

American National Standard Guide for Electrostatic Discharge Test Methodologies and Acceptance Criteria for Electronic Equipment

C63[®]

Accredited Standards Committee C63[®]—Electromagnetic Compatibility

Accredited by the
American National Standards Institute

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American National Standard Guide for Electrostatic Discharge Test Methodologies and Acceptance Criteria for Electronic Equipment

Accredited Standards Committee C63®—Electromagnetic Compatibility

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American National Standards Institute

Secretariat

Institute of Electrical and Electronics Engineers, Inc

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Abstract: Expanded explanations, best practices, and guidance for avoiding the pitfalls associated with electrostatic discharge (ESD) testing to IEC and other international ESD standards are provided and should be considered a supplement to these standards, rather than a replacement. Unique ESD test procedures related to connecting charged peripherals to equipment in use are also included.

Keywords: air discharge, ANSI C63.16, contact discharge, coupling plane, direct discharge, electrostatic discharge (ESD), ESD event, ESD immunity, ESD simulator, ESD test criteria, indirect discharge

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Introduction

This introduction is not part of ANSI C63.16-2016, American National Standard Guide for Electrostatic Discharge Test Methodologies and Acceptance Criteria for Electronic Equipment.

This guide is intended to provide supplemental information for performing electrostatic discharge (ESD) testing to other established ESD standards by including information and test procedures that are not covered in those documents.^a It strives to improve product quality through proper operation in actual equipment installations. The suggestions provided herein should not be construed as mandatory and they should not be applied arbitrarily to all types of electronic equipment. Performance or acceptance test levels are not given in this guide. The specification of performance or acceptance levels for any particular type of electronic equipment remains the responsibility of the manufacturer and the users of the particular equipment.

The original 1993 version of this guide described air discharge and direct metallic contact discharge testing methodologies using two ESD simulation models, the human body with metal object model (hand/metal) and the furniture discharge model. Indirect contact testing to coupling planes was also described. Test descriptions for floor-standing and tabletop electronic equipment were given. The use of statistical criteria to determine the number of test trials based on the confidence factor desired and various pass/fail categories was described.

This latest version of ANSI C63.16 includes the following changes:

- a) Addition of unique new material on testing of charged peripherals being connected to a system and system components being placed in a docking station.
- b) Replacement of reference to specific ESD models with more generic descriptions of ESD simulators representing various ESD discharge models and provision of better guidance on the use of these simulators.
- c) Addition of information on the use of preliminary investigatory testing to identify test points, methods for visually documenting the location of those test points, and the use of a stepped approach in ratcheting up the test voltage to determine failure thresholds.
- d) Elimination of the information on ESD waveforms and waveform verification procedures in deference to IEC 61000-4-2 and other ESD standards as appropriate.
- e) Deletion of recommendations for furniture discharge testing and the use of statistical criteria for determining the number of test trials based on the desired confidence factor.

Because of the complexity of ESD, the variations in types of electronic equipment, and the many different actual use environments, it is a necessity for the reader to review and understand this guide in its entirety prior to commencing equipment testing.

^a Information on references can be found in Clause 2.

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1. Overview

1.1 Scope

This guide provides electrostatic discharge (ESD) test considerations that a manufacturer should use in assessing the expected ESD effects on products in a wide range of environments and customer use. The focus is well beyond that used to simply show that a product complies with a local, regional, or international standard or regulation. The following are included: charged peripheral testing, connector pin testing, and details on the use of ESD simulators. Finally, suggestions for assuring the safety of those who apply the ESD discharge are provided. The annexes include information on test method selection and more background on air and contact discharge for those who want to further understand the differences in these methods.

This guide is not applicable to manufacturing, service, or maintenance of equipment. Personnel who perform these activities should be trained to avoid ESD effects or damage to the equipment.

In summary, this guide has test techniques beyond those that are commonly used (e.g., IEC 61000-4-2), and hence it can be a significant tool for increasing the immunity of products to ESD events.¹

¹ Information on references can be found in Clause 2.

1.2 Purpose

This guide is intended for use by product manufacturers' internal or third-party electromagnetic compatibility (EMC) test laboratories that perform ESD immunity tests on products. It is intended to supplement and complement test methods commonly used for demonstrating compliance with ESD requirements such as IEC 61000-4-2. For completeness, the test methods and parameters described herein reference that ESD standard. The complementary test methods provided herein extend the application of ESD testing and can serve as a resource in the development of ESD test plans. This extension of testing requires more time than that needed to perform tests to international ESD standards such as IEC 61000-4-2. The payoff is that this additional ESD investigation is expected to significantly reduce the number of customer complaints by revealing responses that are not found with the usual ESD testing prescribed in existing international standards. This guide also recommends test criteria for applying ESD events and for evaluating equipment exposure and responses to ESD. The actual test levels and acceptable performance depend on criteria set by the equipment manufacturer, which might be based on customer ESD performance experience with the product and the risk of failure in a wide variety of product use environments in which ESD events have different probabilities of occurrence.

2. References

The following references are intended to assist the user of this guide and are listed here because they have direct application to this guide. The information in each of these standards as applied in this guide is to be considered informative. For all C63 documents referenced in this guide, the latest version applies. For non-C63 documents with no date specified herein, the latest version applies. Regional documents should be checked for any variations from the international standards referenced herein.

ANSI C63.14-2014, American National Standard Dictionary of Electromagnetic Compatibility (EMC) including Electromagnetic Environmental Effects (E3).²

IEC 61000-4-2, Electromagnetic compatibility (EMC)—Part 4-2: Testing and measurement techniques—Electrostatic discharge immunity test.³

3. Definitions, acronyms, and abbreviations

3.1 Definitions

For the purposes of this guide, the following terms and definitions apply. ANSI C63.14 and the *IEEE Standards Dictionary Online* should be consulted for terms not defined in this clause.⁴

actual ESD events: Non-simulated electrostatic discharges (ESDs) that occur in the intended environment of the electronic equipment.

air discharge method: A method of ESD testing in which the charged electrode of the ESD simulator approaches the equipment under test (EUT) or coupling plane regardless of the conductivity of the ESD receptor. The discharge is actuated by the dielectric breakdown of the air to the EUT or the coupling plane.

² ANSI publications are available from the American National Standards Institute (<http://www.ansi.org/>).

³ IEC publications are available from the International Electrotechnical Commission (<http://www.iec.ch/>). IEC publications are also available in the United States from the American National Standards Institute (<http://www.ansi.org/>).

⁴ The *IEEE Standards Dictionary Online* is available at: <http://ieeexplore.ieee.org/xpls/dictionary.jsp>.

antistatic material: A material exhibiting properties that minimize charge generation when rubbed against or separated from the same or other similar material.

arrangement: The physical layout of all the parts of the EUT, local associated equipment (AE), and any associated cabling within the measurement or test area.

associated equipment (AE): The equipment needed to exercise and/or monitor the operation of the EUT.

bleed strap: a conductor containing a 470 k Ω series resistor near each end and used to bleed the charge off the EUT or coupling planes between successive ESD test events.

calibration: The set of operations that establish, under specified conditions, the relationship between values indicated by a measuring instrument or measuring system, or values represented by a material measure, and the corresponding known values of a measurand (ISO/IEC 17025:2005).

configuration: The operational conditions of the EUT and AE, consisting of the set of hardware elements selected to comprise the EUT and AE, mode of operation used to exercise the EUT and arrangement of the EUT and AE.

contact discharge method: A method of ESD testing in which the electrode of the ESD simulator is in firm contact with a conductive surface of the EUT or coupling plane prior to discharge. The discharge is actuated by a switching device (i.e., a relay) within the simulator.

controlled ESD environment: An environment in which an attempt is made to maintain charge levels on humans and objects below a certain level. Typical control measures include humidity controls, equipment earth grounding, use of antistatic materials, ionized air, and high-resistance discharge paths for humans.

coupling plane: A metal plate to which discharges are applied to simulate electrostatic discharge to objects adjacent (vertically or horizontally) to the EUT.

degradation of performance: An undesired departure in the operational performance of any device, equipment, or system from its intended performance. (IEC 60050-161:1990 [ed. 1.0]) (See also IEC 60050-161-01)

NOTE—The term *degradation* can apply to temporary or permanent malfunction.⁵

direct application: A test in which ESD is applied to the surface or structure of the EUT.

NOTE—Applies to both air and contact discharges.

electromagnetic compatibility (EMC): The ability of an equipment or system to function satisfactorily in its electromagnetic environment without introducing intolerable electromagnetic disturbances to anything in that environment.

electrostatic discharge (ESD): A transfer of electric charge between bodies of different electric potential in proximity or through direct contact. (IEC 60050-161:1990 [ed. 1.0])

energy storage capacitor: A capacitor in the ESD simulator representing the capacity of a human body and that charges to the test voltage value.

NOTE—This element may be provided as a discrete component or a distributed capacitance.

equipment under test (EUT): A device or system being evaluated for compliance that is representative of a product to be marketed.

⁵ Notes in text, tables, and figures of a standard are given for information only and do not contain requirements needed to implement this standard.

ESD event: The occurrence of a single ESD.

ESD receptor: The surface (or target) of the object at rest being subjected to the ESD event.

ESD response: The EUT reaction to ESD.

ESD simulator: A testing device used to simulate an ESD event.

ESD test voltage: The amplitude (usually expressed in kV) of the initial electrostatic voltage that exists prior to discharge.

exerciser: A device used to operate the EUT.

failure: The inability of a product to meet its operating specification.

hand/metal ESD: An ESD from an intruding human hand that occurs from an intervening metal object such as a ring, tool, key, etc. *Syn.:* **hand/metal discharge**.

holding time: The interval of time within which the decrease of the test voltage due to leakage, prior to the discharge, is not greater than 10% when measured with an instrument that has a dc resistance greater than 1016 Ω and a capacitance less than 10 pF.

human/touch ESD: The ESD that occurs directly from a human fingertip, without the presence of any metallic structure in the ESD path.

immunity (to a disturbance): The ability of a device, equipment, or system to perform without degradation in the presence of an electromagnetic disturbance.

indirect application: A test in which ESD is applied to a coupling plane in the vicinity of the EUT to simulate personnel discharge to objects that are adjacent to the EUT.

intruder: A body that is in motion in an ESD event. The intruder is usually, but not necessarily, charged relative to its surroundings. It is always at a potential different from that of the receptor.

peripheral: Equipment that can be used with the EUT, whether necessary AE or optional devices.

NOTE—Examples of optional peripheral devices include battery packs, external memory, and other equipment not essential to exercise or monitor the operation of the EUT.

reference ground plane (RGP): A flat, conductive surface whose potential is used as a common reference.

rise time: The interval of time between the instants at which the instantaneous value of a pulse first reaches the specified lower and upper limits.

NOTE—Unless otherwise specified, the lower and upper values are fixed at 10% and 90% of the pulse magnitude.

simulated ESD: An ESD that originates from an ESD simulator.

simulator approach speed: The rate at which an air discharge ESD simulator approaches the EUT or coupling plane.

table ESD test: An indirect application in which ESD is applied to the horizontal coupling plane (HCP).

uncontrolled ESD environment: An environment in which no attempt is made to maintain charge levels on humans and objects below a certain level.