ESD Open Forum

Conformity—2009

Provided by the ESD Association

Compliance Verification for Common Hand Tools

Q: I understand that hand tools like pliers, tweezers, screwdrivers, nutdrivers, and wire cutters can do damage to ESD sensitive product. I have a shop and tool crib full of them. How do I go about determining which ones are safe and which are not? Do you know of a quick test I can perform to sort them out?

A: Hand tools can be a significant source of damage to ESD sensitive hardware. The continuing demand for increased speed and capability in a smaller package has necessitated a decrease in the width, and distance between the current carrying paths built into Integrated Circuits. This makes it more likely for smaller charges to jump the gaps and or just damage the path. Indications are that this trend in design will continue well into the next decade. As a result, more and more new IC designs will be classified as HBM Class I and will be more sensitive to electrostatic discharge and overstress during handling. Therefore, everyone involved in handling ESD sensitive products and components will need to make sure that their ESD control programs keep pace with the increasing sensitivities. There always has been a damage threat from hand tools, but it will become more critical with each passing year in light of these industry changes.

This article will outline methods for classifying non-electric hand tools in two dimensions, handle static charging characteristics, and handle resistance. These methods are not intended for the initial qualification and selection of hand tools.

Caution must be taken anytime work is performed on energized product. A wrist strap should not be worn while working with any device operated at more than 50 volts.

The damage threat from hand tools is Charged Device Model (CDM) charging of the hand tool and Machine Model (MM) discharge to the ESDS item. Volt for volt MM discharge is an order magnitude more powerful than HBM discharge because the resistance of human body has been removed from the equation. CDM charging can produce two separate discharge events. Here is how it works. If you ground a conductor (the conductive metal blade of a screwdriver for example) while it is in the presence of any item carrying electrostatic field (a charged piece of plastic, or clothing) the conductor will acquire an electrostatic charge that may be sufficient to cause damage when discharged. If the handle of that hand tool is sufficiently insulative, and if it does acquire a charge, it will remain on the conductive portion of the tool until it is brought in contact with a ground path, even if the user is wearing a wrist strap. That ground path might be an ESD sensitive component. In this case damage may occur both from initial contact with the charged hand tool and again when the charged component is grounded.

Handle Static Charging Properties Test – Hand tools with non-metallic handles
Test Equipment
1. Hand held static field meter.
2. Wrist strap
3. Ground source (Static Safe Work Station or other)

Test Procedure
1. Rub the handle of the hand tool several times against the skin of your forearm or a piece of fabric or any dis-similar material.
2. Hold the tool by the tip or by any means that leaves as much of the handle as possible exposed to the open air.
3. With the other hand bring the field meter to the calibrated measuring distance, typically 1" (2.54cm). Note both the reading and the rate of decay, if any. (See Fig. 1&2)
4. Compare the static charge reading with the damage threshold of the product on which the tool is intended to be used.
5. Tool handles that generate excessive levels of static charge, and that do not decay in a matter of seconds are likely to be insulative and, as we will see in the handle resistance test, and should not be used on ESD/EOS sensitive product.

Fig. 1 Screwdriver handle with a field strength of 1,440 volts

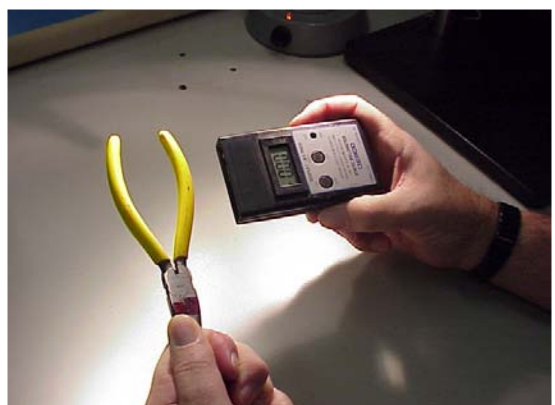

Fig. 2 Grips on needle nose pliers with no measurable field strength

Tool In Hand "System" Resistance Properties Test – This is the more important of the two tests. In the example above, even though a field strength of 1,440 volts was displayed, the actual amount energy available to cause ESD/EOS damage is not significant by virtue of the small size of the handle. This is not the case for the conductive potion of the tool.

The following test procedure is designed to measure the resistance of a "system" comprised of the following parts.

Conductive portion of the hand tool
|
Hand tool handle

|
Hand
|
Wrist Strap
|
Wrist strap resistor

Test Equipment
1. Megohm meter with test leads and alligator clips
2. Wrist strap (test first to confirm proper function)
3. Ground source (Static Safe Work Station or other)

Test Procedure
1. Hands should be clean, dry, and free from lotions and oils unless ESD approved.
2. Attach a test lead from the Megohm meter to the conductive tip of the hand tool using an alligator clip.
3. Plug the wrist strap banana plug into the Megohm meter as the second test lead
4. Press and hold the test button of the Megohm meter for the prescribed test period (10 to 15 seconds). (See Fig. 3&4)
5. If the tool handle yields a resistance that can be categorized as conductive (less than $1x10^6$ ohms), or dissipative (between $1x10^6$ ohms to less than $1x10^{10}$ ohms) and if the tool handle does not generate excessive static tribo-charging as described above, then the tool is safe for general use in an ESD protected area.

Admittedly, a fair amount variability exists in this test, introduced at a minimum by the following factors, moisture content of the skin, relative humidity of the test area, strength of the grip, skin contact with wrist strap.

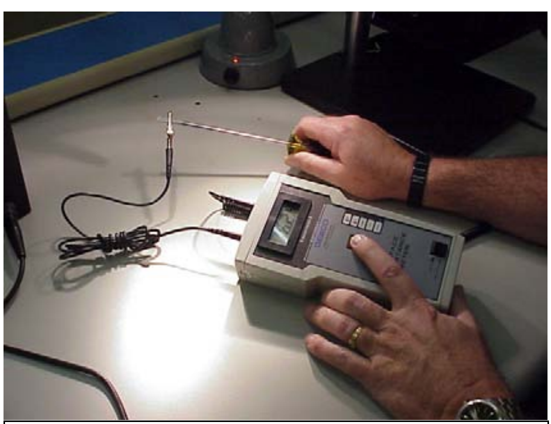

Fig. 3 Screwdriver with a system resistance of $6.21x10^{12}$ ohms (insulative – charge will not flow to ground)

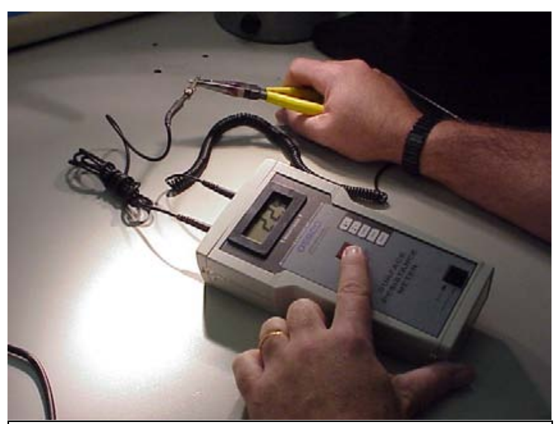

Fig. 4 Needle nose pliers with a system resistance of $2.29x10^6$ ohms (borderline conductive and OK)

In both of the above examples, effect of the wrist strap's built in 1 Megohm resistance has little bearing on the outcome of the test.

The above test can be used to determine which tools to use in an ESD Protected Area.

After segregating the tools here is a guide to what actions can be taken to remediate the tools.

		Tribo-Charging Test Results	
		Low Static Generating	High Static Generating
Resistance Test Results	Dissipative/ Conductive $<1x10^{10}$ ohms	No action required	Treat with topical anti-stat and recheck resistance measurement
	Insulative $> 1x10^{10}$ ohms	Wrap handle with conductive tape connected to the metal/conductive portion of the tool	Implement both actions, replace the tool, or remove it from the ESD protected area

The above steps are not complex and require only basic ESD control and monitoring equipment. They may be used to identify and separate existing inventories of hand tools for proper use according to their inherent properties. The decision to remediate or replace a hand tool is left to the reader based on time, and resources. As mentioned above these tests are not intended for the initial qualification and selection of hand tools. The ESD Association is in early stages of drafting a Standard Test Method for the qualification of non-electric hand tools.

Watch next month for an easy to repeat method for demonstrating the Charged Device Model (CDM) charging process using basic ESD monitoring equipment.

About the Author

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About the ESD Association

Founded in 1982, the ESD Association is a not for profit, professional organization directed by volunteers dedicated to furthering the technology and understanding of electrostatic discharge. The Association sponsors educational programs, develops ESD Standards, holds an annual technical symposium, and fosters the exchange of technical information among its members and others. Additional information may be obtained by contacting the ESD Association, 7900 Turin Rd., Bldg. 3 Rome, NY 13440-2069 USA, Phone 315-339-6937, Fax 315-339-6793. Email info@esda.org.
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