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User Guide of ANSI/ESDA/JEDEC JS-001 Human Body Model Testing of Integrated Circuits

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(This foreword is not part of ESDA/JEDEC Joint Technical Report ESDA/JEDEC JTR001-01-12)

Foreword

The joint ESDA/JEDEC HBM Standard JS-001-2010 merged the JEDEC HBM Standard, JESD22-A114F, and the ESDA HBM Standard, ANSI/ESD STM5.1-2007, into a single document. This accomplishment was a significant advance for the industry, since it reduced the confusion and extra effort for maintaining two standards for the same test. However, JS-001-2010 did not address several important technical issues. To merge the two documents, a number of technical challenges involving the HBM test method, which have emerged over the last several years, were not addressed. The next version of the HBM Standard, JS-001-2011, began to the address these technical issues. This revision was the most significant update to the HBM test standard in many years and incorporated several new test strategies. This technical report is a user's guide intended to help those familiar with the traditional HBM test method, as documented in JS-001-2010, to use the new options available in JS-001-2011 and in the subsequent 2012 version. The specific changes in the 2012 version are not included in this initial version of the guide but will be included in the next revision.

There are three significant issues that have been addressed in JS-001-2011:

1. Excessive test time for high pin count devices.
2. Device wear-out due to stressing protection paths hundreds or thousands of times during test, when the path may only be stressed at most a handful of times, if at all, in a real life situation.
3. Automated HBM test systems required to test high pin count devices have introduced test system parasitics that potentially can cause unanticipated failure modes not intended by the standard HBM test method.

These issues have been addressed with the major changes listed as below ("old" refers to JS-001-2010 and "new" refers to the specific changes that were implemented in JS-001-2011).

Non-supply pin to non-supply pin testing has been changed to reduce test time.

Old: Each non-supply pin was stressed versus all other non-supply pins collectively tied together to terminal B, the ground. This test seldom created failures and has not been required in the Japanese HBM standard, EIAJ ED-4701/304-2, since 2001.

New: Non-supply pin to non-supply pin testing is limited to coupled non-supply pin pairs which present a possible weak non-supply pin to non-supply pin combination.

Non-supply pin testing to all power supplies (cross domains) has been eliminated to reduce cumulative stress and reduce test time.

Old: Each non-supply pin was tested to all power supply groups.

New: Each non-supply pin now belongs to or is associated with a supply group that provides current or voltage to the circuitry connected to that pin. Non-supply pins are directly HBM stressed only to those assigned supply groups.

Supply to supply testing can be done with a single polarity.

Old: For supply to supply testing each supply was tested versus all other supplies with both positive and negative stress. This produced essentially redundant testing in which positive stress of A versus B is very similar to negative stress of B versus A.

New: All supply to supply testing may be done with a single polarity, reducing the interaction of the test system parasitics with the device under test (DUT), if the correct polarity is chosen.

Two pin testing is now permitted

Old: All testing was defined in terms of a single pin being stressed to a group of other pins. This requirement could only be met with relay matrix based test systems, which

introduced parasitic capacitances. These capacitances, which appeared even on pins not being stressed, have been shown to introduce false failures on some products.

New: All pin combinations may be subdivided into two pin combinations in which a single pin is stressed versus a single current return pin. Two pin testers can be made with minimal parasitic tester capacitance which can reduce the unpredictable interactions between the device under test and the tester parasitics.

In addition to the changes discussed above there were several other important changes.

4. The section on reporting was modified to accommodate the changes in the pin combinations discussed above.
5. Discussion of current probe specifications and the preference of CT2 over CT1 current probe with regard to the measurement of the HBM decay time.
6. Change in wording for non-supply pins which are shorted together.
7. Changes to the wording on No Connect Pins.
8. Class 0 has been divided into 2 classes.

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1.0 PURPOSE AND SCOPE

1.1 Purpose

The information and procedures explained in this technical report are intended to help those familiar with traditional HBM testing use the new options that were introduced in JS-001-2011. JS-001-2011 has since been superseded by JS-001-2012 but all of the changes discussed in this guide were retained in the 2012 version.

1.2 Scope

This report describes the technical changes made in ANSI/ESDA/JEDEC JS-001-2011 and explains how to use those changes to apply HBM (Human Body Model) tests to IC components.

2.0 SIMPLIFICATION OF NON-SUPPLY TO NON-SUPPLY (I/O TO I/O) TESTING (JS-001-2011 SECTION 6.3.3.1)

In the JS-001-2010 HBM standard, non-supply pins to non-supply pins [I/O to I/O] testing was accomplished by applying HBM pulses (positive and negative) to each non-supply pin (Terminal A) with all other non-supply pins tied together to ground (Terminal B). Table 2 defined the required stress pin combinations and this specific pin combination was defined as Pin Combination Set N+1.

This one-to-many pin combination method was introduced in the early days of HBM testing as a convenience for what was then considered to be high pin count devices (> 40 pins). As the number of pins on an IC component has increased from a few tens of pins to hundreds and now thousands of pins, this specific pin combination test has not changed. In Japan, the non-supply to non-supply pin test was removed from JEITA HBM test method (EIAJ ESD-4701/304-2 in 2001).

This one-to-many pin combination method has multiple issues:

1. This pin combination only represents a small fraction of the possible non-supply to non-supply pin combinations.
2. This procedure does not represent a real ESD pin combination situation, as simultaneous grounding of all non-supply pins is not realistic.
3. The procedure does not address the potentially real non-supply to non-supply two-pin stress combinations.
4. Almost all non-supply to non-supply pin combination failures can generally be repeated in the non-supply pin to supply pin combination test.

As a result, the new HBM Standard JS-001-2011 has given the user the option of doing the following:

A. Apply the non-supply to non-supply pin test to a set of pins called coupled non-supply pin pairs as defined in Section 3.0 and JS-001-2011 Table 2A. This test is a set of specific pin-to-pin tests.

   Or

B. Continue to test the non-supply to non-supply pin defined in JS-001-2011 Table 2B, which is the same as JS-001-2010 Table 2. This test stresses each non-supply pin to the combined set of all other non-supply pins.

This change allows the user to set-up their HBM test programs so that one pin of the coupled non-supply pin pair is stressed on Terminal A and the other pin is grounded on Terminal B (Table 2A). Testing these coupled non-supply pin pair combinations is considered to be more vulnerable since they fail more frequently during the traditional non-supply to non-supply pin combinations.