

ESD and the OEM: Changing Needs in Industrial Control Systems

by VersaLogic Corp., Marketing Communications

Introduction

How much is your company losing to electrostatic discharge (ESD) damage each year and what can you do about it? If your company is a typical high tech OEM, you may be losing tens to hundreds of thousands of dollars annually to ESD, perhaps without knowing either the cause or the total impact. It is often hard for the management team of an OEM to allocate the time and resources to track a problem such as ESD control. ESD's impact can be significant and may include lower production yields, increased warranty rework, higher inventory requirements, and lower customer satisfaction. But the damage typically cannot be seen, and the results are not always easy to attribute or calculate. The ESD risk to the OEM can be financially significant, however, warranting close management attention.

An OEM has more to lose to static discharge than a component manufacturer, due to the size and cost of finished assemblies (see chart 1). A component that costs only \$10 to replace and retest before shipment could cost hundreds or thousands of dollars to repair or replace in the field. For example, a manufacturer of a complex million-dollar system tracked their 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 amounted to \$28,000 to \$30,000.¹

Even a decade ago when components were less compact and vulnerable, the cost of ESD damage to the electronics industry was estimated as running into the

Chart 1: Static Losses Reported by Level

| | Min. Loss | Max. 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% |

Source: Steven Halperin, "Guidelines for Static Control Management," Eurostat, 1990, cited in www.esda.org/basics/part1.cfm

billions of dollars per year.⁵ At that time, damage estimates did not include the full costs. Today we realize that less than 5% 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, 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.¹

High tech companies lose at least 4 to 6% of annual gross sales due to electrostatic discharge every year, according to Stephen Halperin, president of the Electrostatic Discharge Association. "I know of companies who are aware of ESD losses totaling 10% or more of their gross sales - and that is only the losses above which they had budgeted for," notes Halperin.¹

About ESD

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 rapid 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. Even the action of picking a poly bag up from a bench generates more than enough static electricity to induce damage, as shown in chart 2.

Chart 2: 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 |
| Sitting in chair with urethane foam | 18,000V | 1,500V |

Source: <http://www.esda.org/basics/part1.cfm>

ESD damage risk has increased as technology advances and components become smaller and more tightly spaced.² Unfortunately, electronics are becoming increasingly sensitive to damage at lower voltage levels and the 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.

Effective Workspace ESD Control

What can a company do to mitigate ESD damage loss? Establishing an ESD control program is the first step. But many control programs are not fully adequate. The ESDA standard S20.20-1999 outlines the requirements for an ESD control program with administrative and technical requirements. The standard advises, “When handling devices susceptible to less than 100 volts HBM (Human Body Model), more stringent ESD Control Program Technical Requirements may be required, including adjustment of program Technical Element Recommended Ranges.” In other words, it is up to the company itself to define the level of ESD protection required and develop acceptable minimum standards for control devices.

Each static problem and work environment is unique. Defining and addressing these unique needs is the goal of a well-managed ESD control program. Different procedures may be necessary in each area of the company where the product is handled. The process can be broken down into the following steps.

Define the areas of sensitivity. Work areas requiring ESD protection include product and compo-

nent storage areas, assembly and packaging stations, engineering and testing areas, and anywhere else that products or components are handled or stored (see chart 3).

Identify the sources of ESD. Non-conductive materials such as plastic parts, tape, cardboard and Styrofoam are common culprits of ESD. High voltage items like computer monitors also generate static charges. Measuring ESD levels with a static meter will show problem areas and items.

Establish the level of protection required. Areas with high static generation may require special solutions, even when ESD sensitive components are not directly handled. For example, a plastic in-

jection molding plant may have static levels high enough to require an optical keyboard and mouse on each computer to prevent ESD damage from occurring through the cables. Absolute Maximum Voltage Ratings of components, when known, are useful in determining which components require the most protection.

| Chart 4: ESD Causes and Solutions | |
|---|---|
| ESD Causes | ESD Solutions |
| People | <ul style="list-style-type: none"> • 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 | <ul style="list-style-type: none"> • Carts with drag chains or conductive casters or wheels |
| Production and test equipment | <ul style="list-style-type: none"> • Grounding |
| Production aids (hand tools, soldering irons, tapes, adhesives) | <ul style="list-style-type: none"> • Grounding—3-prong grounded-type AC plug for electrical tools, grounding of work surfaces and personnel, • ESD-protective labels |
| Material handling | <ul style="list-style-type: none"> • ESD-protective packaging and material handling containers—preferably materials that are antistatic and provide discharge protection and electric field suppression |

Chart 3: Typical Facility Areas Requiring ESD Protection

- Shipping and receiving
- Inspection
- Warehouses and storage area
- Assembly
- Test and inspection
- Research and development
- Packaging
- Field service repair
- Offices and laboratories
- Clean rooms

Source: <http://www.esda.org/basics/part3.cfm>

Devise protection methods. These include a combination of signage, grounding systems, and charge generation control. A well-protected area may be one in which grounding floor mats and work surface mats are installed, protected areas are marked with tape, and personnel wear wrist straps, heel straps and ESD protective clothing. See chart 4 for additional static protection solutions. Dry environments benefit from installation of ionization and humidification systems to reduce charge generation. ESD protection devices vary in capability and the protective range should be checked against the sensitivity of the products being handled.

Maintain the system. Different ESD control devices must be installed, used correctly and receive specific maintenance. Many ESD devices lose effectiveness over time. Periodic cleaning keeps the equipment and devices working properly. Wrist straps, heel straps and other personal grounding devices require testing and occasional replacement. Periodic testing, either with static locators or grounding test equipment, is essential to locating problematic conditions. The overall effectiveness of an ESD program is compromised by lack of upkeep, and can result in oversights that cause product damage.

A static charge meter can indicate the strength of the whole program. If an area is found to have minimal static charges, it is evidence of a working system. Properly functioning equipment relies on the support of a well-trained and committed staff. To ensure protection of production floors, testing stations and other areas takes planning, education, maintenance and testing.

Managing the System

The technical aspects of an ESD control program fit within a broader scope of the managed program. A complete program includes a plan, ESD education, protective equipment, and system audits. Establishing an ESD coordinator and ESD teams help ensure an effective program. The team approach allows for a variety of viewpoints, availability of expertise, representation of various departments, and a commitment to success.

Research and consult with experts. Learn all you can about preventing ESD damage at your company. Check with industry groups such as the ESD Association (Rome, NY) and IPC Association (Northbrook, IL). Many engineering and consulting companies also provide specialized expertise. ESD safe product companies can provide good advice, but be aware that they can be biased. As a result, be sure to take your own measurements. See chart 5 for some suggestions on where to start your research.

Develop a plan. Your ESD Control Program Plan should cover the scope of the program and include the tasks, activities and procedures necessary to adequately protect the sensitive items. Prepare and distribute written procedures and specifications so that everyone has a clear understanding of what to do.

Train and retrain your personnel, aiming to instill a mindset that ESD awareness is a valuable ongoing effort. Make sure that the program is understandable, even to non-technical employees. No ESD program will really work without the complete participation of all staff.

Chart 5: How to Learn More

| | |
|--|---|
| ESD Association | www.esda.org |
| IPC Association | www.ipc.org |
| ESD Products Manufacturers | Talk to several vendors |
| Compliance Engineering's ESD Help Desk | www.ce-mag.com/esdhelp.html |
| ESD training resources | training.ipc.org/ (choose ESD Control under Electronics Assembly) www.staticspecialists.com/esdawareness.html |

Enroll the manufacturing team in the program.

Make it their program, and delegate the responsibility of auditing and maintenance. Quality management can then verify records and conduct periodic compliance audits. Delegating in this way not only minimizes the drain on management resources, but also allows the affected employees to take ownership in the process, thus increasing employee participation and compliance.

Adequately protect products and work areas. Test for static charge levels, distribute or install appropriate protective equipment, and use signage to designate critical areas. Test, maintain and replace equipment as necessary to ensure continued safety.

Test for Compliance. Audit your plan to verify 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.

Conclusion

High ESD loss rates are due in part to the failure of many OEMs to recognize static discharge problems and the OEMs' subsequent lack of adequate ESD control programs. All electronics OEMs are susceptible to ESD loss. Electrostatic discharge damage reaches beyond the cost of the electronic component or assembly itself. Associated problems include lower production yields, increased warranty rework, higher inventory requirements, and lower customer satisfaction. Taking action on ESD has many benefits. A well-implemented ESD plan pays handsomely in terms of improved product quality, lower costs and happier customers.

Endnotes

- ¹ Stephen Halperin. Interview by Kristin Allen. June 26, 2002
- ² *Compliance Engineering*. (2002, March/April) "Controlling ESD through Polymer Technology" by Neil T. Hardwick. Retrieved May 29, 2002, from www.ce-mag.com/archive/02/03/hardwick.html
- ³ *ESD Association*. (2001, August 15) "Fundamentals of ESD, Part One – An Introduction to ESD" Retrieved May 29, 2002, from www.esda.org/basics/part1.cfm
- ⁴ *San Francisco Chronicle* (c.2001) "PC-to-Handheld Connections Damage Desktops, Users Say" by Vanessa Hua. Retrieved July 17, 2002 from http://199.97.97.16/contWriter/cnd7/2001/08/28/cndin/2304-0678-pat_nytimes.html
- ⁵ Lonnie Brown and Dan Burns, "The ESD Control Process is a Tool for Managing Quality," *Electronic Packaging and Production*, April 1990, pp 50-53
- ⁶ *ESD Association*. (2001, August 15) "Fundamentals of ESD, Part Two – Principles of ESD Control" Retrieved May 29, 2002, from www.esda.org/basics/part2.cfm
- ⁷ *IPC - Association Connecting Electronics Industries*. VT-54 Training Package, "ESD Control" Copyright 2000.