

Electrostatic Protection for Semiconductor Products

Users should be aware of certain problems not often associated with the use and handling of semiconductor devices. Common problems relative to ESD (electrostatic discharge) and the role it can play in the manufacturing of systems using microelectronic devices are described here.

A common misconception is that only metal-oxide semiconductors, such as used in CMOS technology, are susceptible to ESD damage.

This has been shown, in numerous studies and testing, not to be the case. Bipolar products also can be susceptible and, in some cases, even have lower thresholds of failure or parametric degradation than MOS product. All semiconductor devices should be treated as though they are sensitive to static discharge. This approach will save the handler considerable costs both in manufacturing and field reliability.

Electrostatic potentials are pervasive in that they exist virtually everywhere that electrical insulators are present. The insulator does not necessarily have to be a solid since even liquids and gasses may possess insulating properties. High electric fields may be built up in these insulating materials and discharge themselves easily into a semiconductor device without the slightest indication that a field even existed. Everyone should be familiar with the effect of hair standing on end during the cold and dry winter months. This phenomenon is a result of static charge. It is important to note that the threshold at which a human can detect, by sense of feel, a static charge is roughly 4 kilovolts. This means an operator, assembler, technician, or engineer may be inducing static and never be aware that the event occurred.

There exists a group of materials known as the “Triboelectric Series”. Simply put, this is a group of materials that have a high propensity to generate static charge and thus create problems for semiconductor manufacturers as well as equipment manufacturers. Some of these materials are common in many workplaces and in manufacturing environments. The list includes such materials as acetate, glass, nylon, polyester, cotton, acrylics, polyurethane foam, TEFLON (PTFE), PVC (vinyl), and numerous others. These materials should be kept from coming in direct contact with any semiconductor device no matter what its ESD sensitivity because they can generate static fields in the tens of kilovolts.

Static charge carries very limited energy, but damage to a semiconductor junction or gate dielectric in MOS devices does not require high energy to fail or be degraded. The simple discharge of static into a device is enough to catastrophically rupture a MOS gate oxide or create a damaged junction on a bipolar device. These effects can be subtle in

that they are difficult to recognize visually on a device even under extreme magnification (>500×). Often a SEM (scanning electron microscope) is required to identify the damage location and confirm that an ESD event in fact had occurred.

Input Protection Networks

Many semiconductor devices incorporate input protection networks directly onto the die to improve static sensitivity. Their purpose is to protect the device while in its application with ground and power applied and not meant to provide protection in any environment that does not have power and ground connections applied. Even in the case of a free-standing board populated with semiconductors, the input protection networks will be of little value since a PC board edge connector will simply act as an extension of the device’s leads and any discharge into the card may ultimately wind up at a device terminal.

For this reason, an assembly or PC board should be handled with the same care relative to ESD as a free-standing device. If a board is transported, it should be placed in a conductive container designed to protect static sensitive components. In addition, it always is prudent to use a shorting bar on any PC board edge connector to assure that static discharge does not reach any device through the edge connections.

Static Protective Materials

There are many brands of static protection materials that may be procured. The user should be aware that the efficacy of all these materials is not the same when it comes to static charge dissipation.

Some materials, such as “static bags” and “static protective tubes”, are coated simply with a conductive spray that will degrade over time and repetitive use. These systems are more appropriate for a one-time use and should not be considered for repeated use. The best ESD protection comes from materials that are “volumetrically” conductive. That is, their entire bulk is conductive and not just their surface. These materials can be used repetitively without the concern for degradation with time and use. Conductive sprays also are materials that one should be wary of since many degrade in their efficiency rapidly and their ability to reduce static levels varies greatly from vendor to vendor.

The best course of action for any user of semiconductor devices and systems that employ semiconductors is to assume that all product is susceptible and thus protect their devices as well as their systems throughout the entire manufacturing process.

Revision History

Number	Date	Description
1	May 26, 2022	Updated branding and minor editorial updates

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