Standard Practice for In-Use Resistance Testing of Gloves and Finger Cots
ESD Association Standard Practice for Protection of Electrostatic Discharge Susceptible Items –

In-Use Resistance Testing of Gloves and Finger Cots

Approved September 11, 2005
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Foreword

This standard practice is intended to provide test procedures for measuring the intrinsic electrical resistance of gloves and finger cots; and electrical resistance of gloves or finger cots and personnel together as a system. This standard practice applies to all gloves and finger cots used to control Electrostatic Discharge (ESD). This standard practice provides data that are relevant in the user’s specific environment and application.

The test uses ANSI/ESD STM11.11, Surface Resistance Measurement of Static Dissipative Planar Materials, ANSI/ESD STM 11.12, Volume Resistance Measurement of Static Dissipative Planar Materials, ANSI/ESD STM 11.13, Two-Point Resistance Measurement of Dissipative and Insulative Materials and a Constant Area and Force Electrode (CAFE) specifically designed for resistance measurements at the thumb and finger-tips. A further advantage of the CAFE is that it can be used to test finger cots as well as gloves using an identical procedure.

The user of the CAFE test method should note that the in-use resistance of the glove or finger cot can be much lower than its intrinsic resistance as measured by ANSI/ESD STM11.11, STM11.12, or STM11.13. In addition, once a glove or finger cot is worn it can be measured only once because the glove or finger cot may be contaminated by a person’s skin emissions. This contamination could affect the accuracy and reproducibility of further measurements on a particular glove or finger cot. It is suggested for the best reproducibility for a test group that gloves or finger cots be selected from the same lot. In the case of testing for lot-to-lot product auditing, compliance verification or variation, gloves or finger cots should be selected from multiple lots.

Electrical resistance is one property that can be used to evaluate the electrostatic characteristics of gloves. However, resistance does not fully characterize these materials. An additional property to be considered in the selection and use of gloves and finger cots includes charge accumulation. Suggested test methods for personnel and glove and finger cot charging will be forthcoming.

A common source of electrostatic charge in a work environment is the separation of gloves from the items being picked-up or released, resulting in the generation of electrostatic charge that can accumulate on personnel, gloves or finger cots and induced into items. The effect of this generation and accumulation of electrostatic charge can be minimized with appropriate selection of glove or finger cots. To effectively control electrostatic discharge on personnel and equipment, gloves and finger cots must be used in combination with other grounding devices.

A glove material, which is conductive enough to discharge a person or an object, may also pose a safety hazard. The work performed on an ESD susceptible item often entails the use of tools and test instruments that operate at voltages high enough to cause electrical shock. The presence of a material tested using the methods described in this document will not guarantee personnel safety. This document includes test methods that may be applicable for measurement of gloves and fingers cots that reside in the conductive range, however effects due to skin resistance and electrode resistance may create significant errors. Test voltage may also be an issue for conductive materials.

Beneficial comments (recommendations, additions, deletions and pertinent data, which may be of use in improving future versions of this document, should be addressed to:

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1.0 PURPOSE AND SCOPE

1.1 Purpose
This document provides test procedures for measuring the intrinsic electrical resistance of gloves and finger cots as well as their electrical resistance together with personnel as a system. The system test provides data that are relevant in the user’s specific environment and application.

1.2 Scope
This document applies to all gloves and finger cots used as part of a user defined Electrostatic Discharge (ESD) Control Program Applicability.

This document is intended to provide test procedures for measuring the electrical resistance of gloves or finger cots. Intrinsic resistance measurements include surface, volume, and point-to-point resistance using ANSI/ESD STM11.11, 11.12, and 11.13, respectively. “In-use” resistance measurement of the glove/finger cot and personnel together as a system is defined using a constant area force electrode (CAFE).

The resistance of the glove or finger cot may be much lower during use than its intrinsic resistance due to the interior of the glove/finger cot becoming hydrated once it is placed on the hand/finger of the operator.

2.0 NORMATIVE REFERENCES

ANSI/ESD S1.1, Wrist Straps

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

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

ANSI/ESD STM11.13, Two-Point Resistance Measurement of Dissipative and Insulative Materials

ESD ADV1.0, Glossary of Terms

3.0 DEFINITION OF TERMS

Terms used in this document are in accordance with the definitions found in ESD ADV1.0 Glossary of Terms.

3.1 Constant Area and Force Electrode (CAFE)
An electrode designed to be held by a person's finger, gloved or ungloved, to reproducibly measure resistance from the finger to a counter electrode such as a ground strap worn on the wrist of the same hand. This electrode is suitable for measuring the resistance of a finger wearing a finger cot. See Figures 1 and 2.

3.2 In-Use (System) Resistance Test
A system resistance test from a Constant Area and Force Electrode, through a glove or finger cot, to a person's finger or thumb, using a wrist strap as the second electrode.
4.0 PERSONNEL SAFETY

The procedures and equipment described in this document may expose personnel to hazardous electrical conditions. Users of this document are responsible for selecting equipment that complies with applicable laws, regulatory codes and both external and internal policy. Users are cautioned that this document cannot replace or supersede any requirements for personnel safety.

Ground fault circuit interrupters (GFCI) and other safety protection should be considered wherever personnel might come into contact with electrical sources.

Electrical hazard reduction practices should be exercised and proper grounding instructions for equipment must be followed.

5.0 EQUIPMENT

5.1 A wrist strap with a ground cord containing an integral one megohm resistor

Since an integral one megohm resistor is included in series with the wrist strap, the actual lower limit for the resistance measurement using this ground cord will be in the single-digit megohm range. The integral one megohm resistor should be verified using the test method described in ANSI/ESD S1.1.

5.2 A wrist strap with a ground cord that does not contain an integral one megohm resistor

5.3 Low Resistance Meter

A DC ohmmeter shall be used for gloves that have intrinsic or in-use resistances less than $1.0 \times 10^6$ ohms. The DC ohmmeter shall be capable of measuring a DC resistance of 0.1 ohm through 10 megohms ± 10% with an open circuit voltage greater than 1.5 volts and less than 10 volts.

5.4 High Resistance Meter

5.4.1 The meter shall have an output voltage of 100 volts (± 5%) while under load for measurements of $1.0 \times 10^6$ ohms and above, and 10 volts (± 5%) while under load for measurements less than $1.0 \times 10^6$ ohms.

5.4.2 The meter must be capable of making measurements from $1.0 \times 10^3$ ohms (± 10% accuracy) to $1.0 \times 10^{11}$ ohms (± 10% accuracy). A power supply and ammeter, or an integrated instrument that combines those functions may be used.

5.5 Constant Area and Force Electrode (CAFE)

The electrode design, materials, and specifications are shown in Figure 1.

6.0 MATERIAL TESTING

6.1 Sample Size

Six specimens of each glove type or finger cot type are required for this test procedure.

6.2 Sample Preparation

6.2.1 Standard test conditions for this testing will be 23 ± 3°C, 12% ± 3% RH and 50%± 5% R.H.

6.2.2 The samples shall be conditioned at the standard conditions for 48 hours minimum.

6.3 Surface and Volume Resistance Measurements of Glove Material
The resistance of glove material shall be conditioned and tested using ANSI/ESD STM11.11, Surface Resistance Measurement, and ANSI/ESD S11.12, Volume Resistance Measurement at the two humidity conditions listed in 6.2.1.

6.4  Two Point Resistance Measurements of Finger Cot Material
The resistance of finger cot material shall be conditioned and tested using Two-Point Resistance STM11.13 at the two humidity conditions listed in 6.2.1.

6.5  Baseline Resistance Measurement of Operator
The baseline resistance measurement is made with an ungloved operator. The reading verifies the functionality of the test system and establishes the minimum resistance of the operator only. All in-use testing should be performed at environmental conditions similar to those in which the gloves will be used.

6.5.1  This measurement shall be performed using the DC ohmmeter as specified in Section 5.3.

6.5.2  Select the test subject's hand of preference that will eventually be used to wear the glove/finger cot. Select the thumb and/or finger(s) to be tested. Attach the wrist cuff to the wrist of that hand. Attach the ground cord without the one megohm resistor to one input of the resistance meter. Ensure that the wrist cuff makes a good connection with the skin. An appropriate lotion may be used to assure a good connection. If a lotion is used, use care not to contaminate the gloves/finger cots during subsequent tests.

6.5.3  Attach the Constant Area and Force Electrode (CAFE) via the banana jack to the other input of the resistance meter. See Figure 2.

6.5.4  Balance the CAFE on the fingerprint side of the thumb or first finger of choice of the hand that has the wrist strap connected to it. See Figure 2.

6.5.5  Record the resistance measurement between the electrode on the bare finger and the wrist strap after 15 seconds electrification time. Repeat the test on any other digit that is selected for testing.

6.5.6  Clean the electrode (CAFE) with isopropyl alcohol prior to performing the following steps.

6.6  Low Voltage System Resistance Test (less than 1.0 x 10^6 ohms)

6.6.1  This resistance shall be measured first using an ohmmeter as specified in Section 5.3.

6.6.2  Attach the wrist cuff to the hand that will wear the glove. Attach the wrist strap cord without the one megohm resistor to one lead of the ohmmeter. Ensure that the wrist cuff makes a good connection with the skin.

6.6.3  Attach the (CAFE) to the other lead of the ohmmeter. See Figure 2.

6.6.4  Wear the glove and wait a minimum of 15 seconds to begin the electrical testing.

6.6.5  Balance the CAFE on the fingerprint side of the thumb or first finger of choice of the hand wearing the glove. See Figure 2.

6.6.6  Record the resistance after 15 seconds electrification time. If the resistance measured is less than 1.0x10^6 ohms, record the resistance measurement between the electrode and the wrist cuff. Repeat the test on any other digit that was selected for testing. If the resistance is greater than 1.0x10^6 ohms, perform the testing as specified in section 6.7.

6.6.7  Repeat the above procedure for all of the test specimens at both humidity conditions.

6.7  Low Voltage System Resistance Test (greater than 1.0 x 10^6 ohms)
6.7.1 Use a meter capable of applying a voltage of 10 volts as specified in Section 5.4.

6.7.2 Attach the wrist cuff to the hand that will wear the glove. Attach the wrist strap cord without the one megohm resistor to one input of the resistance meter. Ensure that the wrist cuff makes a good connection with the skin.

6.7.3 Attach the CAFE to the other input of the resistance meter. See Figure 2.

6.7.4 Wear the glove and wait a minimum of 15 seconds to begin the electrical testing.

6.7.5 Balance the CAFE on the fingerprint side of the thumb or first finger of choice of the hand wearing the glove. See Figure 2.

6.7.6 Apply 10 volts to the electrode. Record the resistance after 15 seconds electrification time. If the resistance measured is less than $1.0 \times 10^7$ ohms, then record the resistance reading between the electrode and the wrist cuff. Repeat the test on any other digit that was selected for testing. If the resistance measured is greater than $1.0 \times 10^7$ ohms, perform testing as specified in section 6.8.

6.7.7 Repeat the above procedure for all of the test specimens at both humidity conditions.

6.8 High Voltage System, High Resistance Test greater than $1.0 \times 10^7$ ohms.

6.8.1 Use a meter capable of applying a voltage of 100 volts as specified in Section 5.4.

6.8.2 Attach the wrist cuff to the hand that will wear the glove. Attach the wrist strap cord with the one megohm resistor to one input of the resistance meter. Ensure that the wrist cuff makes a good connection with the skin.

6.8.3 Attach the CAFE to the other input of the resistance meter. See Figure 2.

6.8.4 Wear the glove and wait a minimum of 15 seconds to begin the electrical testing.

6.8.5 Balance the CAFE on the fingerprint side of the thumb or first finger of choice of the hand wearing the glove. See Figure 2.

6.8.6 Apply 100 volts to the electrode. Record the resistance after 15 seconds of electrification time. Record the resistance measurement between the electrode and the wrist cuff. Repeat the test on any other digit that was selected for testing.

6.8.7 Repeat the above procedure for all of the test specimens at both humidity conditions.

7.0 TEST RESULTS

Report all data on the attached data recording sheets. See sample data sheets, Figures 3 and 4.
Figure 1: Constant Area and Force Electrode (CAFE)
Figure 2: Photo of CAFE Test Setup
Material Measurement Data Sheet

Test Facility: ________________________ Date of Testing: ________________________
Conditioning Temperature: _______ °C    Conditioning Humidity: ______%R.H.
Conditioning Time: _______________
Test Temperature: _____________ °C     Test Humidity: __________ %R.H.
Operator: _______________________
Glove or Finger Cot Type: ______________________
Test Voltage: _______________

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<th>STM11.13 Point-to Point Resistance</th>
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Figure 3: Resistance Test Data Sheet
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<th>Test Voltage: ____________</th>
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Average

Std. Dev.

Minimum

Maximum

Data Summary for All Fingers:

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Glove Type: ______________________ | Test Voltage: ____________ |
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Average

Std. Dev.

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Maximum

Data Summary for All Fingers:

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<th>Minimum</th>
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<tbody>
<tr>
<td>Std. Dev.</td>
<td>Maximum</td>
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</tbody>
</table>

Figure 4: Constant Area and Force Electrode (CAFE) Gloves/Finger Cot Test Data Sheet
8.0 BIBLIOGRAPHY

ESD TR 03-99 ESD Glove and Finger Cots


ASTM D257-93, Standard Test Methods for DC Resistance or Conductance of Insulating Materials