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Discontinuing Use of the Machine Model for Device ESD Qualification

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Foreword

The machine model test, as a requirement for component ESD qualification, is being rapidly discontinued across the industry. This publication is intended to document why MM evaluation is not necessary for qualification. The following major conclusions can be made about MM in general:

1. MM is redundant to HBM at the device level since it produces the same failure mechanisms, and the two models generally track each other in robustness and in failure modes produced.

2. The MM test has more variability and, consequently, less repeatability than HBM due to the MM's greater sensitivity to parasitic effects in the tester circuitry.

3. There are no significant engineering studies (with verified data) which could be used to establish a required passing level for MM.

4. The test method was incorrectly given the name "machine model", though no firm, unique connection between the model and actual machine-induced device failures was ever established. In fact the model was developed as a "low-voltage HBM".

5. CDM does a better job of screening for fast metal-to-metal contact events than MM.

6. The vast majority (> 99%) of electrical failures in manufacturing correlate to CDM or to EOS and not to MM.

7. MM testing has not shown any additional failures not explained by CDM, HBM or EOS.

8. MM testing consumes resources and creates time-to-market delays while providing no additional failure modes or protection strategies which have not been covered by HBM and CDM.

9. *It is important to understand the scope of this memorandum*. It summarizes what has been learned about the test method *only*. The information summarized here in no way diminishes the importance of proper grounding of any metal which may come in contact with ESD-sensitive devices or the importance of avoiding hard metal-to-metal discharges.

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1.0 SCOPE

Over the last several decades the so called "machine model" (aka MM) and its application to the required ESD component qualification has been grossly misunderstood. The scope of this JEDEC document is to present evidence to discontinue use of this particular model stress test without incurring any reduction in the IC component's ESD reliability for manufacturing. In this regard, the document's purpose is to provide the necessary technical arguments for strongly recommending no further use of this model for IC qualification. The published document should be used as a reference to propagate this message throughout the industry.

2.0 REFERENCES

[1] JEDEC JESD47 “Stress-Test-Driven Qualification of Integrated Circuits”, www.jedec.org

[2] JEDEC JESD22-A115 “Electrostatic Discharge (ESD) Sensitivity Testing Machine Model (MM)”, www.jedec.org

[3] ANSI/ESD STM5.2-2012 “Machine Model (MM) – Component Level “ www.esda.org

[4] M. Tanaka, JEITA/JEDEC Meetings, Tokyo, September 2011.

[5] M. Tanaka, K. Okada, and M. Sakimoto, “Clarification of Ultra-high-speed Electrostatic Discharge and Unification of Discharge Model,” EOS/ESD Symposium, pp, 170-181, 1994.

[6] Industry Council on ESD Target Levels, “White Paper 1: A Case for Lowering Component Level HBM/MM ESD Specifications and Requirements,” August 2007, at www.esda.org or JEDEC publication JEP155, “Recommended ESD Target Levels for HBM/MM Qualification”, www.jedec.org

[7] ANSI/ESD S20.20; 2007; Development of an Electrostatic Discharge Control Program for: Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices)

[8] ESDA standards document definitions and hierarchy are summarized at https://www.esda.org/standards/.

3.0 TERMS, DEFINITIONS, AND LETTER SYMBOLS

AEC	Automotive Electronics Council
ANSI	American National Standards Institute
CDM	charged-device model
EOS	electrical overstress
EPA	ESD protected area
ESD	electrostatic discharge
ESDA	Electrostatic Discharge Association; ESD Association
FAR	failure analysis report
HBM	human body model
IC	integrated circuit
JEDEC	Joint Electronic Devices Engineering Council
JEITA	Japan Electronics and Information Technology Industries Association
MM	machine model
OEM	original equipment manufacturer
STM	standard test method