Guest Editorial

How ESD damage affects OEMs and what they can do to mitigate the damage

By Kristin Allen

High tech companies lose at least 4-6 percent of annual gross sales due to electrostatic discharge (ESD) every year, according to Stephen Halperin, president of the Electrostatic Discharge Association. "I know of companies who are aware of ESD losses totaling 10 percent or more of their gross sales – and that is only the losses above which they had budgeted for," notes Halperin.

Damage from electrostatic discharge affects productivity and product reliability in virtually every aspect of today's electronics environment. The OEM's risk is often more significant than the component manufacturer's due to the size and cost of completed assemblies. A component might cost $10 to replace and retest before shipment. However, if incorporated into a finished system or deployed into the field, the same component could cost hundreds or thousands of dollars to repair or replace. For example, a manufacturer of a complex million-dollar system tracked its ESD losses with astounding results. When a small (under $5) electronic part failed, the technician had to break the seal on the system, pull the subassembly, and replace or repair it. Not including the cost of the part that failed, the company's cost to disassemble, repair, retest, and reassemble each system was $28,000-$30,000.

Hundreds of times a day, ESD events occur below the human sensitivity threshold of 3000 volts. With circuit boards and other delicate electronic components, this discharge of electrons to ground causes significant and expensive damage. Devices vary significantly in their sensitivity to ESD, but a mere 20-volt event will damage many of the more complex components. Figure 1 shows ESD damage to a south bridge chip on a single-board computer as seen through a microscope. Contact with an input device, such as a mouse or keyboard, at an injection molding facility caused the damage. Even the action of picking a poly bag up from a bench generates more than enough ESD to induce damage, as shown in Table 1.

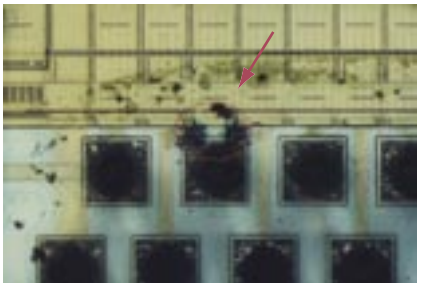

Figure 1

The risk of ESD damage increases as technology advances and components become smaller and more tightly spaced. Unfortunately, electronics are becoming increasingly sensitive to damage at lower voltage levels, and costs of the damage are rising astronomically. Practices that companies followed just five years ago may be insufficient today to protect their more sensitive products.

About latent damage

In the electronics industry, almost any action on the production floor can create an electrostatic charge resulting in product damage. Some of this damage is immediate and can be detected through pre-shipment testing. An often worse scenario, however, is latent damage. Latent component defects are a partial degrading of a device that might escape immediate detection but might cause it to fail prematurely, once in service. It is generally not possible to prove or detect these failures, particularly in assembled products. A company that experiences a high number of unexplained field failures in its electronic products is likely seeing such latent defects.

Impact on the OEM

The stages where damage can occur include manufacturing, shipping, handling, installation to an OEM device, testing of a device, or operation (see Table 2). ESD is often considered a component manufacturer's issue, but losses actually tend to be higher downstream. Estimated product losses for the user average about 10 percent higher than for component manufacturers (see Table 3). The high loss rate is due in part to many OEMs' failure to recognize static control problems and their subsequent lack of adequate ESD control programs.

Damage due to static electricity causes losses to the global electronics industry in excess of $45 billion each year, according to Halperin. The estimate, based on a sampling of electronics companies, includes the cost of damaged goods and their replacement, as well as field service costs for equipment repair.

A decade ago when components were less compact, estimates indicated that the cost of ESD damage to the electronics industry would run into billions of dollars each year. At that time, damage estimates did not include the full costs. Today, statistics show that less than 5 percent of the total cost of ESD failure is the device cost. When the associated costs of repair and rework, shipping, labor, increased inventory to cover projected product failure,

Examples of Static Generation: Typical Voltage Levels

Means of Generation	10-25% Relative Humidity	65-90% Relative Humidity
• 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

Table 1

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Typical Facility Areas Requiring ESD Protection
• Shipping and receiving
• Inspection
• Warehouse and storage areas
• Assembly
• Test and inspection
• Research and development
• Packaging
• Field service repair
• Offices and laboratories
• Clean rooms

Table 2

paperwork, warranties, and overhead are included, the real cost to the OEM of inadequate static control becomes apparent. The cost of customer satisfaction is also a significant issue.

Basic principles of static control

Each static problem and work environment is unique and has unique needs. Here are some basic steps that a company will need to consider.

- Design in immunity. Use less sensitive devices or provide appropriate input protection on devices, boards, assemblies, and equipment.
- Define the level of control needed in your environment. Each environment differs. For example, a plastic injection molding plant will need an extra level of protection for their sensitive electronic equipment due to high levels of static generated by raw materials used during the manufacturing process. Such a company found that the plastic pellets generated so much static that they had to install an optical keyboard and mouse on each of their computers to prevent ESD damage from occurring through the cables.
- Identify and define the electrostatic protected areas. The areas that involve handling of sensitive parts need conductive and dissipative devices.
- Eliminate and reduce generation. Reduce as many static generating processes or materials as possible. For example, minimize the contact and separation of dissimilar materials and common plastics. Maintain a high relative humidity. Table 1 shows how a higher humidity level can improve protection from ESD.
- Dissipate and neutralize through static dissipative products. Implement proper grounding in conjunction with the use of conductive or antistatic (dissipative) mats, ESD jackets, and wrist or heel straps. Use local ionization systems, if necessary, to prevent the accumulation of static charge. See Table 4 for a list of potential static control measures.
- Set up proper grounding or shunting to dissipate discharge.
- Package and transport susceptible devices using shielding and charge-reducing bags and containers. Antistatic or pink poly bags reduce charge generation but do not provide static shielding. Effective protection requires the use of static shielding packaging in combination with the antistatic bags. When transporting ESD-sensitive items, use pushcarts or racks that are designed for ESD-sensitive devices.

Elements of an effective ESD control program

While each company is unique in terms of ESD control needs, an effective ESD control program will include at least these six critical elements.

1. Establish an ESD coordinator and ESD teams. The team approach helps to ensure a variety of viewpoints, availability of expertise, representation of various departments, and a commitment to success.
2. Assess your organization, facility, processes, and losses. Document your processes and note potential problems. Measure electrostatic levels on personnel, equipment, and materials. Document your losses in terms of components, repair, rework, and returns. Identify the sensitivity levels of various components.
3. Establish and document your ESD control program plan. The plan should cover the scope of the program and include the tasks, activities, and procedures necessary to adequately protect sensitive items. Prepare and distribute written procedures and specifications so that everyone has a clear understanding of what they should do.
4. Build justification to get the support of top management.
5. Define a training plan. Train and retrain your personnel, aiming to instill a mindset that ESD prevention is a valuable ongoing effort. No ESD program will really work without the complete participation of all employees.
6. Develop and implement a compliance verification plan. Audit your plan to ensure that the ESD control system is successful. Technological changes will dictate improvements and modifications. Provide feedback to management and employees. Adjust company practices to keep the program on track.

Static Losses Reported by Level			
Description	**Minimum Loss**	**Maximum Loss**	**Est. Avg. Loss**
Component manufacturers	4%	97%	16-22%
Subcontractors	3%	70%	9-15%
Contractors	2%	35%	8-14%
User	5%	70%	27-33%

Table 3

ESD Causes	ESD Solutions
People	• Grounded wrist straps • ESD-protective floor mats and finishes • Dissipative shoes or heel straps • ESD-protective clothing, particularly for clean rooms and very dry environments • ESD-protective workstations and work surfaces
Carts and other wheeled equipment	• Carts with drag chains or conductive casters or wheels
Production and test equipment	• Grounding
Production aids (hand tools, soldering irons, tapes, adhesives	• Grounding – three-prong grounded type AC plug for electrical tools, grounding of work surfaces and personnel • ESD-protective labels
Material handling	• ESD-protective packaging and material handling containers – preferably materials that are antistatic and that provide discharge protection and electric field suppression

Table 4

Understanding and prevention

ESD is one of the most serious problems facing the electronics OEM today. Damage caused by electrostatic discharge has significant repercussions beyond the cost of the electronic component or assembly. Electronics manufacturers experience lower production yields, increased warranty rework, higher inventory requirements, and lower customer satisfaction. Effective control of ESD can ensure improved product quality, lower costs, and happier customers.

The largest issue in dealing with ESD is a lack of understanding of the nature of the problem. Education is inexpensive and highly effective. Understanding ESD and preventing it will save money and prevent wasted hours of trying to "figure out why it won't work."

How to learn more about ESD

ESD Association

The best source of information is the ESD Association. This national nonprofit group of field experts began for the purpose of ESD education. The group offers educational meetings and extensive documentation through publications and its Web site. Local ESD Association chapters provide access to nearby ESD experts, educational meetings, and networking opportunities.

ESD product manufacturers

For additional information, contact the companies that manufacture equipment and materials to eliminate and control ESD. Talk to several vendors and a number of experts in order to make optimal purchasing decisions. A helpful resource site to review on the Web is www.staticspecialists.com.

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VersaLogic *has been a supplier of industrial computers since 1976. The company focuses on high-quality, board-level products for embedded applications. Product lines include PC/104, PC/104-*Plus, *EBX, and STD 32 Bus. VersaLogic's customers recently rated the company a "Platinum" level embedded board vendor (2002 VDC study).*

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Books and publications

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Web sites

ESD Association
www.esda.org

ANSI/ESD Association Standard S20.20-1999
www.esda.org/pdf_files/s2020std.pdf

Compliance Engineering's ESD Help Desk
www.ce-mag.com/esdhelp.html

IPC ESD training resources
http://training.ipc.org/
(choose ESD Control under Electronics Assembly)

More training resources
www.staticspecialists.com/esdawareness.html

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