Electrostatic Discharge Control For Image Sensors

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1. Introduction:

Image Sensor Solutions image sensor devices, unless stated otherwise in the device performance specifications, are rated as follows for ElectroStatic Discharge (ESD) sensitivity:

CCD Image Sensors:
Class 0 (<250V per JESD22 Human Body Model test), or Class A (<200V JESD22 Machine Model test.)
Note: We have recently started to use the JESD classification method. If the specification does not state JESD22 testing, Class 0 / Class A may be inferred.

ISS Class 0 / ACCD sensors have limited ESD protection and are at the low end of the voltage range (~50V).

CMOS Image Sensors:
These sensors are rated as Class 2 Human Body Model (>2000V), Class B Machine Model (200 – 400V).

ESD events may cause immediate damage to a device so that it is no longer functional, or the effect may not be noticed until a considerable time has passed with the unit operating to specification (Latent defects). ESD events may also show up as shifts in device characteristics.

Maximum voltage levels at gates are noted in the device performance specifications. Do not exceed these ratings. Different gates have different levels of protection.

Placing the device into a socket backwards, voltage overload, etc. may cause device breakdown similar to ESD effects to occur.

This note contains information about ISS image sensors and minimum recommended requirements for ESD control.

The cost of an appropriate ESD control program is generally well offset by the savings achieved in avoiding damaged devices.

2. Definition of Terms:

Term	Definition
Conductive Flooring	Floor tiling/matting with a surface resistivity 10^5 to $10^9\Omega$ per square. Conductive floors are recommended when wrist straps usage is not possible and personnel use conductive shoes or heel straps with connection to the skin.
Conductive Foam	Foam used to short the external leads of ESDS devices ($1x10^3$ to $1x10^6\Omega$-cm volume resistivity).
Conductive Footwear	Shoes, shoe covers or heel straps specifically designed to reduce static charges on the human body by contact with conductive/dissipative flooring
Conductive Material	Material with a surface resistivity $\leq 10^5\Omega$ per square and volume resistivity $\leq 10^4\Omega$ per square.
Dissipative Flooring	Floor tiling/matting with a surface resistivity from $10^9\Omega$ to $10^{12}\Omega$ per square.
ESDS devices	ElectroStatic Discharge Sensitive devices.
Ground	Earth or building ground.
Insulative Material	Material with a surface resistivity $>10^{12}\Omega$ per square, or a volume resistance $>10^{11}\Omega$-cm.

3. Personnel:

Operating Personnel:
Unprotected personnel may generate thousands of volts as they perform normal duties in the manufacturing area. All operating personnel should be protected as follows:

Wrist Straps:
Personnel should have their own wrist straps and cords, not shared. These should either be tested daily or under constant monitoring while in use.
Wrist straps must be worn against the skin.
Dirty wrist straps must be cleaned, if possible, or replaced
Wrist straps should only be connected to earth ground through a 1MΩ resistor. (The resistors are often built into the wrist strap/cable.)

Note:
Personnel must NOT be connected directly to ground.

Gloves:
Nitrile gloves are recommended because of their volume and surface conductivity profile. Gloves should not tribocharge when handling devices.

Clothing:
All personnel handling ESD sensitive devices must wear static dissipative smocks or suits that are closed. An open smock may allow voltages generated by an operator's normal clothing to cause an ESD event. Smocks may be further connected through the wrist strap or tablemat to ground.

Note:
All ESD protective items should be suitably approved before use.

Transient Personnel:
Visitors to ESDS work areas must wear closed, static dissipative smocks but, in the absence of further protection, for example, wrist straps, and an understanding of the problems caused by ESD and the protective program in place, should not be allowed within 5 feet of an active workstation.

4. Facility:

Environment:
Relative Humidity (RH) is an important factor in controlling ESD damage. It is recommended that the Relative Humidity be in the 40 to 50% range at 65 – 75°F. However, this alone is not enough to protect sensitive devices. In the 40 – 50% RH range, hundreds of volts may still be generated as an operator moves, for example. If the RH drops below 30% thousands of volts may be generated.

Ionization:
Full room or clean hood ionization may be considered as part of a complete ESD protection program. (Also see section 5 – Equipment.)

Floors:

Floor Conductivity:

If wrist strap usage is possible, a floor surface resistivity of $<10^{12}\Omega$ per square and a Resistance to Ground of $<10^{12}\Omega$ is the recommended. (Dissipative Flooring)

More Conductive flooring is recommended when wrist straps are not feasible and connection from the operator to the floor is made via heel straps or conductive shoes or booties.

However, wrist straps are preferred because they can easily be checked for effectiveness, including constant monitoring at the workstation.

Cleanliness:

Conductive or dissipative floors must be kept clean. Waxing should be avoided.

Awareness:

Post ESD awareness signs in ESDS sensitive work areas.
Posting such a sign on the door warns potential visitors of the need for protection. Escorts should instruct visitors of the potential for ESD problems.

5. Workstations:

Workstations should be protected as follows:

Equipment:

Ionized Air Blowers:
AC blowers are recommended with a balance of +/- 20volts, maximum, +/- 10 volts preferred.
Voltage decay from 1000V to 100Vunder such an ionizer to be less than 10 seconds.
Pulsed DC blowers are not recommended.

Assembly Equipment:
Soldering/desoldering and all other assembly tools should be ESD protected.

Table Mats:

Resistance:
Resistance from groundable point on mat to building ground: $<10^{6}\Omega$
Surface resistance to groundable point on mat: $<10^{9}\Omega$
Resistance between two locations on the mat: $<10^{9}\Omega$

Note:
ESD protective benches may replace a more traditional bench with a conductive table mat.

Cleanliness:

The workstation, including the table mats, should be kept clean of dust, ink marks, etc. Dirty table mats should either be cleaned or replaced. Similarly, replace torn tablemats.

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6. Handling Devices:

Shipping:
ISS image sensors are packed with four levels of protection:

1st. Level:
Image sensors are placed in conductive plastic tubes, clamshells or boxes. In clamshells and boxes, a layer of conductive foam is in contact with the leads of the devices.

2nd. Level:
ESD protective bags or boxes are used to hold one to several 1st-level containers.

3rd. Level:
The 2nd-level containers are further wrapped in anti-static bubble wrap.

4th. Level:
The 3rd-level packages are then placed in the outer shipping boxes and packed with anti-static treated peanuts.

ESD warning labels are used at each level of packing to inform users of the need for care when handling these devices.

Other active ISS products are similarly packed.

Receiving:
Shipping containers may be opened and image sensors in their 2nd-level containers moved to storage areas without ESD protection.

It is recommended that devices be removed from their 2nd-level containers at ESD protected workstations after all other levels of packing materials have been removed from the area. (See Section 7.)

Storing:
Store image sensors in, at least, their 1st-level containers.

Circuit Assembly:

Cleaning Image Sensors:
Improper cover glass cleaning may cause ESD events to occur. See ISS Application Note MT/PS-0237, Cover Glass Cleaning for Image Sensors.

In-Process Assembly and Testing:
Allow devices to slowly discharge any potential charge build-up when:

- Removing devices from their 1st-level container.

- Removing devices from test sockets.
  Hundreds of volts may be generated during the removal of devices from some test sockets. Allow this charge to dissipate in an ionized air stream before shorting the leads together in, for example, conductive foam. (The amount of time required for dissipation may be determined by measurement of the effectiveness of the ionized air blower. In the presence of a suitable ionizing blower, a delay of a few seconds is sufficient.)

- Removing temporary covers from sensors. (ISS supplies devices with taped on glass covers or plastic snap-on-lids.)

Avoid touching the leads.

Handle sub-assemblies in a similar manner to image sensors. For example, keep leads shorted for as long as possible, store sub-assemblies in ESD protective containers, etc.

Use ESD protected tools and equipment.

7. Restricted Materials and Equipment:

Materials:
Some materials are detrimental to an ESD protected operation because of their propensity to become charged; this charge may then be transferred to the image sensor.
A short list of materials that should be restricted includes:

Vinyl covered notebooks
Masking/Sealing tape
Plastic sleeves, penholders, bottles, etc.
Paper
Wood
Styrofoam
Brushes
Polyester
Cotton
Aerosol Sprays
Plastics

In short only have approved materials at a workstation.

8. Audits:

The essence in maintaining a controlled ESD environment is to constantly monitor the performance of protective equipment and materials, and the discipline of personnel in the work area. These audits should be formal and informal. Informal audits, for example, might be walkthroughs to gauge the discipline of the personnel in the work area. Formal audits include monitoring the performance of protective equipment such as the balance of ionizing blowers, table mat surface resistance, etc.

9. Training:

A training program should be in place to certify all personnel who work in ESD environments. A regular refresher program should also be part of the training process.

References:

Electrostatic Discharge Association, (www.esda.org) - Industry Standards:
ESD TR20.20: ESD Handbook (From ESDA)
ANSI S20.20: Development of an Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies and Equipment
ANSI ESD STM7.1: Floor Materials Resistive Characteristics of Materials
ANSI ESD STM9.1: Resistive Characterization of Footwear
ANSI ESD STM97.1: Floor Materials and Footwear – Resistance in Combination with a Person
EIA/JESD22-A114-B: Electrostatic Discharge (ESD) Sensitivity Testing Human Body Model (HBM)
EIA/JESD22-A115-A: Electrostatic Discharge (ESD) Sensitivity Testing Machine Model (MM)
ESD ADV3.2: Selection and Acceptance of Air Ionizers
JEDEC Standard JESD625-A, Requirements for Handling Electrostatic-Discharge-Sensitive (ESDS) Devices