<b>System to ground R<sub>S</sub></b>	
4	Schneck (Abeba)		~ 10 <sup>7</sup> Ohm	< 100V
5	XXXXXX (Comodos)		~ 10 <sup>8</sup> Ohm	< 100V
6	XXXXXX (Abeba)		~ 10 <sup>8</sup> Ohm	< 100V

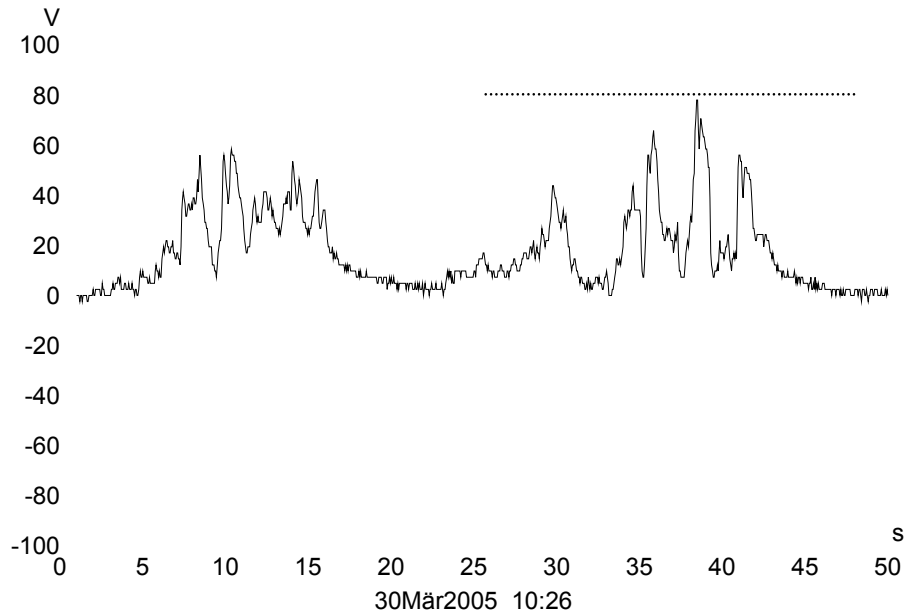
The resistance values of the flooring after the cleaning process were always very inhomogeneous, the values drifted from 2,0 x 10<sup>5</sup> Ohm up to 2,0 x 10<sup>10</sup> Ohm.

The resistance values of the flooring were in some cases over the limit of 1,0 x 10<sup>9</sup> Ohm.

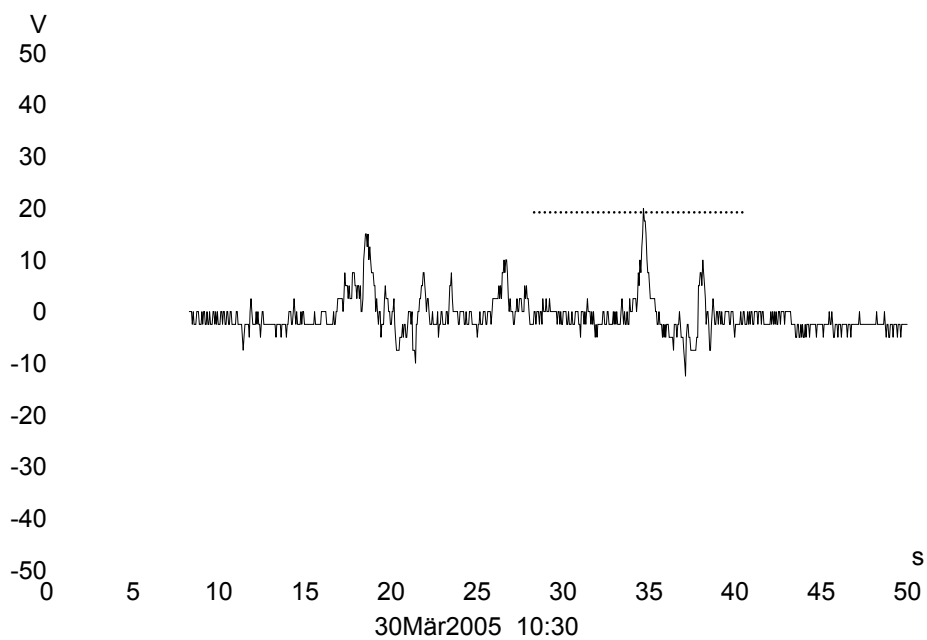
The walking test regarding EN 61340-4-5 showed that nevertheless the functionality of the system was given.

Walking test regarding EN 61340-4-5 after cleaning:

Personnel charge was less than 100 Volts. ESD shoes type COMODOS:

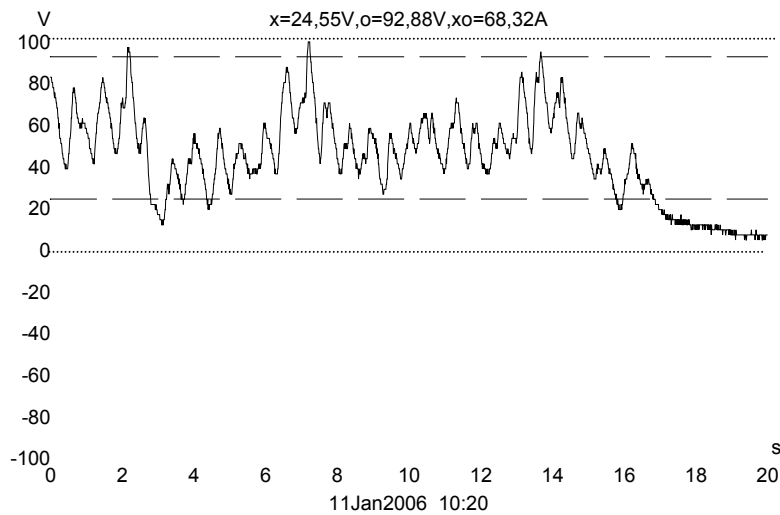


Personnel charge was less than 100 Volts. ESD shoes type ABEBA:



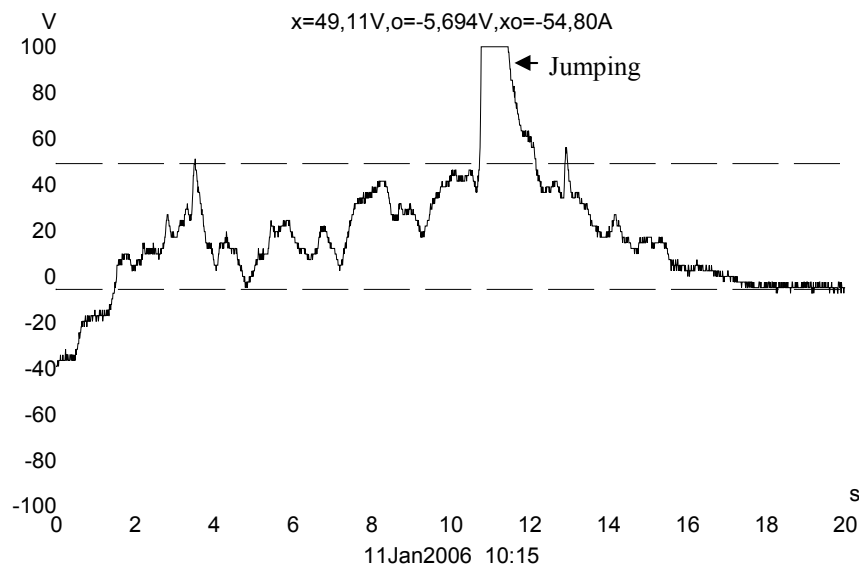
A very critical situation was given also during an ESD Audit in January 2006 in a electronic facility in the Black Forest in Germany with an **humidity of lower than 10%**.

Walking test done on a ESD flooring with  $R_S < 3,5 \times 10^7$  Ohm (Kautschuk), **without ESD Garment:**



The personnel charge was nearly at the limit of 100 Volts although the resistance values of the system Person / Footwear / Flooring were lower than  $3,5 \times 10^7$  Ohm.

Walking test done on the same ESD flooring **with ESD Garment:**



The personnel charge with a worn ESD garment was lower than 50 Volts.

**Result / Recommendation:**

Because the correlation between walking test and resistance values for the verification of the System-functionality Person / Footwear / Flooring for personnel grounding regarding IEC 61340-4-5:2004 and IEC 61340-5-1 Ed.2.0 (IEC-101/218/CDV) is not given.

We recommend to do a walking test study in each case of verification of ESD flooring systems if the system Person / Footwear / Flooring is the main provision for personnel grounding.

Especially in seasons with low humidity (German Winter) the functionality of the system Person / Footwear / Flooring is not given in direct correlation with ohmic resistance values. In situations of very low humidity the necessity of ESD garments to avoid personnel charge is also given.

**Test Equipment:**

Resistance Measurement:

TERA Ohmmeter KEINATH TOM TF 600 with electrodes regarding EN 61340-4-1.  
Measurement Voltage: 10V /100V

Charge of personnel:

KEINATH SEM3000® / Walking test regarding EN 61340-4-5

$R_i > 10^{16} \Omega$ ; Voltage Range  $\pm 2000V$

Limits regarding IEC 61340-5-1 Ed.2.0 (IEC-101/218/CDV).

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