

ESD SP5.6-2019

ESD Association Standard Practice

ESD SP5.6-2019

Revision and redesignation of ANSI/ESD SP5.6-2009



*For Electrostatic Discharge
Sensitivity Testing –*

*Human Metal Model (HMM) -
Component Level*

*Electrostatic Discharge Association
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***ESD Association Standard Practice for
Electrostatic Discharge Sensitivity Testing –
Human Metal Model (HMM)
Component Level***

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EOS/ESD Association, Inc.



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FOREWORD

This standard practice¹ defines methods for generating and applying stress pulses as part of the evaluation of electrical component sensitivity to electrostatic discharge. The name Human Metal Model (HMM) is derived from the anticipated ESD stress that could be generated from a person holding a metal tool. The current pulse delivered to the component in this test is intentionally the same pulse as defined in the IEC 61000-4-2 testing method. Customers of IC manufacturers have begun requesting that ICs be evaluated for their ability to withstand the IEC 61000-4-2 stress pulses. However, because this IEC specification only describes testing a complete system, that specification cannot be directly applied to devices such as ICs and discrete components. This document provides IC manufacturers and IC customers with testing methods applicable to devices that utilize the current waveform of IEC 61000-4-2. The technique described in this document is termed "Human Metal Model" testing to differentiate it from the system level IEC 61000-4-2 and from Human Body Model testing of integrated circuits, ANSI/ESDA/JEDEC JS-001. Many companies have developed their own testing techniques using IEC 61000-4-2 pulses from hand-held gun generators for device and circuit design evaluation. This technique or practice is being utilized on products in packaged configurations. Development of the HMM Standard Practice is in response to the need of the industry for consistent testing methods.

ESD testing of devices and components with HBM and CDM (Charged Device Model ANSI/ESD/JDEC JS-002) has become standard for qualification of parts. Device level ESD testing with HBM and CDM is only intended to be applicable to electrostatic events occurring up to final assembly of the system or consumer product.. Complete systems are tested using system level ESD test methods, usually IEC 61000-4-2, to verify that they can withstand typical electrostatic stresses in the field. Recently, some system manufacturers have begun requiring system level testing to be done on devices before designing them into the final product. This is being done under the assumption that system level test results from devices or components should be directly applicable to the results of these same components in the final system. While it may be prudent to require some level of testing on devices, modules, or components that are connected to external ports, merely using a system level test for these devices can yield ambiguous results which are likely to be a poor predictor of reliability within a system. Without a full description of the test setup during stress the amount of stress current delivered to the component under stress testing can vary dramatically between different laboratories performing the test. Another source of ambiguity comes from the effect of the electromagnetic (EM) field radiated from an ESD gun designed for system level testing. In a system, individual devices and components are afforded at least a certain amount of shielding by the enclosure of the system. This is not present in the stand-alone device or component. Thus the EM field generated during a contact discharge ESD gun event, on a system enclosure or the external connectors of a system enclosure, can interact with the traces, connections and circuits much more directly and may cause side effects to correct system operation, such as system memory loss, system spurious reset, system supply and ground disturbs and system display disturb. Clearly, a method of testing is required that can deliver the types of stresses the component will experience in the final product in a manner that is systematic and controlled. This standard practice seeks to do this by providing the user with instructions for test methods that should allow repeatable IEC stress to devices. To eliminate excess gun radiation from IEC device testing, the same waveform can be generated by a pulse generator with a 50-ohm output. . The stress can then be delivered through a 50-ohm coaxial cable to the test board holding the component or device under test. Test methods and specifications for this alternative method are included.

This standard practice addresses testing of components in both powered and un-powered conditions. Use of the standard practice is intended to result in devices, modules and components being tested in a more consistent fashion and in a better controlled environment than they would

¹ ESD Association Standard Practice (SP): A procedure for performing one or more operations or functions that may or may not yield a test result. Note, if a test result is obtained it is not reproducible.

be using an unmodified system level test procedure. This document defines a standard practice to be used in the semiconductor industry for HMM testing in both industrial and academic institutions. (This document is intended to be used by electrical technicians, electrical engineers, semiconductor process and device engineers, system engineers, ESD reliability and quality engineers, and circuit designers.) The document is to act as an educational guide, a learning document, and as a reference for the practices being used today. The values stated in the document are guidelines, not specifications. The values stated are the majority consensus of the contributors from both industry and academic environments.

This test method only addresses physical damage to the device being tested. System level ESD testing according to IEC 61000-4-2 addresses functional failures and system upset in addition to physical damage. For this reason this test method should only be used to provide a figure of merit for the onset of physical damage due to ESD events on a system input/output which is directly connected to the device pins tested. Stress levels are reported as the pre-charge voltage of an IEC 61000-4-2 pulse source or an equivalent IEC voltage for a HMM 50-ohm pulse source.

The context of this document is the application of HMM techniques for the electrical characterization of components. These components can be single devices, a plurality of devices, integrated circuits, or semiconductor chips. This methodology is relevant to both active and passive elements. This test method is applicable to diodes, MOSFET devices, bipolar transistors, resistors, capacitors, inductors, transient voltage suppressors (TVS) and related components. The IEC gun contact discharge mode test method is described in this standard practice because it provides more repeatable pulses than the air discharge mode.

This document was originally approved on September 16, 2009 and was designated ANSI/ESD SP5.6-2009. The application of the HMM test method has had mixed results. A Round Robin experiment, reported in 2012 [1], gave very poor results in terms of repeatability and reproducibility. Experiments designed to determine the source of the variability, reported in 2016 [2], failed to determine the source of the original poor results, because the new results were relatively consistent between different pulse sources and laboratories. Although the test results based on SP5.6-2009 have been disappointing the HMM Working Group has elected to amend, rather than revoke, the document as part of the periodic review process. The working group believes that it is better to have guidance in place for the application of system level ESD stress on components than to have no guidance at all. There are also several aspects of SP5.6-2009 that needed improvement. The updated document includes more advice on the use and handling of ESD guns, which may improve consistency. Additionally, in SP5.6-2009 the test setup for the 50-ohm HMM pulse source was for a pin to pin stress, rather than pin to ground which is the stress of most interest in the electronics industry. The HMM working group intends to continue to work on understanding and improving the repeatability and reproducibility of HMM test. The HMM working group believes that the methods and procedures outlined in this document are a best practice for the application of system level ESD stress to components, but there are issues which can lead to variable results between ESD guns from different manufacturers and HMM pulse sources. These issues include the wide variations in current waveforms from ESD guns and the difference in source impedance between ESD guns and 50-ohm HMM pulse sources.

References

- [1] Kathy Muhonen, et al, "HMM Round Robin Study: What to Expect When Testing Components to the IEC 61000-4-2 Waveform", Proceedings of EOS/ESD Symposium, 2012.
- [2] Mirko Scholz, et al, "HMM single site testing: Can we reproduce component failure level with the HMM document?", Proceedings of EOS/ESD Symposium, 2016.

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TABLE OF CONTENTS

1.0 PURPOSE.....1

2.0 SCOPE.....1

3.0 REFERENCED PUBLICATIONS 1

4.0 DEFINITIONS 1

5.0 PERSONNEL SAFETY.....2

6.0 EQUIPMENT 2

6.1 CURRENT MEASUREMENT SYSTEM.....2

6.2 ESD PULSE SOURCE 3

6.3 OHMMETER 3

6.4 VOLTMETER.....3

7.0 WAVEFORM AND PULSE GENERATION REQUIREMENTS.....3

8.0 TEST SETUP 4

8.1 TEST SETUP OVERVIEW 4

8.1 Test Setup A 4

8.2 Test Setup B 5

8.3 Test Setup C (Closed Coupling Method) 6

9.0 TESTING AND WAVEFORM VERIFICATON.....7

9.1 TEST PROCEDURE 7

9.2 WAVEFORM INTEGRITY MEASUREMENT PROCEDURE.....8

9.2.1 Procedure for ESD Gun with Discharge Point Directly Connected to the Circuit Board Ground.....8

9.2.2 Procedure for ESD Gun with Discharge Point Connected to Component Ground Pin 8

9.2.3 Procedure for Waveform Verification With Test Setup C.....9

9.3 TEST BOARD DESCRIPTION 9

9.3.1 Circuit Board 9

9.3.2 HMM 50-ohm Test Board 11

9.4 UNPOWERED BOARD.....11

9.5 POWERED BOARD AND TEST LEVELS 11

10.0 FAILURE CRITERIA AND DOCUMENTATION 12

ANNEXES

Annex A (Informative): HMM General Guidance	13
Annex B (Informative): Single Lab Testing Results	18
Annex C (Informative): Revision History for ESD WIP5.6-2018.....	20

TABLES

Table 1: General Waveform Parameters.....	3
Table 2: Human Metal Model Pulse Parameters.....	4

FIGURES

Figure 1: HMM Waveform Illustrating the Parameters Used to Define the Pulse	4
Figure 2: Schematic of HMM Test Setup (Powered Board)	5
Figure 3: Test Setup A Diagram	5
Figure 4: Test Setup B Diagram	5
Figure 5: Layout of IEC 50-ohm Coaxial Source Test Fixture Board	6
Figure 6: Example Layout of IEC 50-ohm Coaxial Source Test Fixture Board	6
Figure 7: Test Configuration for HMM 50-Ohm Coaxial Source for Stress between Two Pins on DUT	7
Figure 8: Layout of Circuit Board Showing Ground Connections.....	10
Figure 9: Physical Arrangement	14
Figure 10: Resulting Waveforms	15
Figure 11: Simultaneous Measurement of Current Measurement using IEC Probe and F-65A..	16
Figure 12: Comparison of Fischer F-65A Probe with IEC Current Probe	16
Figure 13: Comparison of the Obtained Failure Level During Pass-Fail Testing in Site 1 and 2 for (a) DUT1 and (b) DUT2	19
Figure 14: Overall Standard Deviation and the Standard Deviations for Each Type of Stress Source and DUT1 and DUT2	20