

Investigating the Human Sensory Threshold for Electrostatic Discharge Using Current Waveform Measurements

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Abstract:

Human perception thresholds are often used to highlight vulnerabilities of electrostatic discharge (ESD) sensitive devices. However, research on human sensory thresholds for ESD is limited, and voltage thresholds are frequently overstated within the electronics industry. Emerging evidence suggests that individuals may detect ESD at lower voltages than those cited in non-peer-reviewed sources.

It is well established that standard test methods, such as IEC 61000-4-2 and MIL-STD-883, do not accurately reflect real-world human metal discharge or human body discharge scenarios. Each discharge event can be considered unique. To address this issue, we recorded and analyzed over 130 discharge current waveforms, measured with a 1 Ω current target, from 11 healthcare participants to better understand the characteristics of real human ESD events.

Discharge impedances and peak currents varied greatly, and individual discharges were often composed of multiple discharge events. The average resistance, derived from integrated energy, was significantly higher than that assumed in human body model testing, even at voltages up to 8 kV.

The perception and sensing of ESD depend not only on source parameters such as voltage and capacitance but also on the characteristics of the resulting current waveform. To investigate this, each instance of ESD perception was linked to the corresponding current waveform.

Most volunteers perceived discharges at ± 2000 V, with integrated energy below 200 μ J. At this level, many also reported hearing the discharges. Two out of 11 participants found ± 4000 V uncomfortable at energies below 1 mJ, and five reported discomfort at 8000 V with energy below 4 mJ. One participant experienced pain at ± 6000 V with energy below 2 mJ.

The statistical uncertainty of repeated ESD events was examined, and examples of variations in full discharge waveforms are presented. The test methodology is outlined in detail to support potential future research.

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