ESD Control – Revised Document May 2013

SUBJECT:

Tutorial Slides on ESD Control - Understanding ESD Control Programs for ICs with various HBM and CDM Sensitivities

BACKGROUND:

The purpose of this material is to educate the semiconductor industry about the nature of the ESD control processes (Basic versus Detailed) that are used at production and assembly of IC components. There is confusion in the industry about the specific ESD control process and how they apply to the IC component sensitivity to HBM and CDM. An understanding of all these issues is important for component ESD qualification.

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The methods may or may not differ. Typically what is really addressed is the control process, how often are items checked, how materials are evaluated. With a good process, no matter if it is ESD or any other process, the checks and balances will be designed to add or subtract items and controls as required

Background

- **Basic ESD Control is mandatory across the semiconductor industry for handling IC components**
- **Detailed ESD Control is gradually becoming important for the industry**
- **There has been some confusion about the extent of these programs as the new ESD levels are established for IC qualification**
- The difference which will be discussed later is really the understanding of how effective these controls are, regardless of the standard used.

Purpose

- **The purpose is to clarify the issues of "Basic" versus "Detailed" ESD control**
- **Describe the HBM and CDM levels at which these specific programs apply**

Basic ESD Control Program

- Avoid personnel charging and discharging into the device by **grounding personnel**
- Avoid discharges between different items by handling them only when they are at the same potential, e.g. by using **ESD safe work surfaces**
- Use **ESD safe packaging materials** when removing devices from the ESD safe workplace
- *Electronics manufacturers use at least this level across the globe, while most do more than this basic level.*

The point here is that when using existing ESD control a process engineer does not need to understand how these items work in order to achieve these levels of control.

Basic ESD Control Program

- If the precautions described in the bullets below are followed, the charge on personnel and work surfaces will be less than 100V.
- This means it is clearly safe to handle devices with an HBM robustness ≥ 500V
  - ✓ Personnel Grounding through wrist straps or properly selected footwear/flooring system
  - ✓ Grounded work surfaces
  - ✓ ESD-safe Packaging Materials
- *If these are not fulfilled, the control program has no meaning and even 2kV HBM devices may be in jeopardy.*

The point here is that using existing ESD control, a process engineer does not need to understand how these items work in order to achieve these levels of control.

CDM Control

- CDM control requires additional steps of control of charging of devices by
  - ✓ Controlling insulators
  - ✓ Controlling charging of boards/devices during processing
  - ✓ Avoiding hard (metal-to-metal) discharges
- Many basic ESD control elements like dissipative work surfaces reduce the CDM risk
- Programs following above requirements have CDM control intrinsically implemented (process analysis may be required)

While these are good things to say, most process engineers do not understand how they are controlling the charging of boards or avoiding metal to metal discharges. Some engineers use dissipative work surfaces to reduce CDM risk but forget to address other incidences of metal-metal contact which cannot be easily solved using these materials. An example is placing a device onto a circuit board there is a metal to metal contact between the connection and solder pads.

ESD Controls Summary

- 1. General ESD Control includes:
  - **Basic ESD Control**
    - ✓ Grounded Personal
    - ✓ Static Safe Workstation
    - ✓ Packing (Safe Packaging Materials)
  - **CDM Control**
    - ✓ Controlling insulators
    - ✓ Controlling charged boards/devices
    - ✓ Avoiding hard discharges
- 2. Detailed ESD Control includes:
  - Better understanding of the above processes

Detailed ESD Control Program

- For IC devices with <<500V HBM or <250V CDM, more detailed control programs are necessary
- Detailed ESD control programs may have
  - ✓ **redundant elements to give higher safety in case one element fails**
  - ✓ **compliance verification programs based on materials used**
  - ✓ **data to prove the program works**

The real point (data to prove the program works) is the most important. Many times it is realized that after a careful evaluation, an existing program is fine the way it is to handle more sensitive items. So one does not want to say that more or more frequent things are required unless they are based on some facts or data analysis

General ESD Control includes CDM Specific

General ESD Control

Basic ESD Control:

- **Grounding**
- **Table Mats**
- **Safe Packaging Materials**

Basic CDM Control:

- **Control of Insulators**

Data indicates that with these controls in place devices are safe to: ≥500V HBM and ≥250V CDM

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For Sensitive HBM / CDM

Detailed ESD Control

For Sensitive HBM:

- **Must follow S20.20**
- **IEC 61340-5-1**
- **Or JESD625B**

For Sensitive CDM:

- **Must follow all items of above standards**
- **Must include detailed and extended verification**

No matter which standard is selected, with a better understanding of the ESD control process, the elements in these standards still apply.

HBM Table*

HBM Level of IC	Impact on Manufacturing Environment
2 KV	Basic ESD Control methods allow safe manufacturing with proven margin
1 kV	
500 V	
100 V to <500 V	Detailed ESD Control methods are required

Basic Programs: Include wrist straps, grounded work surfaces, and safe packaging materials, and are safe with proven margin to 500V.

Detailed Programs: ANSI/ESD S20.20 or IEC-61340-5-1 are comprehensive program standards patterned on ISO9000 and can be basis for facility certification. JESD625 is widely used in the IC industry. Implementation of these standards provides protection of devices with at least HBM >= 100 volts and probably lower.

* **Published as part of JEP155** Industry Council 2013

CDM Table *

CDM classification level (tested acc. to JEDEC)	ESD control requirements
$V_{CDM} \geq 250V$	• **Basic ESD control methods** with grounding of metallic machine parts and control of insulators
$125V \leq V_{CDM} < 250V$	• **Basic ESD control methods** with grounding of metallic machine parts and control of insulators + • **Process specific measures** to reduce the charging of the device **OR** to avoid a hard discharge (high resistive material in contact with the device leads).
$V_{CDM} < 125V$	• **Basic ESD control methods** with grounding of metallic machine parts and control of insulators + • **Process specific measures** to reduce the charging of the device **AND** to avoid a hard discharge (high resistive material in contact with the device leads) + • **Charging/discharging measurements at each process step.**

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Summary (1)

- **Basic ESD Control**
  - Any electronic manufacturer has to follow at least basic controls
  - The basic program can be
    - Following one of the known standards
    - A customized in-house program following the basic control requirements
  - With either of the above basic programs, 1kV HBM devices are safe and should require no additional precautions
  - Variations in the basic programs for different production areas is of no concern in the change from 2kV to 1kV HBM
  - Vast amounts of industry data for the last 10 years supports the conclusion that even 500V HBM devices are safe if the basic program is followed

Summary (2)

- **General ESD Control**
  - Includes both Basic ESD and CDM controls
  - General CDM steps are basic in nature and are always important regardless of the devices' HBM performance
  - With the General ESD Control in place, ≥ 500V HBM and ≥ 250V CDM are safe

Summary (3)

- **Detailed ESD Control**
  - Comply with S20.20 or IEC 61340-5-1, and CDM elements of JESD625
  - Requires regular compliance verification
  - With the advent of advanced technology IC devices, majority of the industry is progressing towards these detailed steps
  - Effective implementation of these programs are intended to provide protection for devices with ≥ 100V HBM and ≥ 100V CDM