The Engineering Society For Advancing Mobility Land Sea Air and Space®
INTERNATIONAL
400 Commonwealth Drive, Warrendale, PA 15096-0001

SURFACE VEHICLE RECOMMENDED PRACTICE

SAE J1113/13

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Submitted for recognition as an American National Standard

ELECTROMAGNETIC COMPATIBILITY MEASUREMENT PROCEDURE FOR VEHICLE COMPONENTS—PART 13—IMMUNITY TO ELECTROSTATIC DISCHARGE

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SAE J1113/13 Issued FEB95

1. ***Scope***—This SAE Recommended Practice specifies the test methods and procedures necessary to evaluate electrical components intended for automotive use to the threat of Electrostatic Discharges (ESDs). It describes test procedures for evaluating electrical components on the bench.

   Functional status classifications for immunity to ESD are given in Appendix A.

   A procedure for calibrating the simulator that is used for electrostatic discharges is given in Appendix B.

1.1 Measurement Philosophy—The familiar static charge generated and discharged when moving about inside a vehicle or exiting from a vehicle has assumed greater significance with the increase of vehicular electronic components. Tests simulating the electrostatic discharge of humans, in common use by various industries, were examined and it was determined that they were not applicable to the automotive environment. As a consequence, tests tailored to the automotive environment were developed.

Tests that simulate an electrostatic discharge (ESD) into a vehicular electrical system are based on the human ESD model. The ESD model consists essentially of a capacitor formed by a person to his surroundings and discharged through a path that includes the person's resistance as well as vehicle loads. Sensitive electrical devices can be adversely affected by energy either injected or radiated from electrostatic discharges.

ESD generates collapsing radiated EM fields as a result of the rapid high-voltage charge transfer. These EM fields are an inherent part of the discharge event and are not simulated separately.

Components can also be damaged by ESD during handling and they should therefore be evaluated for ESD sensitivity in a non-powered mode. A test procedure to evaluate the ESD sensitivity classification of components in a non-powered mode is under preparation.

2. ***References***—General information regrding this document including definitions, references and general test and safety considerations is found in SAE J1113/1.

2.1 Applicable Documents—The following publications form a part of this specification to the extent specified herein. The latest issue of SAE publications shall apply.

2.1.1 SAE PUBLICATION—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE J1113/1

2.1.2 IEC PUBLICATION—Available from International Electrotechnical Commission, 3, rue de Veramba, P.O. Box 131, 1211 Geneva 20, Switzerland.

IEC 801-2 (1987 issue)

3. Test Equipment—This section describes test equipment that is applicable to all parts of this document, including Appendix B.

3.1 An ESD simulator that simulates the Human Body ESD model (see Figure 1) having the following characteristics shall be used:

a. Voltage Range—Variable from -15 to +15 kV
b. Capacitance—330 pF ± 10% pF
c. Resistance—2000 Ω ± 10% Ω
d. Risetime
   (1) Direct Contact—0.7 to 1.0 ns
   (2) Air Discharge—≤5 ns
e. Tip—IEC Standard 801-2 (Figure 2)

3.1.1 The ESD simulator shall be designed so that the discharge capacitance is fully charged to the desired voltage before the energy can be switched to the DUT.

3.1.2 The construction of the ESD simulator must be such that the high voltage ground and the chassis ground are electrically isolated from each other.

3.1.3 The ESD Simulator is commercially available.

3.2 Ground Plane—The ground plane shall be a conductive metallic sheet (i.e., copper, brass or galvanized steel)[1] as defined in J1113, Part 1. The ground plane shall be connected to the facility earth ground by a ground strap as short and as wide as possible, length less than 1 m and at least 50 mm wide. The inductance of the ground strap shall be ≤2 μH.

3.3 Isolation Blocks—Isolation blocks, if used, shall be constructed of clean, dry Delrin (tm) or an insulating material. The blocks are to be 25 mm in height and project beyond the DUT by at least 20 mm on all sides.

3.4 Coaxial Target—A 50 Ω coaxial target is defined by the International Electrotechnical Commission (IEC) Standard 801-2 (1987 issue) (see Figure 3). It is available commercially. The target is used during the ESD simulator verification of Appendix B.

3.5 20 dB Attenuator—A 50 Ω, 20 dB wideband attenuator (bandwidth 18 GHz) may be needed at the output of the coaxial target during the simulator verification of Appendix B.

3.6 Measurement Instrumentation—Quarterly certification of the risetime for the ESD simulator requires an analog measurement device with a minimum effective single shot bandwidth of 1 GHz or a digital measurement device with a minimum sampling rate of 2 Gigasamples per second and a single shot bandwidth of at least 500 MHz. Each instrument shall have 50 Ω input impedance.

3.7 Probe—The ESD simulator charging voltage shall be verified using an electrometer (impedance 100 Gigohm minimum).

3.8 Test equipment used to verify the functional and parametric requirements of the DUT shall not be sensitive to ESD.

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[1] Aluminum ground planes are not recommended because aluminum oxide buildup causes a nonconductive layer.

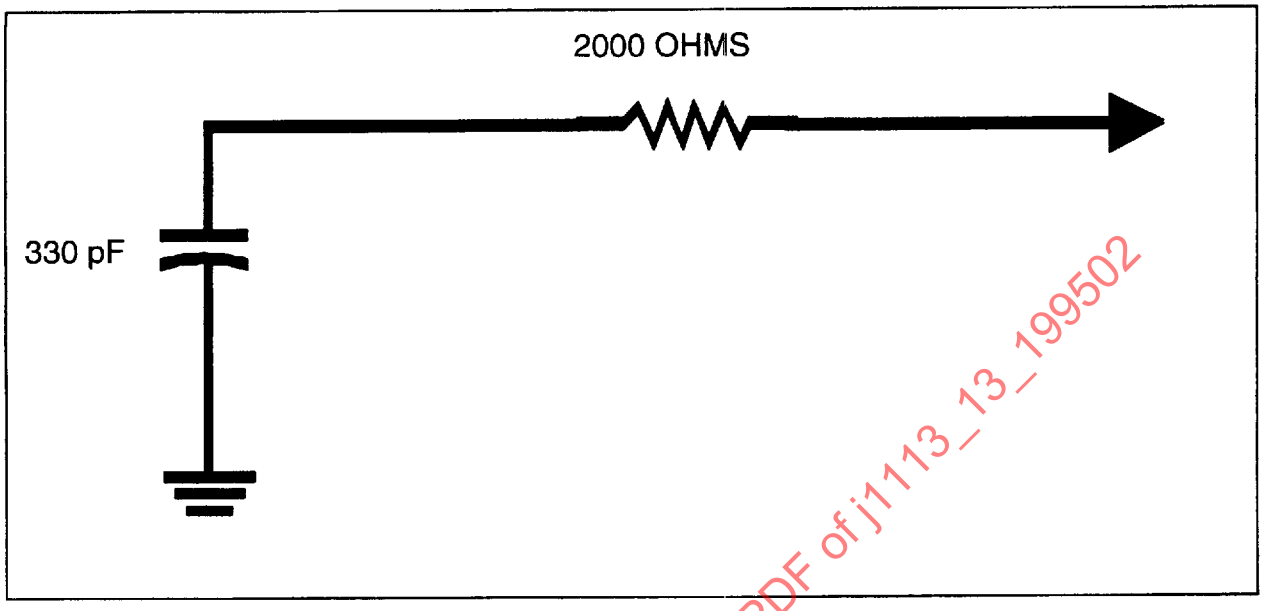

FIGURE 1—HUMAN BODY ESD MODEL

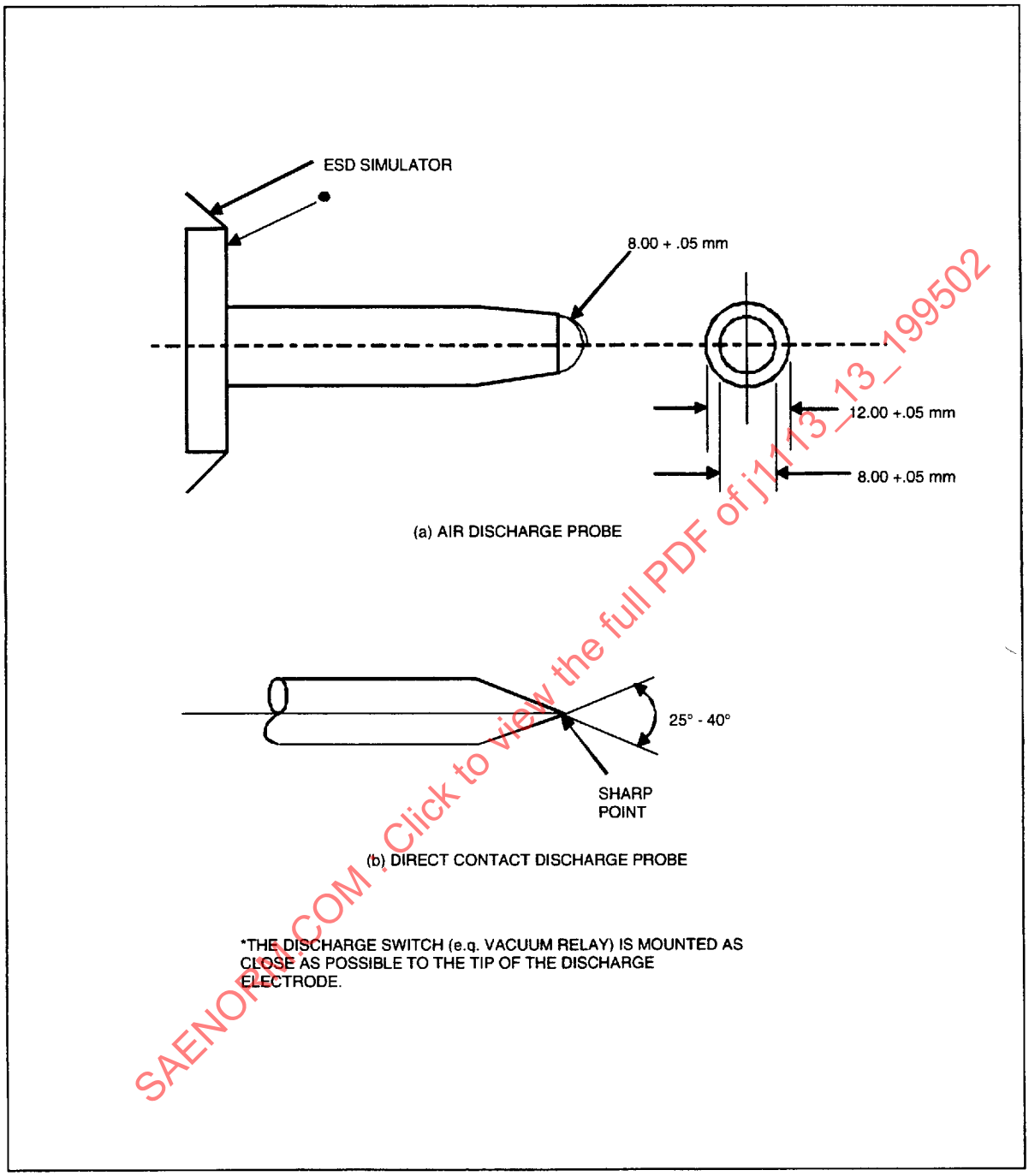

FIGURE 2—ESD SIMULATOR DISCHARGE TIP PROBES

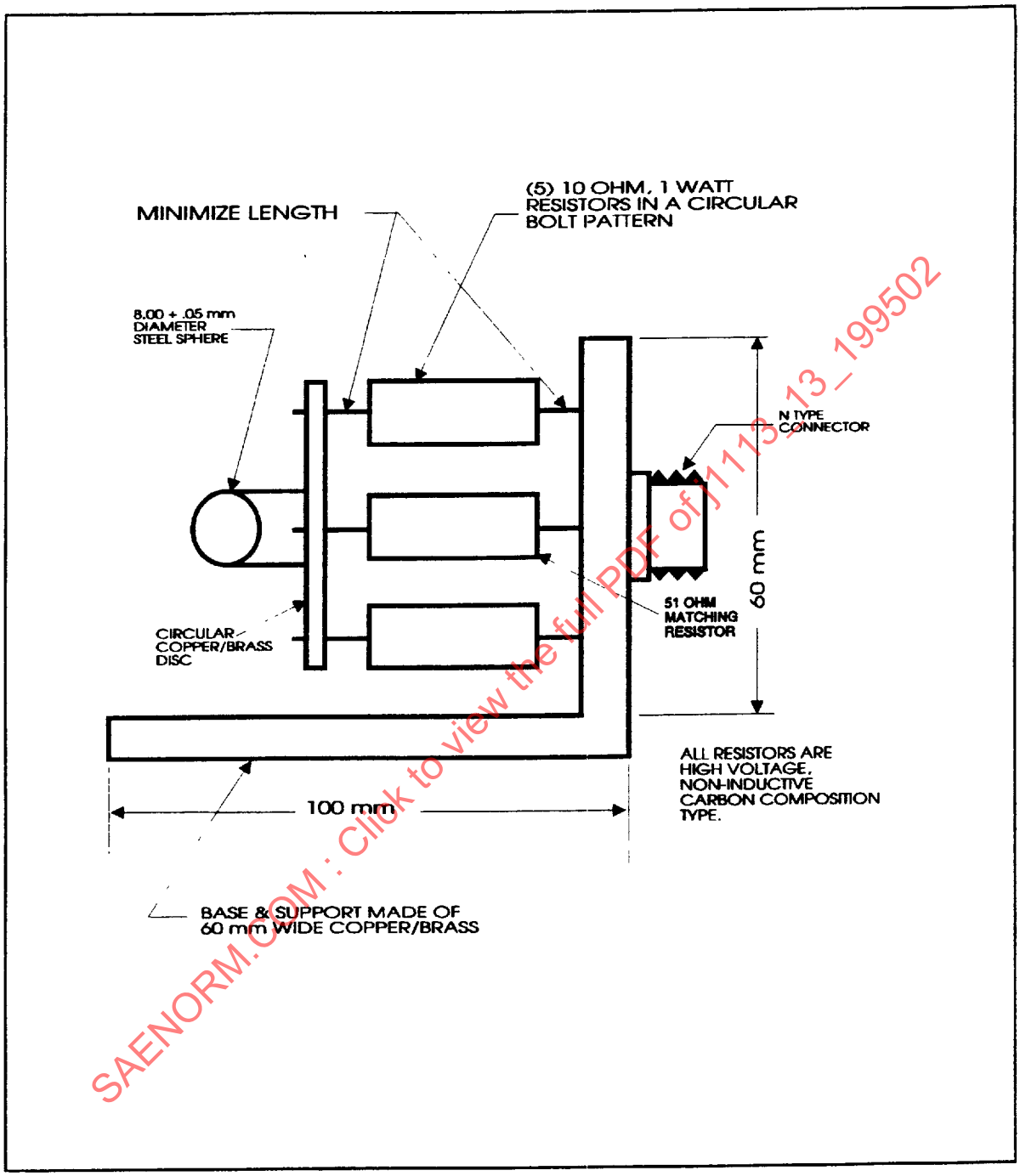

FIGURE 3—ESD COAXIAL TARGET FROM IEC STANDARD 801-2

4. Test Setup and Procedure

4.1 Prior to performing the test, a test plan shall be generated which shall include interface test points, component mode of operation, and any special instructions and changes from the standard test.

4.2 Before the application of any discharges to the DUT, the ESD Simulator Discharge Verification procedure of Appendix B shall be performed.

4.3 Test Environment

4.3.1 TEMPERATURE RANGE—23 °C ± 3 °C; 20 °C preferred.

4.3.2 RELATIVE HUMIDITY—30 to 60%; 30% preferred.

4.4 The test setup shall be configured in accordance with Figure 4.

4.5 The ESD simulator high voltage ground shall be directly connected to the ground plane by a grounding strap.

4.6 The DUT shall be placed at the center of the ground plane (see Figure 4). Chassis-mounted components are to be placed directly on the ground plane. Components which will be isolated from ground in normal installation shall be tested with an insulator between the component and the ground plane using the isolation blocks defined in 3.3. All voltage supply pins shall be connected to an appropriate power source (automotive battery). All other pins shall have inputs applied as necessary to put the DUT into a simulated mode of operation.

NOTE—Test equipment susceptibility to ESD may limit the ability to conduct testing using normal operational inputs; at a minimum the DUT shall be in a powered, idling mode.

4.7 Each exposed shaft, button, switch, or surface of the DUT, which will be accessible to the occupant from inside the vehicle, shall be tested at each of the voltage levels as defined in Appendix A or as specified in the test plan in accordance with the following two methods.

4.7.1 DIRECT CONTACT DISCHARGE—The ESD simulator shall be placed in direct contact with all accessible discharge points. Each discharge point shall be tested to the contact discharge voltage levels in Appendix B.

4.7.2 AIR DISCHARGE—The ESD simulator shall be placed at a minimum distance of 15 mm away from the DUT. The simulator fingertip probe shall be held perpendicular (±15 degrees) to the discharge location. The simulator fingertip probe shall very slowly be moved towards the DUT (i.e., ≤5 mm/s) until a single discharge is obtained. Each point shall be tested to the air discharge voltage levels in Appendix A.

NOTE—If no discharge occurs, continue moving the probe towards the DUT until the simulator discharge tip is in contact with the discharge point. If the simulator makes contact with discharge point and no discharge has occurred, discontinue testing at that voltage level and location.

4.8 Each discharge point shall be subjected to a minimum of three positive polarity and three negative polarity discharges at each voltage level. The time duration between discharges shall be a minimum of 5 s.

NOTE—At each voltage level, all discharge points of a device may be tested first at a single polarity and then tested with the alternate polarity.

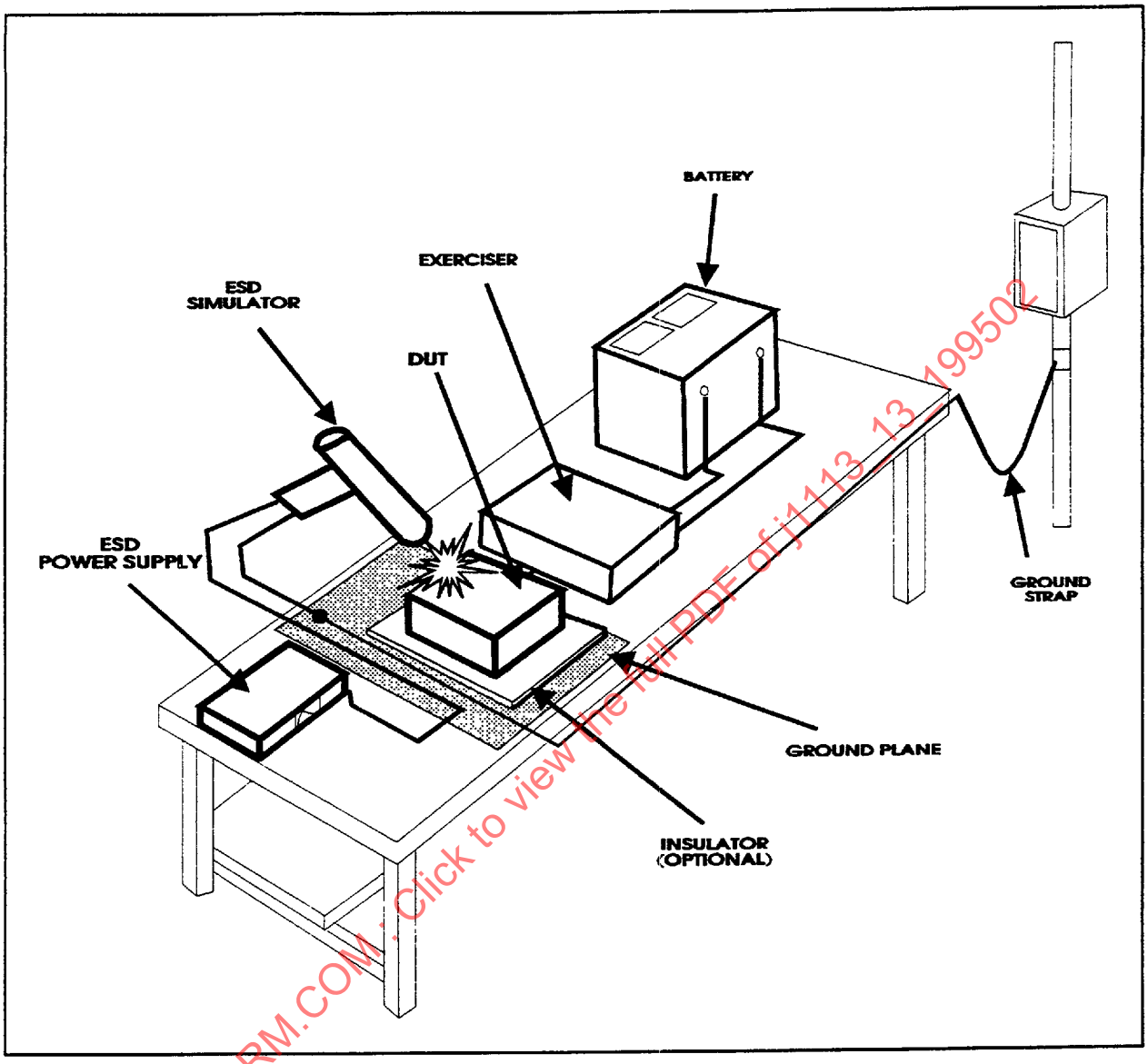

FIGURE 4—TEST SETUP

DATA SHEET 1

ELECTROSTATIC DISCHARGE TEST RECORD FOR COMPONENTS

COMPONENT DESCRIPTION _____ TEST NO. _____

PART NO. _____ PAGE _____ OF _____

COMPONENT FUNCTIONS _____

_____

TEMPERATURE _____ RELATIVE HUMIDITY _____

SPECIAL TEST CONDITIONS _____

TEST FACILITY _____

REQUESTED BY _____ PHONE _____

TESTED BY _____ DATE _____

DISCHARGE POINT	VOLTAGE/POLARITY	PERFORMANCE DEVIATION

FIGURE 5—DATA SHEET 1—ELECTROSTATIC DISCHARGE TEST RECORD FOR COMPONENTS

4.9 During and after each series of three discharges, the DUT shall meet all applicable performance requirements.

4.10 Record all deviations noted (visible, audible, failures, etc.) on a data sheet such as the example Data Sheet 1.

5. Test Severity Levels

5.1 A full description and discussion of the Function Performance Status Classification including Test Severity Levels are given in SAE J1113/1 Appendix A. Please review it prior to using the suggested Test Severity Levels presented in Appendix A.

PREPARED BY THE SAE EMI STANDARDS COMMITTEE

APPENDIX A
TEST SEVERITY LEVELS

A.1 The test levels shown in Figure A1 are the recommended Performance Objective for this test.

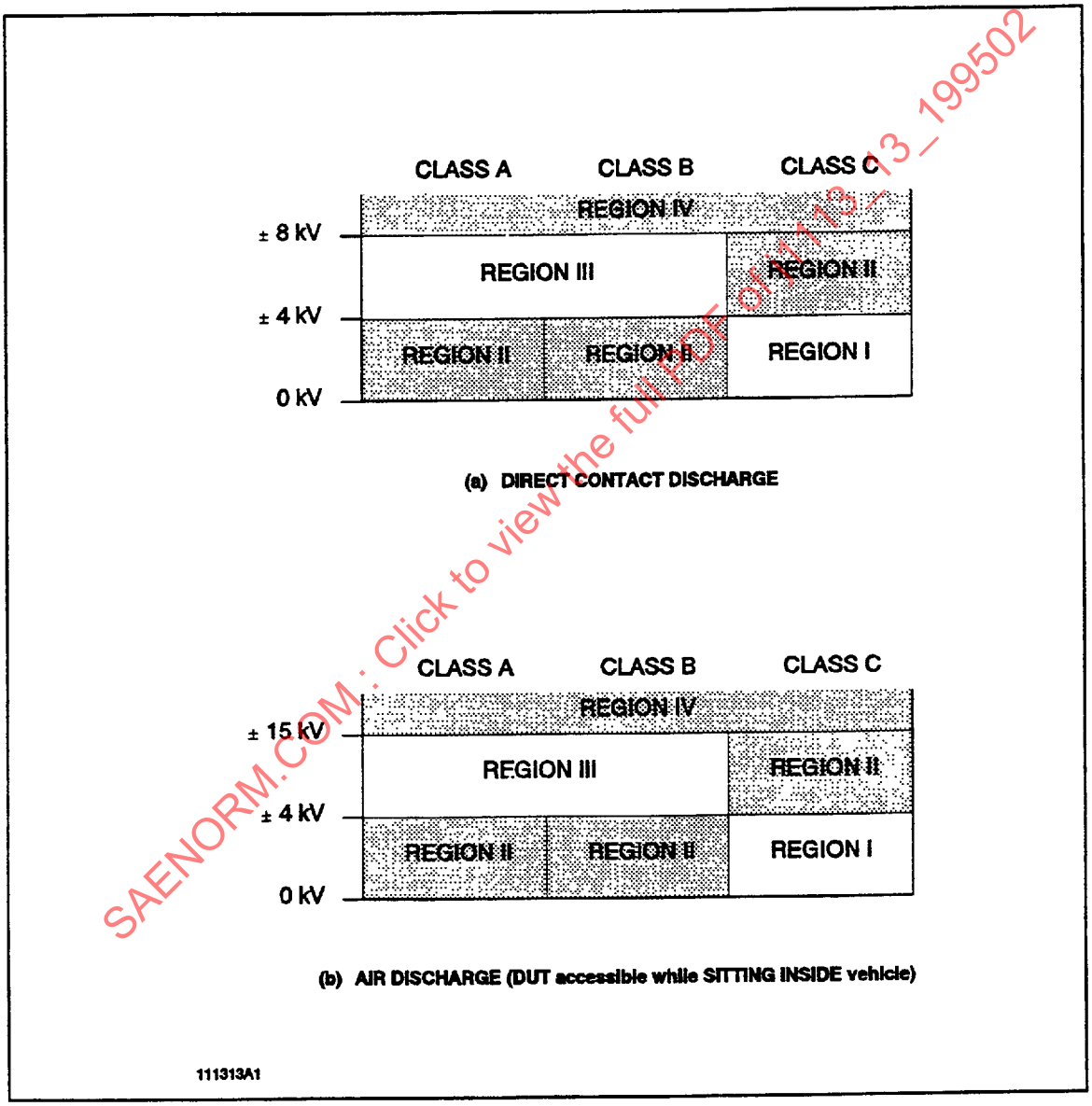

FIGURE A1—SUGGESTED TEST SEVERITY LEVELS

APPENDIX B
ELECTROSTATIC DISCHARGE SIMULATOR VERIFICATION PROCEDURE

B.1 Scope and Field of Application—This Appendix defines a test method for verifying the operation of an ESD simulator that is used for testing automotive electronic components and systems.

Two verification procedures are specified. One method is to be performed at 3-month intervals and the second method is to be performed daily.

B.2 ESD Simulator Quarterly Verification Setup and Procedure

B.2.1 The test setup shall be configured according to Figure B1. Figure B2 shows an equivalent schematic of the setup. Note that a 20 dB wideband attenuator may be required as shown in Figure B1 depending on the vertical sensitivity of the oscilloscope.

B.2.2 The coaxial target shall be located on and bonded to the center of the ground plane. The target output shall be connected to the oscilloscope through a 50 Ω double-shielded, high-frequency, semi-rigid cable with length ≤1 m. The cable shall not be looped and shall be insulated from the ground plane.

B.2.3 The ESD simulator high-voltage ground shall be directly connected to the ground plane by a grounding strap with length ≤1 m and inductance ≤2 μH. The ESD simulator shall be set up and operated according to its instruction manual.

B.2.4 To calibrate the display voltage of the ESD simulator, first adjust the ESD simulator voltage to the desired level and polarity. Next, using the 150 pF ESD simulator probe head, verify the voltage setting at levels of ±2 kV, ±4 kV, ±6 kV, ±8 kV, and ±15 kV. The electrometer reading shall be within ±500 V for voltages ≤±5 kV and ±10% for voltages >±5 kV to ≤±15 kV.

B.2.5 ESD Simulator Risetime Procedure

B.2.5.1 The horizontal time base and vertical amplifier level of the oscilloscope shall be configured in order to view the risetime of the ESD waveform. The horizontal sweep shall be set to single event trigger.

B.2.5.2 DIRECT CONTACT DISCHARGE VERIFICATION (SEE FIGURE 2)—Discharge to the target at each test level and polarity shown in Table B1 and verify the risetime and first peak current parameters specified in Table B1. Figure B3 illustrates a typical waveform shape.

B.2.5.3 AIR DISCHARGE VERIFICATION (SEE FIGURE 2)—The ESD simulator shall be placed a minimum distance of 15 mm from the coaxial target sphere. The ESD simulator, with air discharge probe attached, shall be held perpendicular (±15 degrees) to the target. From this position the simulator air discharge probe shall be slowly moved towards the target (≤5 mm/s) until a single discharge occurs. Only single event discharge waveforms are acceptable. Test voltages for air discharge risetimes are ±15 kV. Figure B3 illustrates a typical waveform shape.

NOTE—The slow approach method specified above minimizes multiple discharges, discharges at lower voltage levels, and ringing in measurement equipment.

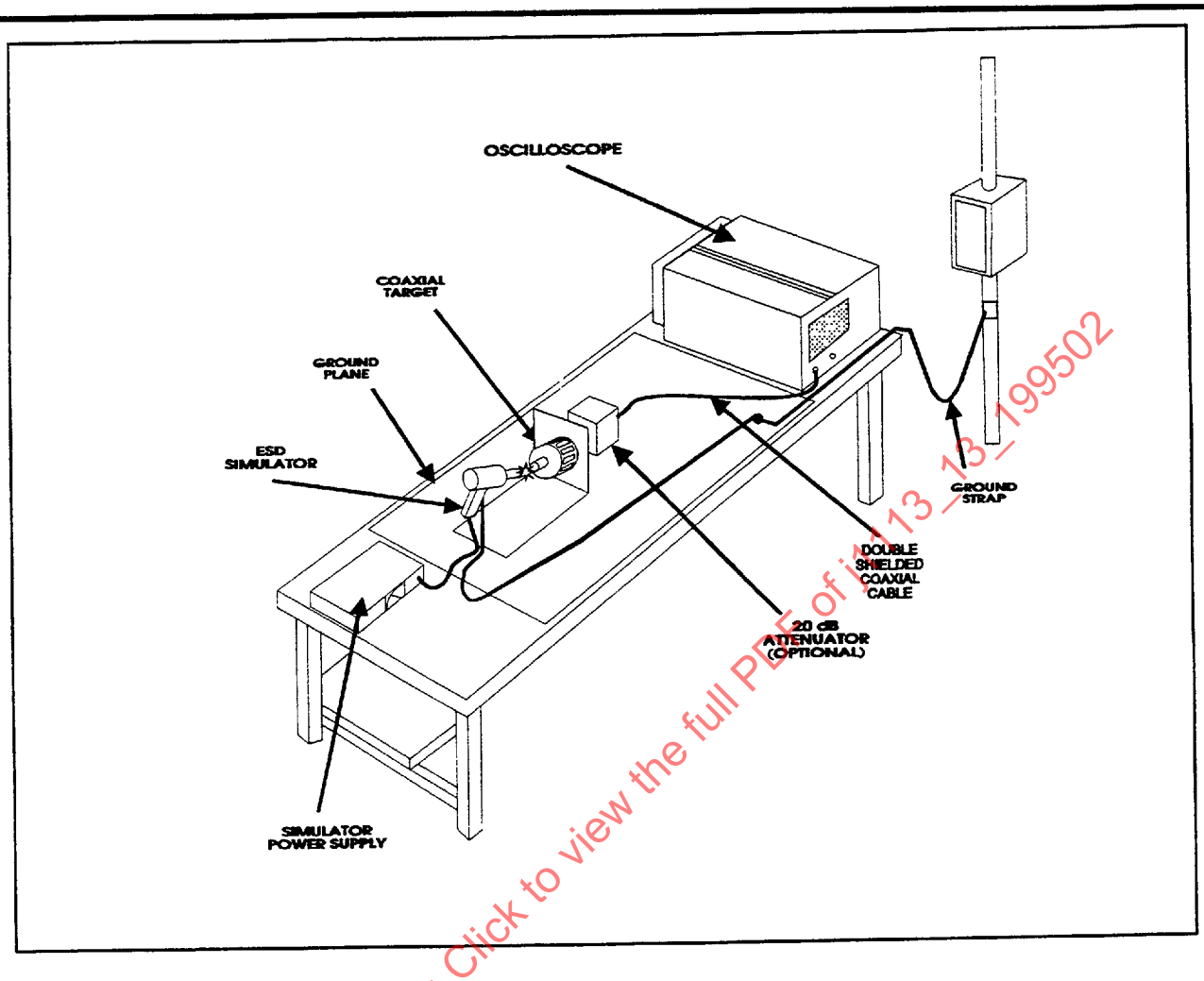

FIGURE B1—ESD SIMULATOR VERIFICATION TEST SETUP CONFIGURATION