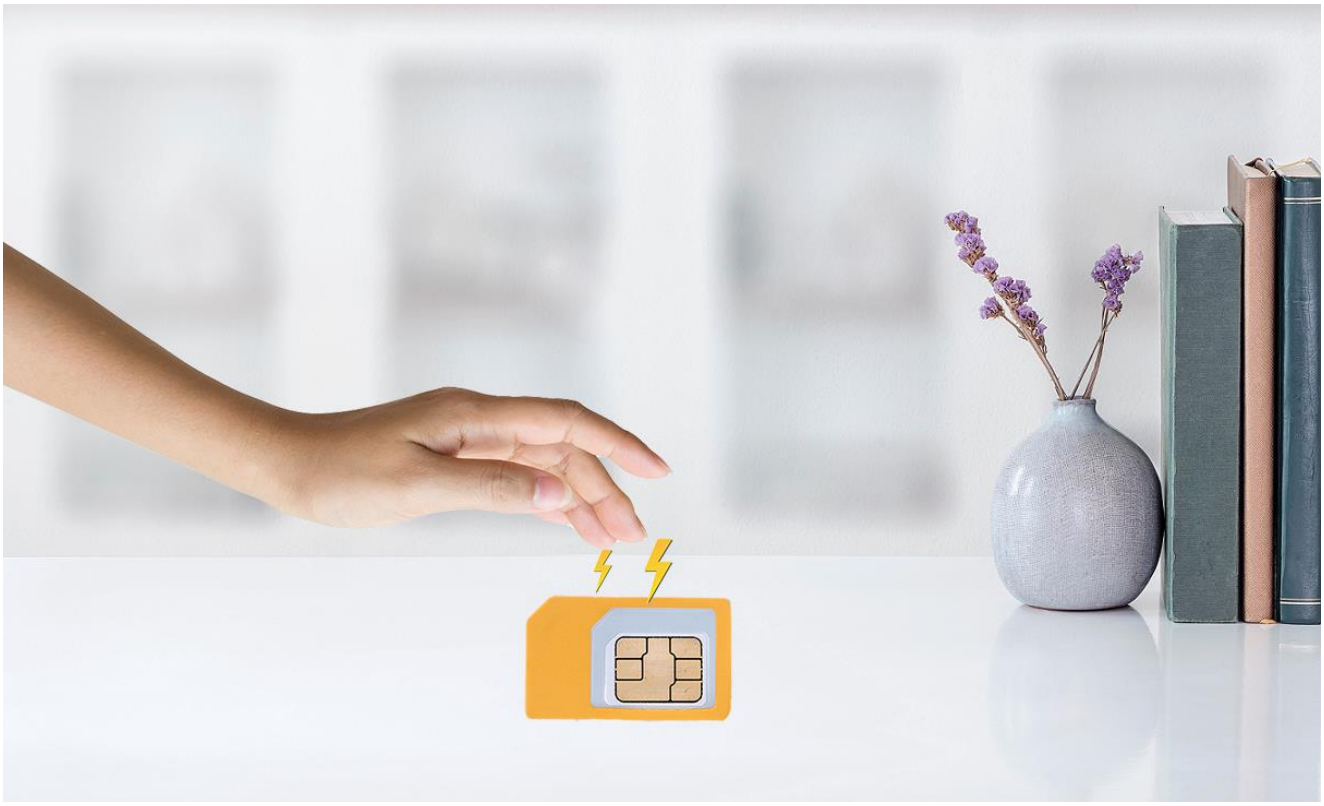
Guidelines for understanding and controlling static electricity in the usage of CacCard



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Overview

Static electricity has always existed in the workplace. It has become a major concern in the industry only since the incorporation of static-sensitive integrated circuits and other microelectronic components into electronic systems. Technology advances dramatically increase component density on a circuit chip and significantly decrease power requirements for circuit operation. Therefore, these components and the printed circuit boards that house them became increasingly susceptible to impairment or destruction from the effects of electrostatic discharge (ESD).

With increasing static sensitivity and with significantly increasing individual circuit board costs, a more consistent and higher level of static control is required. Doing otherwise risks would increase degradation in customer service, higher maintenance and repair costs, and damage the equipment.

This brief set of guidelines provides a common understanding of static electricity, the basis and magnitude of static charge generation, electrostatic discharge and its impact, and the rules for effective static control in the workplace. Every work group handling CacCard should ensure that they have a defined static control program in place. Each program should provide ongoing employee awareness and periodic evaluation of the effectiveness of the local program itself.

The issue and its cause

when the climate is dry and humidity level is low, CacCard may cause the cabinet to stop working or reboot if it is not used properly. The root cause of the issue if human body has accumulated a big amount of electricity and pass it over to anything touched.

When CacCard, which has been charged with high voltage, is inserted into the card reader, the electricity is released instantly and cause the card reader stop working. And we sometimes have to reboot the computer to make it work again.

The card user typically acts as the generator of static voltage. Under unfavorable environmental conditions a user can accumulate a significant charge, which is transferred to the card body. This may result in the card being charged to a voltage of several kV. During dry, cold winter conditions with Relative Humidity less than 20%, 5,5 kV has been recorded.

In the laboratory, this scenario is represented by the Human Body Model (HBM), which consists of a charged capacitor, representing the charged user, in series with an ohmic-resistive element, corresponding to the electrical resistance between the user and the card. The resistance is variable and depends on the pressure the user exerts onto the card surface. It limits the amount of current driven from the human body to the grounded terminal connector.

What is static electricity

Static electricity is a stationary charge of electricity resting on the object's surface. The location of this positive or negative charge on the object's surface generally depends on conductivity of the surface material. Static charges on non-conductive surfaces (polystyrene foam, rubber, plastic, etc.) are generally localized. Charges on conductive surface (un-grounded metal, human skin, etc.) are generally evenly distributed across the surface.

How and when are static charges generated

A static charge is caused by the transfer of electrons between two objects. The charge is generated either by contact and separation of objects (known as direct charging by friction or triboelectric charging) or by passing one object through a charged electrostatic field surrounding another object (inductive charging). In both cases, objects may acquire and retain a static charge on their surfaces ranging from 5 to more than 50,000 electrostatic volts.

Generally, non-conductive materials are more prone to charging by friction. Conductive materials are more likely to be charged by induction. For example, friction between a carpet and a shoe generates a charge on and an electrostatic field surrounding, the shoe sole as you walk

across the carpeted floor. The charge is then immediately passed by induction to the conductive moisture layer on your skin surface. As described below, people are the primary cause of static charging in the workplace, and non-conductive materials are the prime source of most static charges.

Many materials in today's world generate static charges through the heat of friction with another material, and some much more so than others. **Table A**, "Triboelectric Series," indicates a variety of materials and the type of relative degree of static charge they will generate by friction. Generally, the farther apart materials are located in the table, the greater the magnitude of the charge that may be generated. A material acquires a positive charge with respect to any material below it on the scale.

Table A – Triboelectric series

Materials	Polarity (+ or -)
Human hands, asbestos, acetate, glass, human hair, nylon, wool, fur, lead, silk, aluminum, paper, cotton, wood, steel	Acquires a more positive charge (+)
Sealing wax, hard rubber, acetate fiber, epoxy glass, nickel, copper, silver, brass, gold, platinum, stainless steel, synthetic rubber, acrylic, polystyrene foam, polyurethane foam, polyester, orlon, polyethylene, polypropylene, PVC (vinyl), silicon, Teflon	Acquires a more negative charge (-)

Table B shows "Typical Charge Generators" in the workplace. The table includes many common items that are encountered with each day, such as synthetic clothing, vinyl floors and chair coverings. The listing demonstrates that static electric generators are all around us.

Table B – Typical charge generators

Item	Type
Work surfaces	Formica, finished word, synthetic mats, ungrounded metal, glass or fiberglass
Chairs	Fiberglass, vinyl, other plastics, ungrounded metal, finished wood
Clothes	Synthetics, gloves, wool, shoes and boots
Floors	Carpeted, vinyl, waxed
Packaging materials	Polyethylene bags, bubble pack material, foam packaging pellets, plastic trays and boxes

Table C, "Typical electrostatic Voltages", shows how many volts of static electricity are generated by some typical activities involving people. Many people do not realize that a short walk across a carpet on a dray day charge an individual with up to 35,000 volts of static electricity – or that the simple act of standing up from a standard vinyl chair can generate a 5,000 volts charge, even on a somewhat humid day. These charges are of significant magnitude.

Table C – Typical electrostatic voltages

Means of generation	Voltage
Walking across carpet	Up to 35,000
Walking across vinyl floor	Up to 12,000
Motions of worker at bench	Up to 6,000
Vinyl envelopes for work instructions	Up to 7,000
Common poly bag picked up from bench	Up to 20,000
Work chair padded with polyurethane foam	Up to 18,000
Removing circuit boards from standard bubble wrap	Up to 26,000
Packaging circuit boards in standard foam-lined box	Up to 21,000

What is electrostatic Discharge (ESD)

Electrostatic discharge in the sudden transfer of a static charge between two objects – not necessarily with respect to ground—just to each other. The extreme example of ESD is lightning. The massive charge generated by the friction between cold and warm air masses is discharged through the air to ground. A more common example is the sight, sound and feel of the spark that "zaps" the person or other conductive surface that is touched after walking across a carpeted floor. The spark of an ESD event, and particularly the heat created by the sudden transfer of energy, is what damages sensitive electronic components.

The impact of ESD

Human senses can only perceive an electrostatic discharge of about 3,500 volts or higher. That is, we do not see, feel, or hear static discharges below 3,500 volts. This threshold become very important in relationship to the sensitivities of today's electronic components.

Table D, "Microelectronic device sensitivity", shows the known ESD sensitivity range of a number of electronic components commonly used in today's telecommunications industry. It is important to recognize the range of voltage within which and ESD event will likely impair or destroy the component. Such damage often requires replacement of the entire circuit board. Most

of the devices listed have an upper limit of 3,000 or fewer volts. This mean that they can be destroyed by a person's electrostatic discharge – without the person ever knowing it. This "invisibility" makes ESD the significant hazard that it is and makes its prevention vital.

Table D – microelectronic device sensitivity

Device type	Range of ESD sensitivity volts
VMOS	30 – 1,800
MOSFET	100 – 200
GaAsFET	100 – 300
EPROM	100 – 2,500
JFET	140 – 10,000
OP AMP	190 – 2,500
CMOS	250 – 2,000
Schottky Diodes, TTL	300 – 2,500
Film Resistors (Thick, Thin)	300 – 3,000
BIPOLAR Translators	300 – 7,000
ECL (PC Board Level)	500 – 1,500
SCR	600 – 1,000
Schottky TTL	1,000 – 2,500

Uncontrolled ESD causes premature, unnecessary failure of circuit boards through its destructive impact on electronic components. These failures result in degraded or lost service to customers, increased maintenance and repair expenses and a higher amount of capital investment for the larger inventory of circuit board required to maintain desired service levels. All these factors directly impact a company's profitability and competitiveness in today's communications marketplace. Effective static control helps to diminish these requirements.

Solution we use to deal with ESD

We are using several means to deal with ESD issues.

1. CacCard Reader has special design to release the static electricity in hardware level. Some diodes and capacitors can act as ESD protection and release the surge current when it happens.
2. Cabinet has effective grounding mechanics to circulate the static electricity to the ground. The computer, components and power supply have reliable connection to the ground line. 1 & 2 should have prevented most ESD issues from happening
3. **Use RFID functionality of the CacCard**. Each CacCard has RFID feature, and we can link it together. The steps are in the configuration tab of CAC-GUI.
4. **Use keypad functionality of CacCard**. The cabinet has already gotten keypad feature preset for CacCard and linked them together.

5. If ESD sometimes interrupts the check in/checkout process and you still feel like to use CacCard, probably we need to release the static electricity before inserting the card into the reader.

   The following is the illustration:

a) Take out CacCard. The card might have static electricity on it.

b) Place the card on the surface of the cabinet for a moment. The chip of the card needs to touch the cabinet, so that the electricity on the chip can be discharged.

c) Insert CacCard in the reader and follow the regular procedure.


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