

Basic Knowledge for Eliminating ESD Failures

(ESD: Electro Static Discharge)



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1. Static Electricity: Generation and Charge

•What is static electricity?

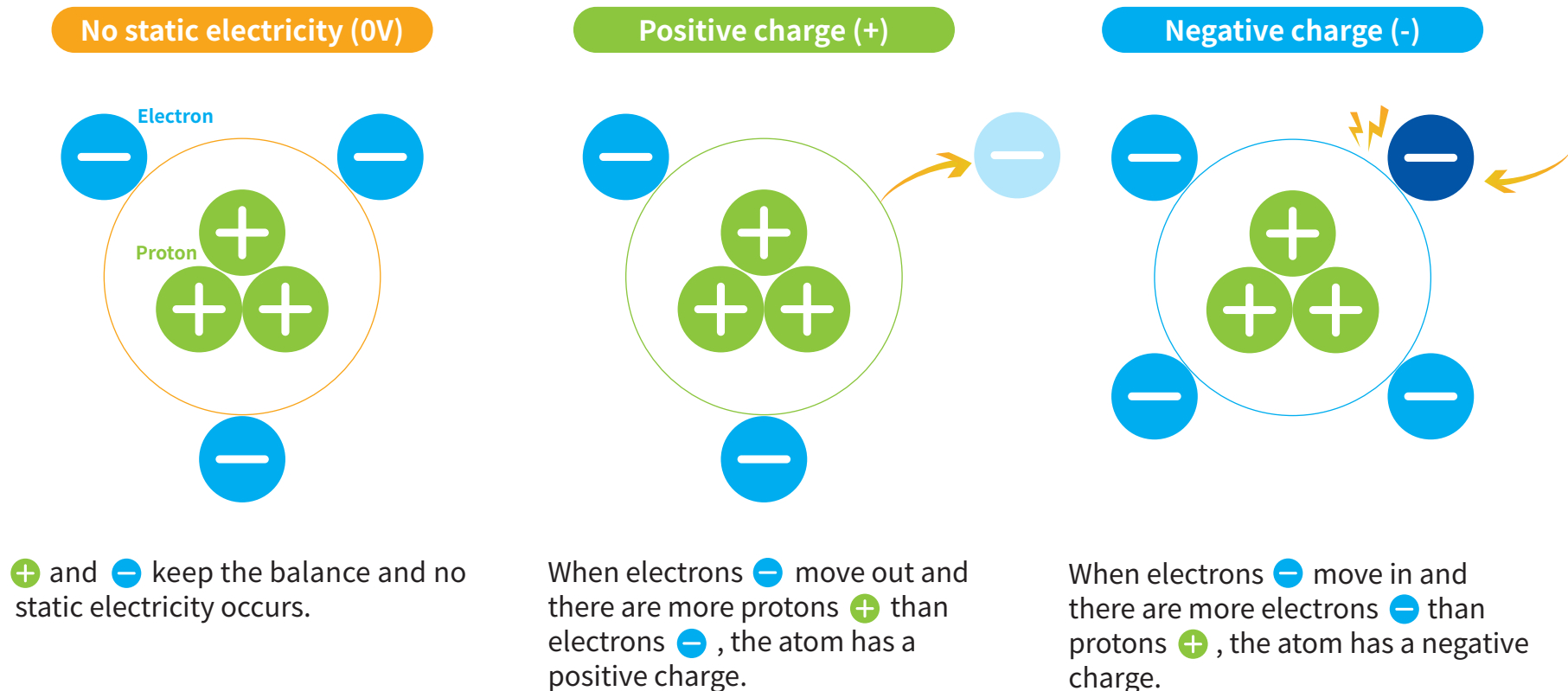
An object electrically consists of neutral electrical arrays of protons (positively charged) and electrons (negatively charged).

When these electrical arrays lose balance due to friction, etc. and the electrical polarity shifts to one side, it is called "charged". This charged physical phenomenon is called static electricity.

An object is charged either positively or negatively depending on the material. When a charged object comes in contact with another object and they have a potential difference, electrons disperse. This phenomenon is called "discharge."

[Example] the structure of an atom

* The structure of an atom varies between substances.



1. Static Electricity: Generation and Charge (continued)

● Human actions and charge amount

Causes of static electricity	Static electricity voltage (V)
Walking on a nylon carpet	2000 ~ 2500
Walking with one's feet sliding on a nylon carpet	4500
Standing up from a sofa	3500 ~ 4500
Taking off an acrylic sweater	4500 ~ 5000
Taking off polyester working clothes	4000 ~ 4500
Folding an acrylic blanket	5000 ~ 6000

⇒ Even a small action can cause static electricity by friction or ablation.

【Note】

These values are reference values at 25°C/40%Rh. Higher voltage occurs at lower humidity.

● Charge in a human body and sensation at the time of discharge

Charge amount (V)	Sensation at the time of discharge
1000	Cannot be felt at all
2000	Feels like something on the outside of the finger without pain
2500	Feels like being stabbed with a needle without pain
3000	Feels like being stabbed with a needle with slight pain
4000	Feels like being deeply stabbed with a needle with pain in the finger

⇒ A person can only feel a discharge of 2,000 V or higher.

Many components are destroyed by voltages less than 1,000 V.

Components can be destroyed by discharges that humans cannot detect.

2. Mechanism of Electrostatic Destruction

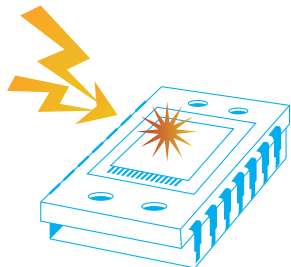
● What is electrostatic destruction?

An IC is covered with a thin film of highly insulating material such as silicon oxide. When static electricity discharge causes a temporary flow of high-voltage electricity, the insulation layer of silicon oxide is broken and the circuit inside is damaged. This phenomenon is called electrostatic destruction.

In general, a diode is destroyed when a reverse voltage of several hundred volts is applied.

● Causes of destruction and destruction models

[Example ①] A discharge from a charged body to a device causes damage to the device.



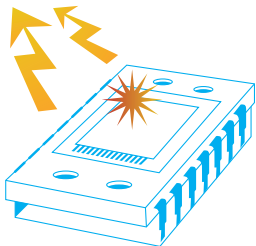
● Human-Body-Model (HBM)

This model assumes that a charged human body touches a semiconductor device and a discharge occurs from the human body to the semiconductor device.

● Machine-Model (MM)

This model assumes that energy charged to the equipment capacity causes a discharge to a semiconductor device.

[Example ②] When a charged device discharges to another object, it undergoes sudden stress and is damaged.



● Charged-device-Model (CMD:Charged-device-Model)

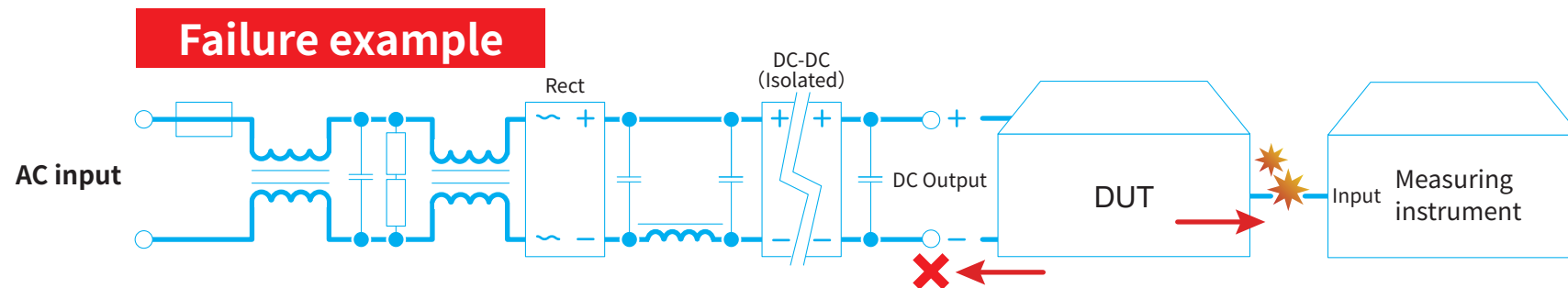
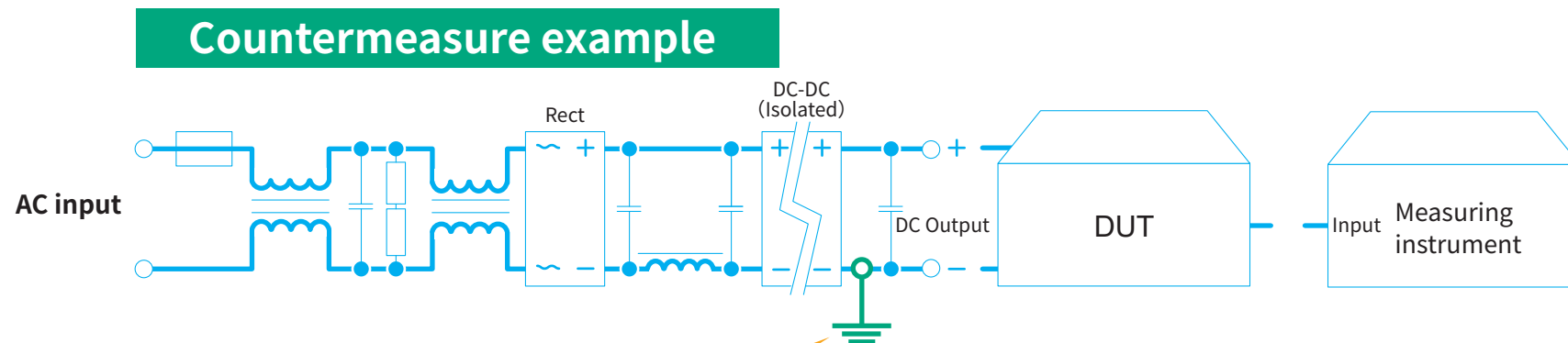
This model assumes that a semiconductor device rubs against or approaches a charged object and carries static electricity, inner components such as a chip connected to a lead terminal are charged, and a discharge occurs from the lead terminal to the outside.

3. Case Examples of Electrostatic Failure

[Failure case 1:] No ground circuit to DUT

The AC adapter had no grounding as it was a two-pole type insulated from the AC line. Therefore, the static electricity of DUT could not be discharged. As a result, an electrostatic discharge occurred because a measuring instrument was connected and the front-end semiconductor was damaged.

A human body discharging static electricity often causes an incident. It is therefore necessary to take measures considering the human body.



Countermeasure case example :

Ground the minus terminal of the AC adapter of DUT.
Replace the two-prong plug with a grounded three-prong plug.

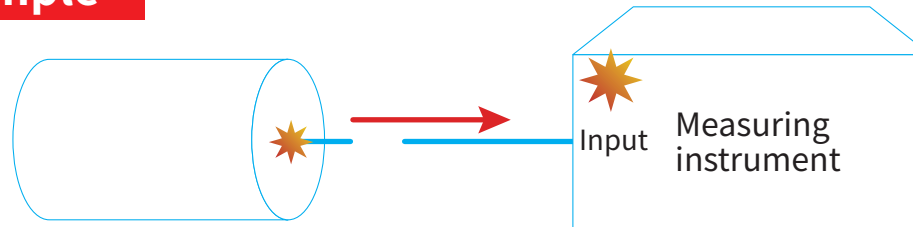
3. Case Examples of Electrostatic Failure (continued)

【Failure case 2:】 Discharging due to the charge of a coaxial cable

After a coaxial cable was connected to a measuring instrument, the instrument did not function. In the coaxial cable, the core line and the shield line are insulated from each other. Therefore, even if the shield line is grounded, the electric charge of the core line is not discharged.

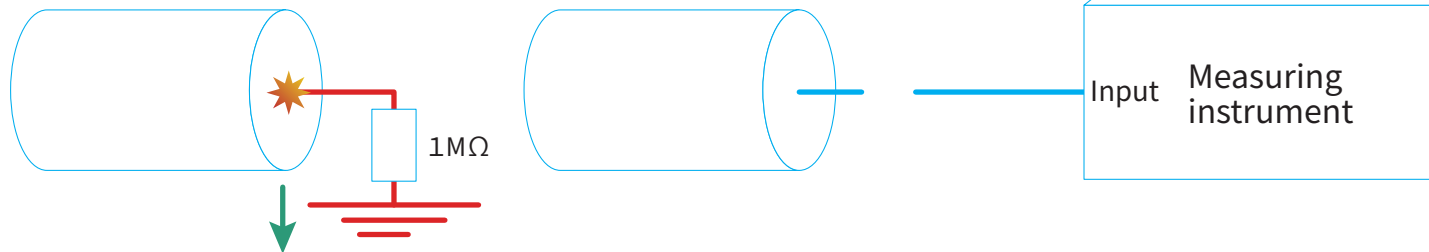
A human body discharging static electricity often causes an incident. It is therefore necessary to take measures considering the human body.

Failure example



Countermeasure example

Discharge once and then connect.



Countermeasure case example :

Ground the core line once for discharge and then connect the cable to the measuring instrument.

4. Basic Rules for Anti-Static Measures

● Basic concepts for anti-static measures

(Prevent discharge from human bodies or objects to products or inspection equipment)

Basic 1

Create processes, equipment, and a production environment to prevent the generation of static electricity

➤➤➤ Process design, electrically conductive floors, and humidity control to prevent the generation of friction and contact.

Basic 2

Do not bring objects easily charged with static electricity into the process

➤➤➤ Eliminate insulators such as vinyl or plastic material from the target area

Basic 3

Let static electricity release immediately to prevent discharge

➤➤➤ Use of grounding, electrically conductive mats, ion blowers, and tools with anti-static measures

Basic 4

Regularly check anti-static measures and maintain their effectiveness

➤➤➤ Regular verification of the effectiveness of anti-static items

Basic 5

Raise awareness about the necessity of anti-static measures among workers and process managers

➤➤➤ Education and enlightenment to deepen workers' knowledge and understanding

