ESD Standards: An Annual Progress Report

by The ESD Association

Industry standards play a major role in providing meaningful metrics and common procedures that allow various manufacturers, customers, and suppliers to communicate from facility to facility around the world. Standards are increasingly important in our global economy. In manufacturing, uniform quality requirements and testing procedures are necessary to make sure that all involved parties are speaking the same language. In ESD device protection, standard methods have been developed for component ESD test models to measure a component's sensitivity to electrostatic discharge from various sources. In ESD control programs, standard test methods for product qualification and periodic evaluation of wrist straps, garments, ionizers, worksurfaces, grounding, flooring, shoes, static dissipative planar materials, shielding bags, packaging, electrical soldering/desoldering hand tools, and flooring/footwear systems have been developed to ensure uniformity around the world.

The ESD Association (ESDA) is dedicated to advancing the theory and practice of Electrostatic Discharge (ESD) protection and avoidance. The ESD Association is an American National Standards Institute (ANSI) accredited standards developer. The ESD Association's consensus body is called the Standards Committee (STDCOM) which has responsibility for the overall development of documents. Volunteers from the industry participate in working groups to develop new and to update current ESDA documents.

STDCOM is charged with keeping pace with the industry demands for increased performance. The existing Standards, Standard Test Methods, Standard Practices, and Technical Reports assist in the design and monitoring of the Electrostatic Protected Area (EPA), and also assist in the testing of ESD sensitive electronic components. Many of the existing documents relate to controlling electrostatic charge on personnel and stationary work areas. However, with the ever increasing emphasis on automated handling, the need to evaluate and monitor what is occurring inside of process equipment is growing daily. Since automation has become more dominant, the Charged Device Model (CDM) has become the primary cause of ESD failures and thus the more urgent concern. Together the Human Body Model (HBM) and Charge Device Model cover the vast majority of ESD events that might occur in a typical factory.

The ESD Association document categories are:

- **Standard (S):** A precise statement of a set of requirements to be satisfied by a material, product, system or process that also specifies the procedures for determining whether each of the requirements is satisfied.
- **Standard Test Method (STM):** A definitive procedure for the identification, measurement and evaluation of one or more qualities, characteristics or properties of a material, product, system or process that yield a reproducible test result.
- **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 may not be reproducible.
- **Technical Report (TR):** A collection of technical data or test results published as an informational reference on a specific material, product, system or process.

The ESDA Technology Road Map is compiled by industry experts in IC protection design and test to provide a look into future ESD design and manufacturing challenges. The roadmap previously pointed out that numerous mainstream electronic parts and components would reach assembly factories with a lower level of ESD protection than could have been expected just a few years earlier. This prediction has

proven to be rather accurate. As with any roadmap, the view the future is constantly changing and requires updating on the basis of technology trend updates, market forces; supply chain evolution and field return data. Work has commenced on the next version. Industry experts will be extending the horizon beyond the 2013 predictions in the updated roadmap. The roadmap will also contain, for the first time, a roadmap for the evolution of ESD testing. This will include forward looking views of possible changes in the standard device level tests (HBM and CDM), as well as the expected progress in other important areas such as transmission line pulsing (TLP), transient latch-up (TLU), cable discharge events (CDE) and charged board events (CBE). A view of work on electrical overstress (EOS) will also be included. The revision is scheduled for publication in January 2012.

The ESD Association Standards Committee is continuing several joint document development activities with the JEDEC Solid State Technology Association. Under the Memorandum of Understanding agreement, the ESD Association and JEDEC formed a Joint Task Force for the standardization work in which volunteers from the ESD Association and JEDEC member companies can participate. This collaboration between the ESDA and JEDEC has paved the way for the development of harmonized test methods for ESD, which will ultimately reduce uncertainty about test standards among manufacturers and suppliers in the solid state industry. At the time of this publication, ANSI/ESDA/JEDEC JS-001-2011, a second revision of the joint HBM document, has been released for distribution. This document replaces ANSI/ESDA/JEDEC JS-001-2010, the current industry test methods and specifications for Human Body Model device testing. A second joint committee is currently working on a joint Charged Device Model (CDM) document with a goal of publishing in 2012. These efforts will assist manufacturers of devices by providing one test method and specification instead of multiple, almost - but not quite -identical, versions of device testing methods.

The ESD Association is also working on a process assessment document. The purpose of this document is to describe a set of methodologies, techniques, and tools that can be used to characterize a process where ESD sensitive items are handled. The goal is to characterize the ability of a process to safely handle ESD sensitive devices that have been characterized by the relevant device testing models. The document will apply to activities that manufacture, process, assemble, install, package, label, service, test, inspect, transport or otherwise handle electrical or electronic parts, assemblies and equipment susceptible to damage by electrostatic discharges. At the present time, this document will not apply to electrically-initiated explosive devices, flammable liquids, or powders.

The standard covering the requirements for creating and managing an ESD control program is ANSI/ESD S20.20 “ESD Association Standard for the Development of an Electrostatic Discharge Control Program for – Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices)”. ANSI/ESD S20.20 is a commercial update of and replacement for MIL-STD-1686 and has been adopted by the United States Department of Defense. In addition, the 2007-2008 update of IEC 61340-5-1 Edition 1.0 “Electrostatics - Part 5-1: Protection of Electronic Devices from Electrostatic Phenomena General Requirements” is technically equivalent to ANSI/ESD S20.20. A five-year review of ANSI/ESD S20.20 began in February 2011 and technical changes are being made to the document based on industry changes and user requests. There are unique constraints with the revision that must be taken into account including facility certification and continued harmonization with other standards – IEC 61340-5-1 and newly revised JEDEC 625B. A target date of February 2012 has been given for the release of a draft document.

In order to meet the global need in the electronics industry for technically sound ESD Control Programs, the ESD Association has established an independent third party certification program. The program is administered by the ESD Association through country-accredited ISO9000 Certification Bodies that have met the requirements of this program. The Facility Certification Program evaluates a facility's ESD program to ensure that the basic requirements from industry standards ANSI/ESD S20.20 or IEC 61340-5-1 are being followed. More than 384 facilities have been certified worldwide since inception of the program. The factory Certification Bodies report strong interest in Certification to S20.20, and consultants in this area report that inquiries for assistance remain at a very high level. Individual education also seems of interest once again as 46 professionals have obtained Certified ESD Program Manager status and many more are attempting to qualify as Certified ESD Control Program Managers. A large percentage of the certification program requirements are based on Standards and the other related documents produced by the ESD Association Standards Committee.

Current ESD Association Standards Committee Documents

Charged Device Model (CDM)

ANSI/ESD S5.3.1-2009 Electrostatic Discharge Sensitivity Testing - Charged Device Model (CDM) - Component Level

Establishes the procedure for testing, evaluating, and classifying the ESD sensitivity of components to the defined CDM.

Cleanrooms

ESD TR55.0-01-04 Electrostatic Guidelines and Considerations for Cleanrooms and Clean Manufacturing

This document identifies considerations and provides guidelines for the selection and implementation of materials and processes for electrostatic control in cleanroom and clean manufacturing environments.

Compliance Verification

ESD TR53-01-06 Compliance Verification of ESD Protective Equipment and Materials

This technical report describes the test methods and instrumentation that can be used to periodically verify the performance of ESD protective equipment and materials.

ESD Control Program

ANSI/ESD S20.20-2007 Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices)

This standard provides administrative and technical requirements for establishing, implementing, and maintaining an ESD Control Program to protect electrical or electronic parts, assemblies, and equipment susceptible to ESD damage from Human Body Model (HBM) discharges greater than or equal to 100 volts.

ESD TR 20.20-2008—ESD Handbook (Companion to ANSI/ESD S20.20)

Produced specifically to support ANSI/ESD S20.20 ESD Control Program standard, this 132-page document is a major rewrite of the previous handbook. It focuses on providing guidance that can be used for developing, implementing, and monitoring an ESD control program in accordance with the S20.20 standard.

Flooring

ANSI/ESD S7.1-2005 Resistive Characterization of Materials – Floor Materials

Covers measurement of the electrical resistance of various floor materials, such as floor coverings, mats, and floor finishes. It provides test methods for qualifying floor materials before installation or application, and for evaluating and monitoring materials after installation or application.

Flooring and Footwear Systems

ANSI/ESD STM97.1-2006 Floor Materials and Footwear – Resistance Measurement in Combination with a Person

Provides test methods for measuring the electrical system resistance of floor materials in combination with person wearing static control footwear.

ANSI/ESD STM97.2-2006 Floor Materials and Footwear – Voltage Measurement in Combination with a Person

This standard test method provides for measuring the electrostatic voltage on a person in combination with floor materials and footwear, as a system.

Footwear

ANSI/ESD STM9.1-2006 Footwear – Resistive Characterization

This standard test method defines a test method for measuring the electrical resistance of shoes used for ESD control in the electronics environment (not to include heel straps and toe grounders).

ESD SP9.2-2003 Footwear – Foot Grounders Resistive Characterization

This standard practice was developed to provide test methods for evaluating foot grounders and foot grounder systems used to electrically bond or ground personnel as part of an ESD Control Program. Static Control Shoes are tested using ANSI/ESD STM9.1.

Garments

ANSI/ESD STM2.1-1997 Garments - Resistive Characterization

Provides test methods for measuring the electrical resistance of garments. It covers procedures for measuring sleeve-to-sleeve resistance and point-to-point resistance.

ESD TR2.0-01-00 Consideration for Developing ESD Garment Specifications

This technical report addresses concerns about effective ESD garments by starting with an understanding of electrostatic measurements and how they relate to ESD protection.

ESD TR2.0-02-00 Static Electricity Hazards of Triboelectrically Charged Garments

This technical report is intended to provide some insight to the electrostatic hazards present when a garment is worn in a flammable or explosive environment.

Glossary

ESD ADV1.0-2009 Glossary of Terms

Definitions and explanations of various terms used in Association Standards and documents are covered in this advisory. It also includes other terms commonly used in the electronics industry.

Gloves and Finger Cots

ANSI/ESD SP15.1-2011 In-Use Resistance Testing of Gloves and Finger Cots

This standard practice provides test procedures for measuring the intrinsic electrical resistance of gloves and finger cots.

ESD TR15.0-01-99 ESD Glove and Finger Cots

This technical report reviews the existing known industry test methods for the qualification of ESD protective gloves and finger cots.

Grounding

ANSI/ESD S6.1-2009 Grounding

Specifies the parameters, materials, equipment, and test procedures necessary to choose, establish, vary, and maintain an Electrostatic Discharge Control grounding system for use within an ESD Protected Area for protection of ESD susceptible items, and specifies the criteria for establishing ESD Bonding.

Handlers

ANSI/ESD SP10.1-2007 Automated Handling Equipment (AHE)

This standard practice provides procedures for evaluating the electrostatic environment associated with automated handling equipment.

ESD TR10.0-01-02 Measurement and ESD Control Issues for Automated Equipment Handling of ESD Sensitive Devices below 100 Volts

This document provides guidance and considerations that an equipment manufacturer should use when designing automated handling equipment for these low voltage sensitive devices.

Hand Tools

ESD STM13.1-2000 Electrical Soldering/Desoldering Hand Tools

This standard test method provides electric soldering/desoldering hand tool test methods for measuring the electrical leakage and tip to ground reference point resistance, and provides parameters for EOS safe soldering operation.

ESD TR13.0-01-99 EOS Safe Soldering Iron Requirements

This technical report discusses soldering iron requirements that must be based on the sensitivity of the most susceptible devices that are to be soldered.

Human Body Model (HBM)

ESDA/JEDEC JDS-001-2011 ESDA/JEDEC Joint Draft Standard for Electrostatic Discharge Sensitivity Testing – Human Body Model (HBM) – Component Level

Establishes the procedure for testing, evaluating, and classifying the electrostatic discharge sensitivity of components to the defined human body model (HBM).

Human Body Model (HBM) and Machine Model (MM)

ANSI/ESD SP5.1.1-2006 Human Body Model (HBM) and Machine Model (MM) Alternative Test Method: Supply Pin Ganging – Component Level

This standard practice defines an alternative test method to perform Human Body Model or Machine Model component level ESD tests when the component or device pin count exceeds the number of ESD simulator tester channels.

ANSI/ESD SP5.1.2-2006 Human Body Model (HBM) and Machine Model (MM) Alternative Test Method: Split Signal Pin - Component Level

This standard practice defines an alternative test method to perform Human Body Model or Machine Model component level ESD tests when the component or device pin count exceeds the number of ESD simulator tester channels.

Human Metal Model (HMM)

ANSI/ESD SP5.6-2009 Electrostatic Discharge Sensitivity Testing - Human Metal Model (HMM) - Component Level

Establishes the procedure for testing, evaluating, and classifying the ESD sensitivity of components to the defined HMM.

ESD TR5.6-01-09 Human Metal Model (HMM)

This technical report addresses the need for a standard method of applying the IEC contact discharge waveform to devices and components.

Ionization

ANSI/ESD STM3.1-2006 Ionization

Test methods and procedures for evaluating and selecting air ionization equipment and systems are covered in this standard test method. The document establishes measurement techniques to determine ion balance and charge neutralization time for ionizers.

ANSI/ESD SP3.3-2006 Periodic Verification of Air Ionizers

This standard practice provides test methods and procedures for periodic verification of the performance of air ionization equipment and systems (ionizers).

ESD TR3.0-01-02 Alternate Techniques for Measuring Ionizer Offset Voltage and Discharge Time

This technical report investigates measurement techniques to determine ion balance and charge neutralization time for ionizers.

ESD TR3.0-02-05 Selection and Acceptance of Air Ionizers

This document reviews and provides a guideline for creating a performance specification for the four ionizer types contained in ANSI/ESD STM3.1: room (systems), laminar flow hood, worksurface (e.g. blowers), and compressed gas (nozzles & guns).

Machine Model (MM)

ANSI/ESD S5.2-2009 Electrostatic Discharge Sensitivity Testing - Machine Model (MM) - Component Level

Establishes the procedure for testing, evaluating, and classifying the ESD sensitivity of components to the defined MM.

ESD TR5.2-01-01 Machine Model (MM) Electrostatic Discharge (ESD) Investigation - Reduction in Pulse Number and Delay Time

This report provides the procedures, results, and conclusions of evaluating a proposed change from 3 pulses (present requirement) to 1 pulse while using a delay time of both 1 second (present requirement) and 0.5 second.

Ohmmeters

ESD TR50.0-02-99 High Resistance Ohmmeters--Voltage Measurements

This technical report discusses a number of parameters that can cause different readings from high resistance meters when improper instrumentation and techniques are used and the techniques and precautions to be used in order to ensure the measurement will be as accurate and repeatable as possible for high resistance measurement of materials.

Packaging

ANSI/ESD STM11.11-2006 Surface Resistance Measurement of Static Dissipative Planar Materials

This standard test method defines a direct current test method for measuring electrical resistance, replacing ASTM D257-78. This test method is designed specifically for static dissipative planar materials used in packaging of ESD sensitive devices and components.

ANSI/ESD STM11.12-2007 Volume Resistance Measurement of Static Dissipative Planar Materials

This standard test method provides test methods for measuring the volume resistance of static dissipative planar materials used in the packaging of ESD sensitive devices and components.

ANSI/ESD STM11.13-2004 Two-Point Resistance Measurement

This standard test method measures the resistance between two points on a material's surface without consideration of the material's means of achieving conductivity. This test method was established for measuring resistance where the concentric ring electrodes of ANSI/ESD STM11.11 cannot be used.

ANSI/ESD STM11.31-2006 Bags

This standard test method provides a method for testing and determining the shielding capabilities of electrostatic shielding bags.

ANSI/ESD S541-2008 Packaging Materials for ESD Sensitive Items

This standard describes the packaging material properties needed to protect electrostatic discharge (ESD) sensitive electronic items, and references the testing methods for evaluating packaging and packaging materials for those properties. Where possible, performance limits are provided. Guidance for selecting the types of packaging with protective properties appropriate for specific applications is provided. Other considerations for protective packaging are also provided.

ESD ADV11.2-1995 Triboelectric Charge Accumulation Testing

Provides guidance in understanding the triboelectric phenomenon and relates current information and experience regarding tribocharge testing as used in static control for electronics.

Seating

ANSI/ESD STM12.1-2006 Seating – Resistive Measurement

This standard test method provides test methods for measuring the electrical resistance of seating used for the control of electrostatic charge or discharge. It contains test methods for the qualification of seating prior to installation or application, as well as, test methods for evaluating and monitoring seating after installation or application.

Socketed Device Model (SDM)

ANSI/ESD SP5.3.2-2008 Electrostatic Discharge Sensitivity Testing – Socketed Device (SDM) – Component Level

This standard practice provides a test method for generating a Socketed Device Model (SDM) test on a component integrated circuit (IC) device.

ESD TR5.3.2-01-00 Socket Device Model (SDM) Tester

This technical report helps the user understand how existing SDM testers function, offers help with the interpretation of ESD data generated by SDM test systems, and defines the important properties of an "ideal" socketed-CDM test system.

Static Electricity

ESD TR50.0-01-99 Can Static Electricity Be Measured?

This report gives an overview of fundamental electrostatic concepts, electrostatic effects, and most importantly of electrostatic metrology, especially what can and what cannot be measured.

Susceptible Device Concepts

ESD TR50.0-03-03 Voltage and Energy Susceptible Device Concepts, Including Latency Considerations

This technical report contains information to promote an understanding of the differences between energy and voltage susceptible types of devices and their sensitivity levels.

Symbols

ANSI/ESD S8.1-2007 Symbols – ESD Awareness

Three types of ESD awareness symbols are established by this document. The first one is to be used on a device or assembly to indicate that it is susceptible to electrostatic charge. The second is to be used on items and materials intended to provide electrostatic protection. The third symbol indicates the common point ground.

System Level ESD

ANSI/ESD SP14.1-2004 System Level Electrostatic Discharge (ESD) Simulator Verification

This standard practice was developed to provide guidance to designers, manufacturers, and calibration facilities for verification and specification of the systems and fixtures used to measure simulator discharge currents.

ESD TR14.0-01-00 Calculation of Uncertainty Associated with Measurement of Electrostatic Discharge (ESD) Current

This technical report provides guidance on measuring uncertainty based on an uncertainty budget.

Transient Latch-up

ANSI/ESD SP5.4-2008 Latch-up Sensitivity Testing of CMOS/Bi CMOS Integrated Circuits – Transient Latch-up Testing – Component Level Supply Transient Stimulation

This standard practice was developed to instruct the reader on the methods and materials needed to perform Transient Latch-Up Testing.

ESD TR5.4-01-00 Transient Induced Latch-Up (TLU)

This report provides a brief background on early latch-up work, reviews the issues surrounding the power supply response requirements, and discusses the efforts on RLC TLU testing, transmission line pulse (TLP) stressing, and the new bi-polar stress TLU methodology.

ESD TR5.4-02-08 Determination of CMOS Latch-up Susceptibility - Transient Latch-up - Technical Report No. 2

This technical report is intended to provide background information pertaining to the development of the transient latch-up standard practice originally published in 2004 and additional data presented to the group since publication.

Transmission Line Pulse

ANSI/ESD STM5.5.1-2008 Electrostatic Discharge Sensitivity Testing – Transmission Line Pulse (TLP) – Component Level

This document pertains to Transmission Line Pulse (TLP) testing techniques of semiconductor components. The purpose of this document is to establish a methodology for both testing and reporting information associated with TLP testing.

ANSI/ESD SP5.5.2-2007, Electrostatic Discharge Sensitivity Testing - Very Fast Transmission Line Pulse (VF-TLP) - Component Level

This document pertains to Very Fast Transmission Line Pulse (VF-TLP) testing techniques of semiconductor components. It establishes guidelines and standard practices presently used by development, research, and reliability engineers in both universities and industry for VF-TLP testing. This document explains a methodology for both testing and reporting information associated with VF-TLP testing.

ESD TR5.5-01-08 Transmission Line Pulse (TLP)

This technical report is a compilation of the information gathered during the writing of ANSI/ESD SP5.5.1 and the information gathered in support of moving the standard practice toward re-designation as a standard test method.

ESD TR5.5-02-08 Transmission Line Pulse Round Robin

This report is intended to provide data on the repeatability and reproducibility limits of the methods of ANSI/ESD STM5.5.1.

Workstations

ESD ADV53.1-1995 ESD Protective Workstations

This Advisory document defines the minimum requirements for a basic ESD protective workstation used in ESD sensitive areas. It provides a test method for evaluating and monitoring workstations. It defines workstations as having the following components: support structure, static dissipative worksurface, a means of grounding personnel, and any attached shelving or drawers.

Worksurfaces

ANSI/ESD S4.1-2006 Worksurface - Resistance Measurements

Provides test methods for evaluating and selecting worksurface materials, testing of new worksurface installations, and the testing of previously installed worksurfaces.

ANSI/ESD STM4.2-2006 ESD Protective Worksurfaces - Charge Dissipation Characteristics

Aids in determining the ability of ESD protective worksurfaces to dissipate charge from a conductive test object placed on them.

ESD TR4.0-01-02 Survey of Worksurfaces and Grounding Mechanisms

This document provides guidance for understanding the attributes of worksurface materials and their grounding mechanisms.

Wrist Straps

ANSI/ESD S1.1-2006 Wrist Straps

A successor to EOS/ESD S1.0, this document establishes test methods for evaluating the electrical and mechanical characteristics of wrist straps. It includes improved test methods and performance limits for evaluation, acceptance, and functional testing of wrist straps.

ESD TR1.0-01-01 Survey of Constant (Continuous) Monitors for Wrist Straps

This technical report provides guidance to ensure that wrist straps are functional and are connected to people and ground.

About the ESD Association

Founded in 1982, the ESD Association is a professional voluntary association dedicated to advancing the theory and practice of electrostatic discharge (ESD) avoidance. From fewer than 100 members, the Association has grown to more than 2,000 throughout the world. From an initial emphasis on the effects of ESD on electronic components, the Association has broadened its horizons to include areas such as textiles, plastics, web processing, cleanrooms, and graphic arts. To meet the needs of a continually changing environment, the Association is chartered to expand ESD awareness through standards development, educational programs, local chapters, publications, tutorials, certification, and symposia.