



قال رسول الله (ص)
رَحِمَ اللَّهُ امْرئَ عَمِلَ عَمَلًا فَأَتَقَنَهُ

خدا رحمت کند کسی را که عملی انجام
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آشنایی با کفپوش های الکترو استاتیک

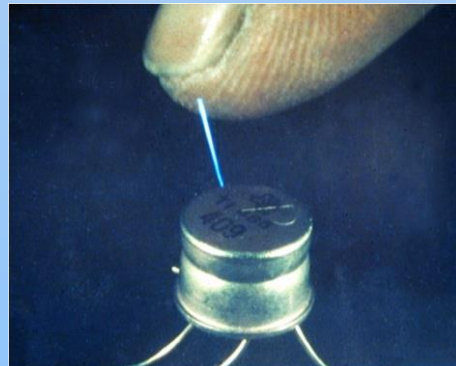
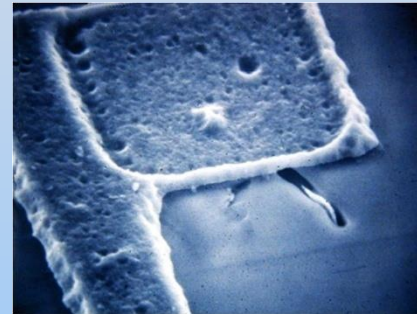
خردادماه ۹۵

معاونت درمان دانشگاه علوم پزشکی اصفهان

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کارشناس رسمی دادگستری در رشته لوازم و تجهیزات پزشکی
پایه ۱ نظارت و طراحی تاسیسات برقی از سازمان نظام مهندسی ساختمان

Electrostatic Discharge



ESD Basics and Protection

**prevent, eliminate and monitor
electrostatic charges**



With the development of Metal Oxide
Semiconductor (MOS)
technology in the 1960s, the effects of an
invisible static discharge (levels below 2000V)

1970 establishment of the ESD Association
were finally realized

What is ESD?

ESD definition

Types of ESD damage

Sources of ESD

Common causes of ESD

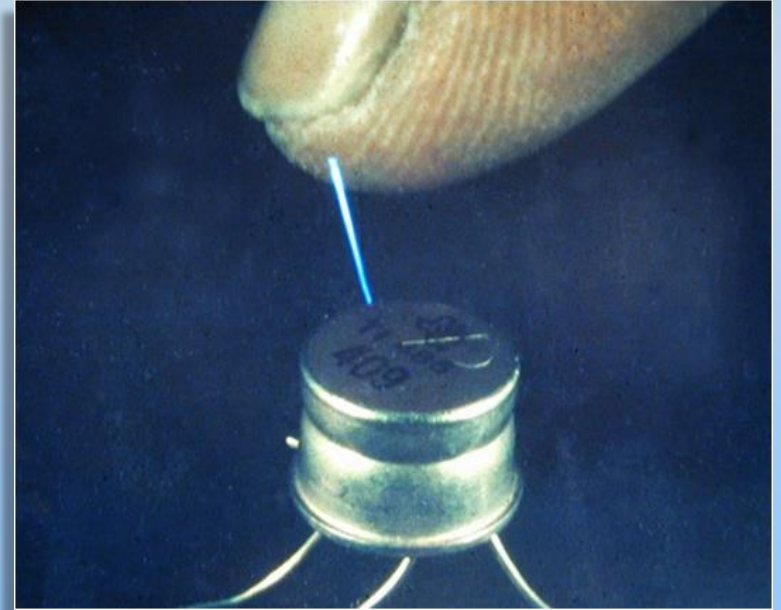
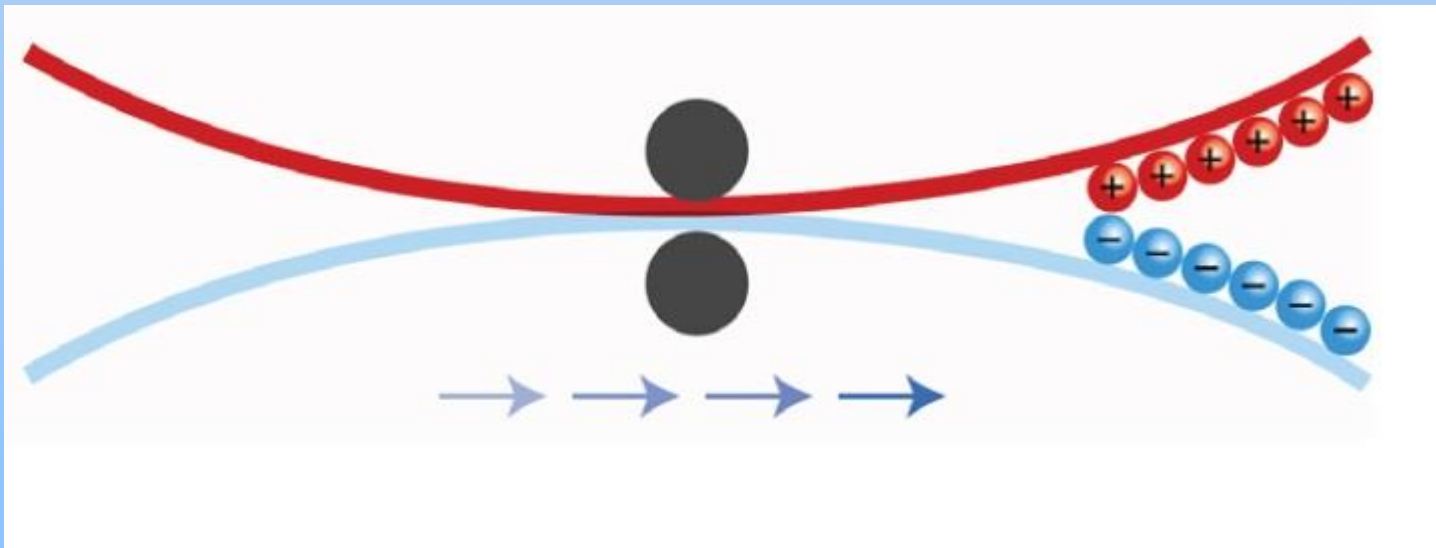
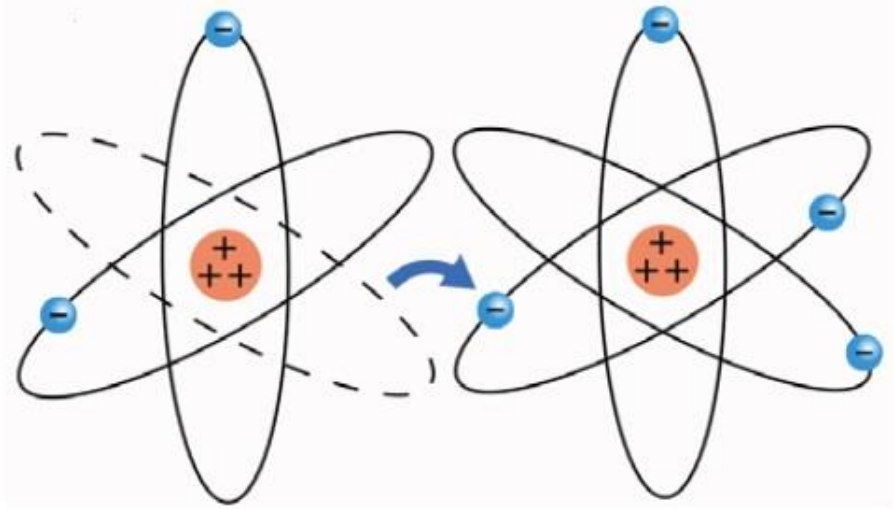
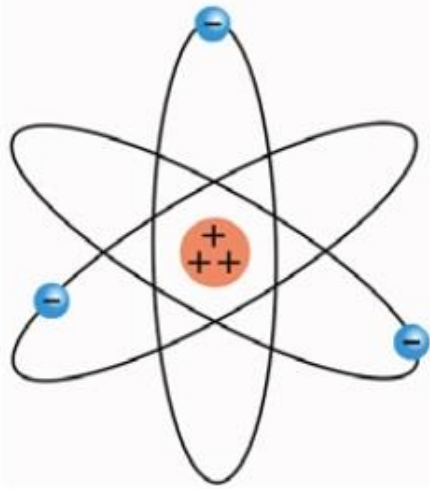


Photo of ESD arcing from finger to component



Triboelectric Series



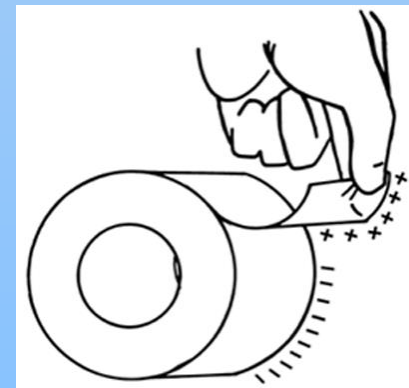
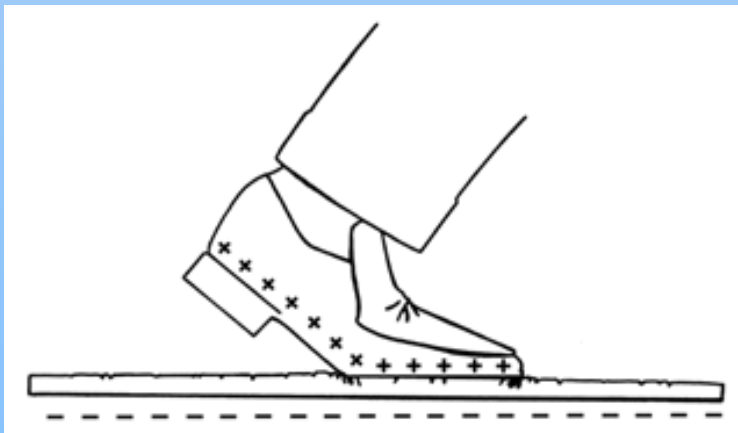
Air
Human body
Glass
Nylon
Wool
Lead
Cotton
Aluminum
Paper
Steel
Wood
Gelatin
Nickel, copper
Gold, platinum
Natural rubber
Sulfur
Acetate
Polyester
Celluloid
Urethane
Polyethylene
Vinyl
Silicon
Teflon

ESD Definition

ESD – Electrostatic Discharge: The transfer of an electrostatic charge between bodies at different electrical potentials.

Also referred to as static electricity –

**Electrostatic charge is most commonly created by the –
contact and separation of two materials which results in
Tribocharging**



ESD Is the Hidden Enemy

There are innumerable ESD events occurring all the time that we cannot see or feel.

People Feel ESD at **2000 Volts!!!!**

Component damage - can occur with as little as **15 – 30 Volts!!!!**

Examples of Static Generation Typical Voltage Levels		
Means of Generation	10-25% RH	65-90% RH
Walking across carpet	35,000V	1,500V
Walking across vinyl tile	12,000V	250V
Worker at bench	6,000V	100V
Poly bag picked up from bench	20,000V	1,200V
Chair with urethane foam	18,000V	1,500V

The relative humidity (**RH**) directly affects the ability of a surface to store surface charges. The higher the RH, the less time an item will hold a charge

Typed of Materials that Charge

Conductors

Materials that easily transfer electric charge.
Can be used to transfer charge to earths ground.

Examples:

Metals

Water

Carbon

People

Insulators

Materials that hold an electric charge and can not easily transfer the charge to earth

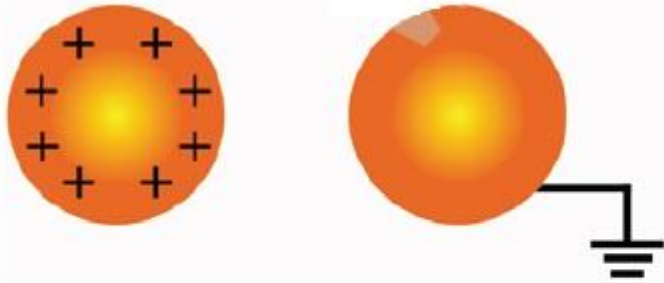
Examples:

Plastics

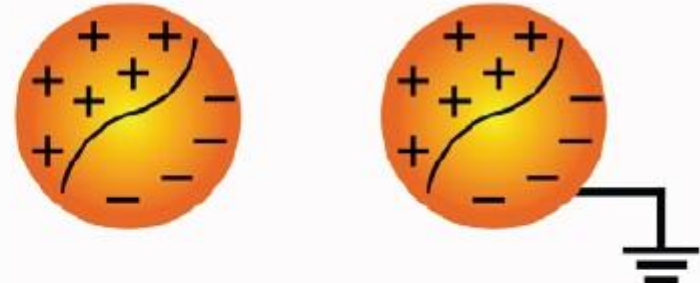
Glass

Dry Air

Typed of Materials that Charge



Conductors

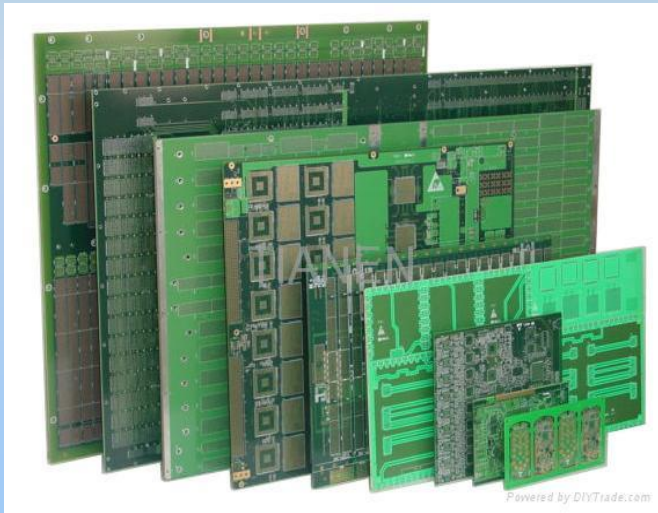


Insulators

What type of Materials are ESD Sensitive?

ESDS – Electrostatic Discharge Sensitive

- Integrated Circuits (DIPs, QFP, BGA, SOT, ...)
- Crystals and oscillators
- Printed Circuit Board Assemblies



Common Causes of ESD

- Opening a common plastic bag
- Removing adhesive tape from a roll or container
- Walking across a floor and grabbing the door knob
- Transporting computer boards or components around in their trays on non-ESD carts
- Sliding circuit boards on a work bench



Types of ESD Damage

CATASTROPHIC FAILURE•

- A device is exposed to ESD and it no longer works
- The device circuitry is permanently damaged
- Such failures may be caught when tested, before shipment

LATENT FAILURE•

- A device is exposed to ESD and is partially damaged, yet it continues to work
- The product may have a failure after the user places it in service

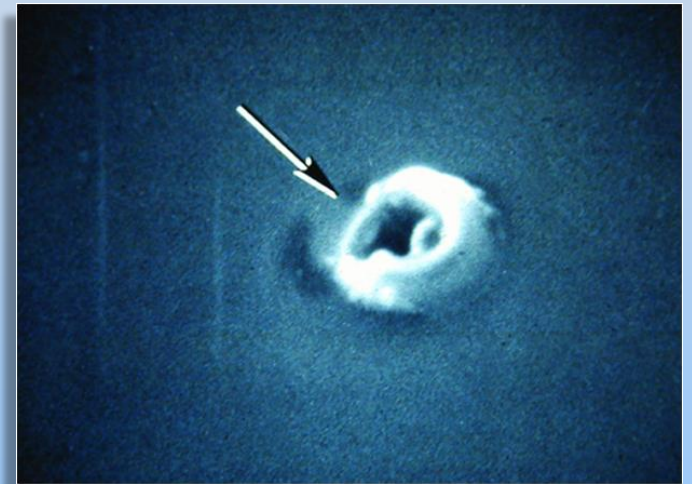
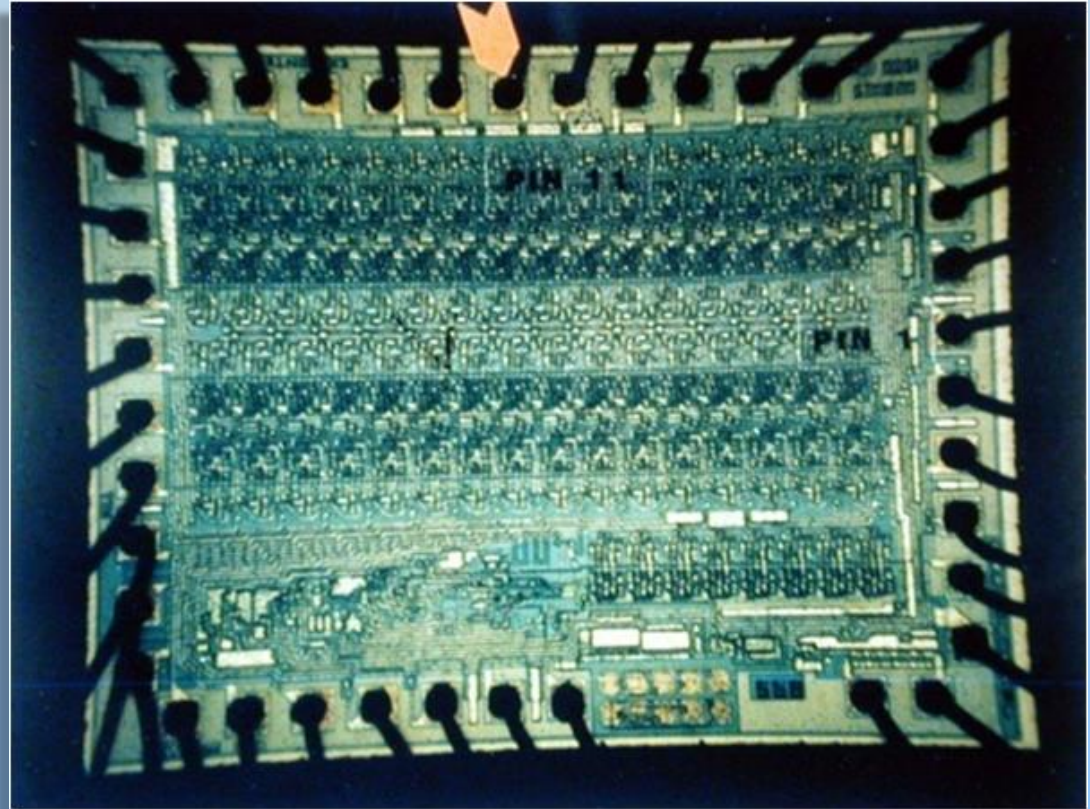


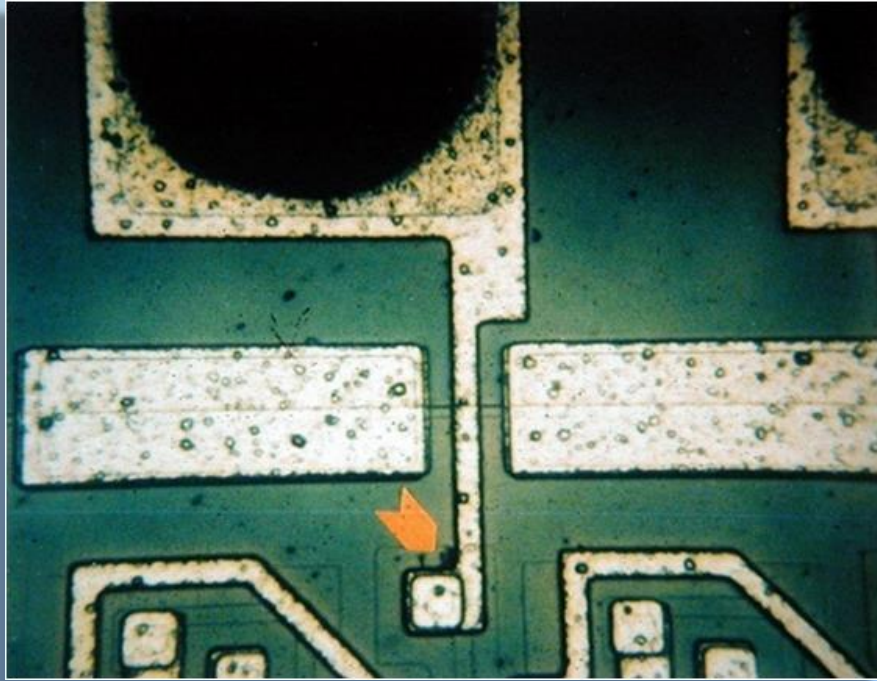
Image of the ESD damage after removal of the capacitor metallization.
Magnification is 10,500 times

Example of ESD Damage

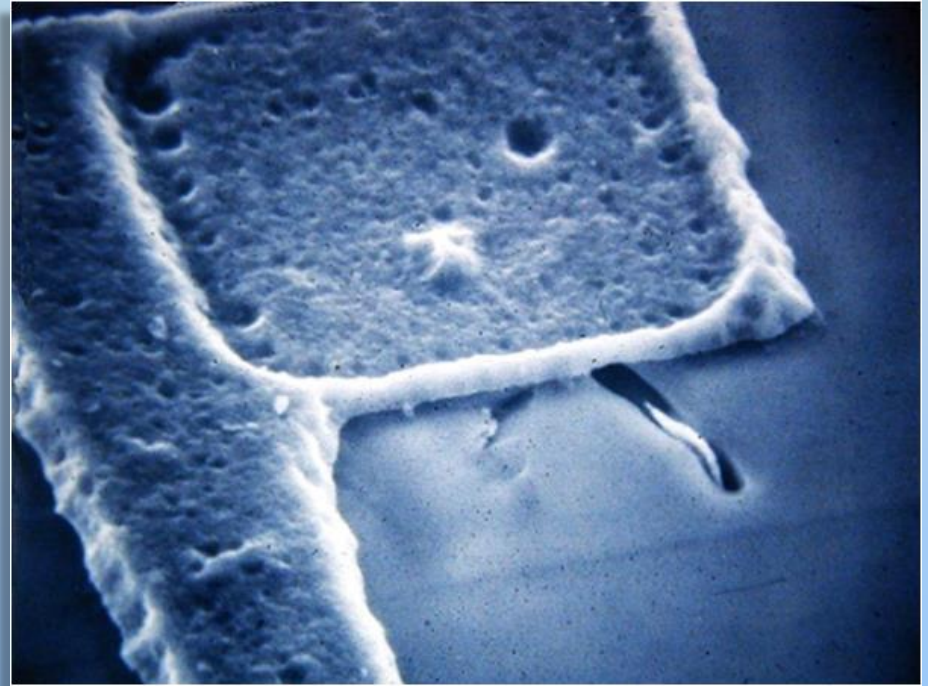
Optical photo of a large Integrated Circuit which has experienced ESD damage to the pin noted by the arrow.



Example of ESD Damage



400 times magnification



5,000 times magnification

Why is ESD Important?

Electrostatic Discharge (ESD) can damage • sensitive electronic devices, resulting in:

Higher manufacturing costs:

- Rework
- Repair
- Scrap

Lower production yields:

Unhappy customers:

- Shorter product life
- Reduce product reliability



electronics industry = Estimates of actual cost of ESD damage to the
\$\$\$ Billions annually

How to control ESD?

ESD Control Program

- ESD Training
- ESD Control Areas
- Ground Conductors
- ESDS Component Handling and Storage



ESD Control Program

The first step in ESD control is to **train all personnel who may come in contact with static sensitive materials**

Create an ESD Control Area

- Any area where unprotected ESDS parts and assemblies may be handled
- ESD areas must be labeled with posted signs and their boundaries marked



ESD Control Program

Personal Grounding:

All personnel, including visitors



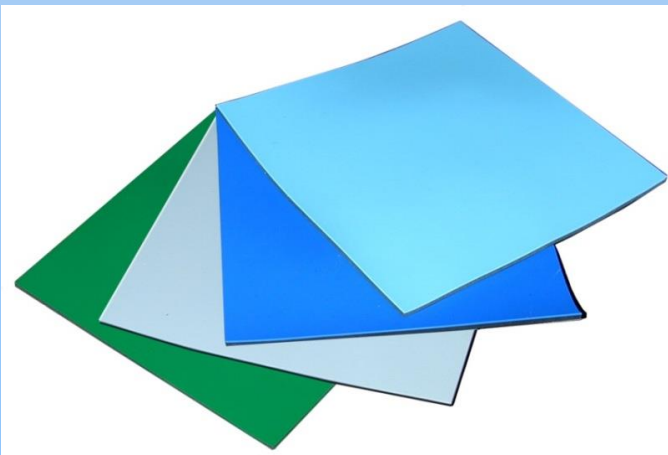
wrist straps



Equipment Grounding

Work Stations and Tables

- Must have static dissipative surfaces connected to the building ground source.
- Must have wrist strap ground connections (2 recommended), preferably banana jack receptacles, connected in parallel to the bldg ground source
- Should be cleaned daily with an antistatic cleaner



ESDS Component Handling and Storage

To move ESDS parts or assemblies inside an ESD control area, use one of the following:

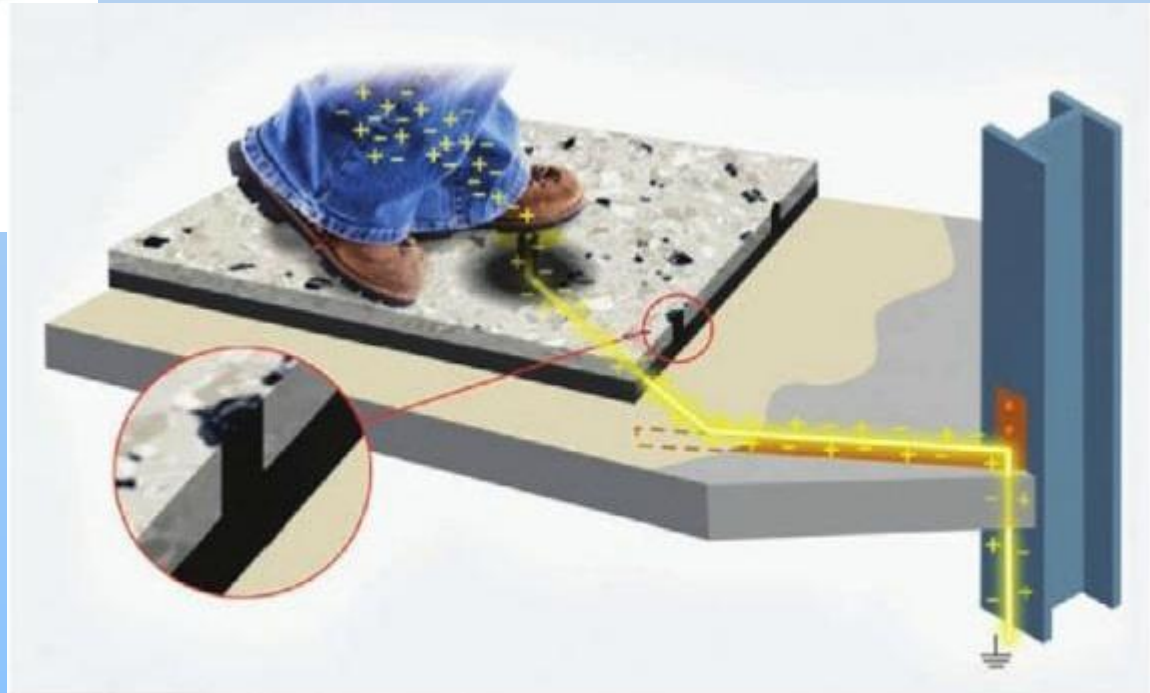
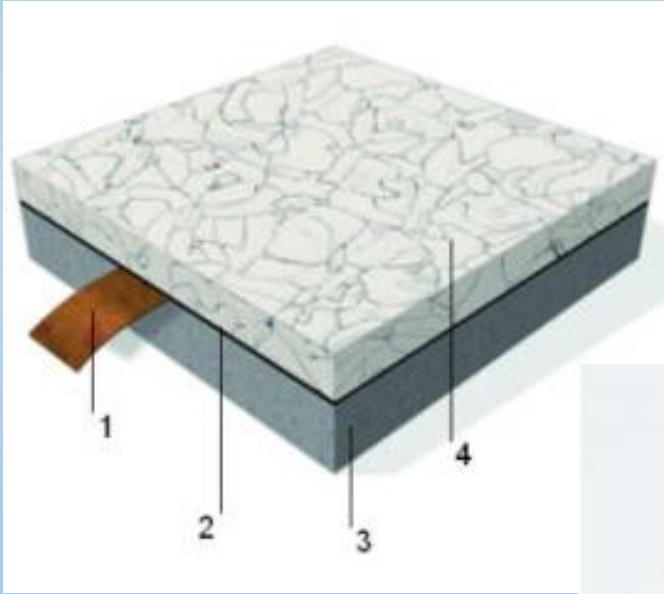
- Static dissipative containers
- Static shielding containers
- Conductive containers or board carriers
- Ground movable racks



Surface Mount Devices
SMD Boxes



Anti Static Flooring



How electrostatic discharge (ESD) flooring works.

Antistatic: the term refers to a material that resists tribocharging

Anti static flooring: The term anti static refers to a condition where static generation is inhibited during contact and separation with a different material.

Anti static flooring can either be :

static dissipative

static conductive

Insulative materials

Insulative materials:

Insulative materials prevent or limit the flow of electrons across their surface or through their volume. Insulative materials have a high electrical resistance and are difficult to ground. Static charges remain in place on these materials for a very long time. Insulative materials are defined as those having a surface resistivity of **at least $1 \times 10^{12} \Omega/\text{sq}$**

Conductive materials:

With a low electrical resistance, electrons flow easily across the surface or through the bulk of these materials. Charges go to ground or to another conductive object that the material contacts or comes close to.

Conductive materials have a surface resistivity less than $1 \times 10^5 \Omega/\text{sq}$.

Dissipative materials:

For these materials, the charges flow to ground more slowly and in a somewhat more controlled manner than with conductive materials. Dissipative materials have a surface resistivity equal to or greater than $1 \times 10^5 \Omega/\text{sq}$ but less than $1 \times 10^{12} \Omega/\text{sq}$

2 Layer ESD rubber worksurfaces

There are several types materials used, but the most common is 2 layer ESD rubber. ESD rubber is constructed with a **dissipative top layer** and a **conductive black bottom layer**.

The dissipative top surface allows charges to drain from its surface in a controlled manner, sending it to the bottom conductive layer. The conductive bottom layer has a low electrical resistance and quickly sends the charge to ground via a ground cord that includes a current limiting resistor for safety. The top layer is also extremely durable, offering excellent resistance to hot solders, soldering irons and most solvents.

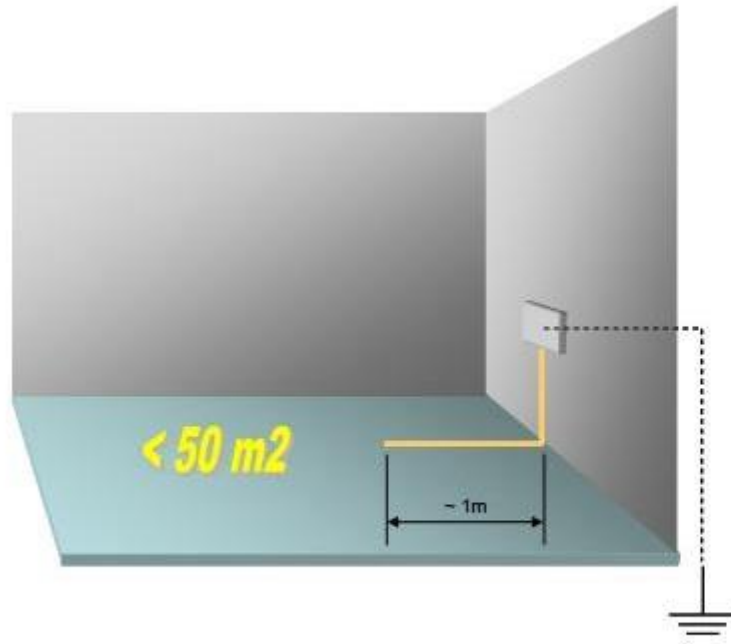


Figure 1 – Copper strip layout
for rooms $< 50 \text{ m}^2$

Ref. ANSI/ESD S20.20-2007



Grounding ANSI/ESD S6.1 section 5.3.3

Standard: ISO 2878:1987 (Flooring Resistance Test)

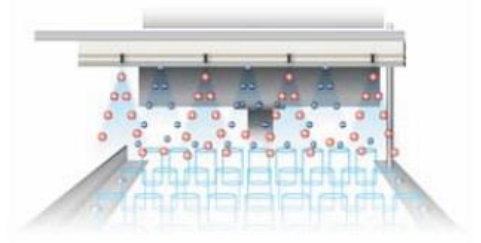
R_{tg} or Resistance to ground

The resistance in ohms measured between a single electrode placed on a surface and ground.

R_{tt} or Point-to-point resistance (or top to top)

The resistance in ohms measured between two electrodes placed on any surface.





STANDARDS ISSUES ADDRESSED

EOS/ESD S1.0 Personnel Grounding Wrist Straps

ESD DS1.1 Evaluation, Acceptance & Functional Testing of Wrist Straps (Revised)

ESD STM2.1 Resistance Test Method for ESD Protective Garments

ANSI/EOS/ESD S3.1 Ionization

EOS/ESD S4.1 Worksurfaces - Resistive Characterization

ESD DS4.1 Worksurfaces - Resistive Characterization (Revised)

ESD STM4.2 Worksurfaces - Charge Dissipation Characteristics

ANSI EOS/ESD S5.1 ESD Sensitivity Testing Human Body Model Component Level

ANSI ESD S5.2 ESD Sensitivity Testing Machine Model Component Level

ESD DS5.2 ESD Sensitivity Testing Machine Model (Revised)

ESD DS5.3 ESD Sensitivity Testing Charged Device Model

ANSI EOS/ESD S6.1 Grounding - Recommended Practice

ANSI ESD S7.1 Floor Materials - Resistive Characterization of Materials

ANSI ESD S8.1 ESD Awareness Symbols

ESD S9.1 Resistive Characterization of Footwear

ANSI EOS/ESD DS11.11 Surface Resistance Measurement of Static Dissipative Planar Materials

ESD DS11.12 Volume Resistance Measurement of Static Dissipative Planar Materials

ANSI ESD S11.31 Evaluating the Performance of ESD Shielding Bags

ESD STM12.1 Seating – Resistive Characterization

ESD ADV 1.0 Glossary of Terms

ESD ADV 2.0 ESD Handbook

ESD ADV 3.2 Selection of Acceptance of Air Ionizers

ESD ADV 11.2 Triboelectric Charge Accumulation Testing

ESD ADV 53.1 ESD Protective Workstations

ESD Packaging Properly Marked

ESD protective packaging should be marked
in accordance with ESD Protective Symbol
[ANSI/ESD S541]



تابلو های ایزوله

IEC 60529

4. Elements of the IP Code and their meanings:

Element	Numerals or letters	Meaning for the protection of equipment	Meaning for the protection of persons
Code letters	IP	-	-
First characteristic numeral	X 0 1 2 3 4 5 6	Against ingress of solid foreign objects: not required (non-protected) ≥ 50 mm diameter ≥ 12,5 mm diameter ≥ 2,5 mm diameter ≥ 1,0 mm diameter dust-protected dust-tight	Against access to hazardous parts with: not required (non-protected) back of hand finger tool wire wire wire
Second characteristic numeral	X 0 1 2 3 4 5 6 7 8	Against ingress of water with harmful effects: not required (non-protected) vertically dripping dripping (15° tilted) spraying splashing jetting powerful jetting temporary immersion continuous immersion	-
Additional letter: optional	A B C D	-	Against access to hazardous parts with: back of hand finger tool wire

Isolated Power System (IPS)



یک سیستم IPS شامل یک قسمت Isolation Power Panel (IPP) و مدار مربوط به هر اتاق عمل می شود.

پنل شامل قسمت های زیر است:

- ترانس ایزوله

Line Isolation Monitor (LIM)

- تعداد مورد نیاز کلید (۱۶ مدار)

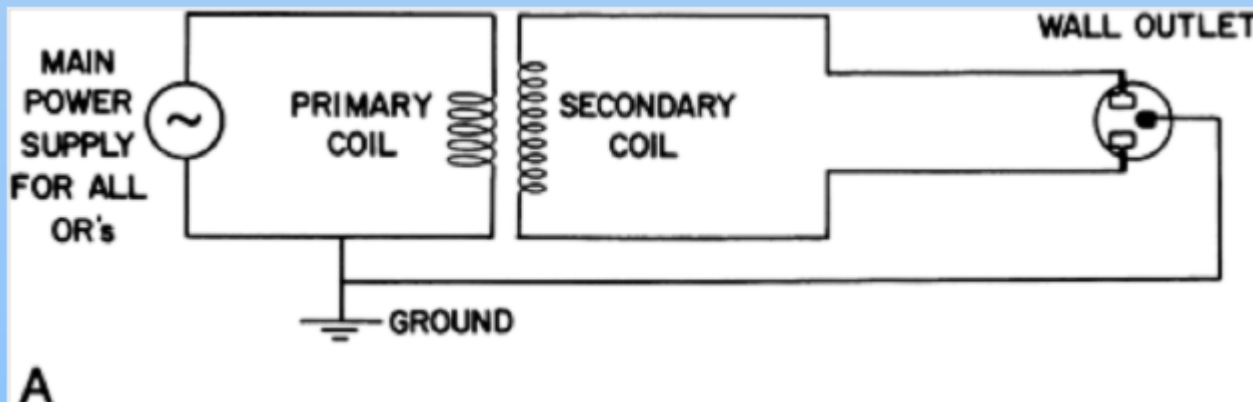
Line Isolation Monitor (LIM)



سیستم های ایزوله (IT System) دارای یک ویژگی منحصر به فرد می باشند:

خطای اول شبکه موجب قطعی سیستم نمی گردد و لذا عملکرد سیستم در این حالت مختل نمی شود.

بنابراین یک سیستم IT مجهز به رله های تشخیص ارت فالت به روش اندازه گیری مقاومت عایقی می تواند برای مدارهایی که نیاز به ایمنی و قابلیت اطمینان بالا دارند ، طراحی و توصیه گردد.



بطور همزمان این رله ها قادرند میزان بار مصرفی و دمای ترانسفورماتور را نشان داده و هنگام عبور از حد مجاز این موضوع را بصورت یک خطا به سیستم اعلام آلارم نمایند که این موارد جزء الزامات استاندارد IEC 61557-8 می باشد.

یکی دیگر از مهمترین ویژگی های برخی از رله های ارت فالت بیمارستانی تشخیص آنلاین بار معیوب (پریز خروجی تابلو ایزوله بیمارستانی) با بهره گیری از سیستم مکان یاب خطا می باشد.