TYPICAL ELECTROSTATIC VOLTAGES

MEANS OF STATIC GENERATION	ELECTROSTATIC VOLTAGES 10 TO 20 PERCENT RELATIVE HUMIDITY	65 TO 90 PERCENT RELATIVE HUMIDITY
WALKING ACROSS CARPET	35,000	1500
WALKING OVER VINYL FLOOR	12,000	250
WORKER AT BENCH	6,000	100
VINYL ENVELOPE FOR WORK INSTRUCTIONS	7,000	600
COMMON POLY BAG PICKED UP FROM BENCH	20,000	1,200
WORK CHAIR PADDED WITH POLYURETHANE FOAM	18,000	1,500
COMMON SANDWICH BAG OR STYROFOAM CUP	20,000	1,200

JUST RAISING AN ARM CAN CHANGE YOUR STORED VOLTAGE BY 100 VOLTS.

STANDING UP TO YAWN CAN CHANGE YOUR STORED VOLTAGE BY 1,000 TO 1,500 VOLTS.

CAUSES OF ESD DAMAGE

TWO OBJECTS TOUCH, RUB OR SLIDE TOGETHER, OR ARE SEPARATED

TWO CHARGED OBJECTS COME CLOSE TOGETHER -- WITHOUT TOUCHING

SAMPLE TRIBOELECTRIC SERIES

More Positive (+)

Air
Human Hands
Asbestos
Rabbit Fur
Glass
Mica
Human Hair
Nylon
Wool
Fur
Lead
Silk
Aluminum
Paper
Cotton
Steel
Wood
Amber
Sealing Wax
Hard Rubber
Nickel, Copper
Brass, Silver
Gold, Platinum
Sulfur
Acetate Rayon
Polyester
Celluloid
Orlon
Polyurethane
Polyethylene
Polypropylene
PVC (PolyVinylChloride)
KEL-F (ChloroTriFluoroEthane)
Silicon
Teflon

More Negative (-)

BASIC DEFINITIONS

Charge for ESD is the static electricity caused by rubbing or separating objects.

Potential is a measurement of amount of charge, and is a relative measurement. For example, if an electronic component has a negative 200 volts of static charge on it relative to ground potential (zero volts), and you have a positive 1000 volts of static charge relative to ground, the potential difference is 1200 volts between you and the component.

Conductive Materials are those materials (such as metals) which are capable of spreading charge across their whole surface **evenly** and **rapidly**. You can picture a conductive object spreading charge like water flowing in a river and its tributaries; the water (charge) level is basically the same everywhere.

Non-Conductive Materials (insulators) do not spread charge across themselves evenly - the charges tend to localize in one spot.

For an example of conductive and non-conductive materials, consider a household lamp. The electrical cord has a non-conductive casing on the outside, and conductive metal wires on the inside. The electricity does not flow through the non-conductive casing, but flows rapidly through the conductive wires to the bottom of the light bulb.

Dissipative Materials are between conductors and non-conductors in their ability to spread charges, and are very important in ESD control. They spread charge fast enough to allow its removal, but slow enough to not create a spark. Examples are:

- Antistatic floor mats,
- Antistatic smocks,
- Antistatic bags, and so forth.

PROTECTING AGAINST ESD

ESD Safe Work Space

The basic rule is to prevent static generation (charging) in the first place. If static charge isn't allowed to build up, there can be no static discharges.

All materials must be classified as conductive/dissipative or non-conductive, because the method to protect against ESD is different for each.

For Conductive/Dissipative Materials in your work space, connect them together to a common ground to drain off all charge that accumulates on both conductive materials and people. *The connection is made through a resistive network (typically one Megohm).*

- Conductive/Dissipative table mats
- Conductive/Dissipative tote boxes
- Wristraps, heelstraps, and so forth

For Non-Conductive Materials in your work space, connecting them together to ground does not drain off charge, so there are only secondary alternatives:

- Keep non-conductors out of the work area completely.
- Use air-ionizers, for example, to neutralize charges on non-conductors that can't be eliminated.
- Place non-static sensitive materials in antistatic bags to prevent polluting your ESD safe work environment with static generating materials.

And FINALLY,

Access to ESD protected work spaces should be restricted to people who are properly trained and attired. *Everyone else* must be escorted, cautioned in ESD protective procedures, and restricted from contacting ESD sensitive items.

PROTECTING AGAINST ESD

ESD Safe Transport and Storage

The basic rule is to prevent static generation (charging) in the first place. If static charge isn't allowed to build up, there can be no static discharges.

All ESD sensitive materials being stored or transported are exposed to static fields, and direct discharges from people.

For non-static sensitive materials, place them in antistatic bags to prevent them from creating static, and to prevent the device in the bag from discharging to cause a current flow.

For static sensitive materials, place them in static shield bags*, *and then close the bags*, to prevent static generation as well as to protect the device in the bag from static fields.

*Please note that conductive tote boxes with a cover and other covered static shielding devices can be used for transport and storage.

HOW ESD CAN AFFECT PRODUCTION

IF only 0.5% of incoming integrated circuits (IC's) are received with ESD damage i.e. 1 out of 200 IC's (or 99.5% 'good' IC's), AND then

IF 50 of these IC's are used per circuit board, you can expect *one out of every four* boards to fail (25%) due to an ESD damaged IC installed on it.

IF you now use six of these boards in your final *system*, knowing one out of four of these boards is expected to fail, then you can also expect the *system* to fail production test 82.2% of the time!

AN 82.2% FAILURE RATE
WITH 99.5% GOOD PARTS