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APPLICATION NOTE

Static Control Program

ANSI/ESD S20.20 Review

The worldwide industry standard for static control programs, ANSI/ESD S20.20, undergoes review every 5 years. This time, the changes were numerous and the review process took almost 2 years. The previous version of the document from 2007 has been reissued in 2014. Until now, the document contained a specification for the use of room ionization in an electrostatic protected area (EPA). The new version of the document has deleted that specification. Since room ionization has extremely important uses in controlling both electrostatic discharge (ESD) and particle deposition, there is some confusion about how to continue to include it as part of the ESD control program specified by S20.20.

This technical note will review the important uses of room ionization, the relevant changes in S20.20 affecting room ionization and several alternatives for including room ionization in the S20.20 static control program.

Uses of Room Ionization

Room air ionization has been in use since the early 1980's in a variety of electronics manufacturing environments. As with all ionizers, room ionization is the only practical means of removing charge from surfaces that are insulators or for some reason cannot be connected to ground. Ionization, in all its forms, complements grounding techniques and static dissipative materials, to form the technical basis of the static control program. Room air ionization is able to provide static charge control over a wide area, needed when the static control problems cannot be localized to a single workbench or equipment operation.

Room ionization is employed to control the two basic static charge problems, ESD and particle attraction, found in electronics (and other) manufacturing areas. ESD is the rapid transfer of charge between objects at different potentials. This charge transfer has two results, heat and electromagnetic radiation. The first problem of concern is when one of the objects is a sensitive electronic device. The heat resulting from the discharge causes melting and failure of the elements of the device, commonly referred to as ESD damage. ESD damage may be catastrophic, resulting in failure during device manufacturing. It may also be latent, where a device may pass all its manufacturing tests, but fails prematurely after it has been installed in circuitry or systems. Clearly, the cost of ESD damage goes up the later the ESD damage occurs in the device use cycle. Room air ionization removes static charge throughout the work area reducing the chance of a damaging ESD event.

When an ESD event occurs, it also produces electromagnetic radiation. This emission can be detected with various instruments and is the basis of the instrument known as the ESD Event detector. But this signal can also be picked up by the production equipment, where it interacts with the electronic circuitry controlling the operation of the equipment. Once again, the result may be catastrophic when the equipment moves in an unplanned fashion resulting in physical damage to the product while in the equipment or the equipment itself. In other instances, the equipment simply stops operating, perhaps damaging the product, but requiring a manual restart. In either case, there can be a loss of the product and/or the equipment operating time. Room air ionization removes charge from objects throughout the work, eliminating the ESD affecting the production equipment.

The other major problem caused by static charge is electrostatic attraction (ESA) of particles. Electronic (and other) components are manufactured in cleanrooms to prevent particle related failures. The presence of static charge in these clean areas increases the attraction of particles to critical product surfaces, often negating the means used to keep these surfaces clean. Increased product loss is the result. Static charge on a surface creates an electric field which exerts an attractive force on nearby particles. If products are charged, studies have shown up to 7 times more particles deposit on the surface compared to an uncharged surface. When particles are attracted to non-product surfaces, they remained trapped in the environment instead of being removed by the cleanroom technology. They may be displaced by physical motion of personnel or equipment and subsequently deposit on products. Room air ionization neutralizes the charge on surfaces within the work area, eliminating the electric field and reducing the attraction of particles.

2014 Changes in S20.20

As industry technology changes, standards must also change. There has been a clear trend in the last 15 years of the electronics industry toward devices that are more sensitive to ESD damage. At the same time there has been a trend to better factory ESD control methods to protect these sensitive devices. ANSI/ESD S20.20 first appeared in 2000 and the 2014 version is the 2nd update of the original document. Since the first version, the static control program of S20.20 was designed to protect 100 volt Human Body Model (HBM) ESD sensitive devices. To accomplish this protection the document concentrated on the personnel and the production environment. Technical requirements addressed personnel grounding, work surfaces, and product transport materials.

Work by the Industry Council for ESD Target Values and other researchers over the last several years has shown that the majority of electronic device failures are not HBM failures, but rather Charged Device Model (CDM), Charged Board Events (CBE), or Cable Discharge Events (CDE). This indicates that while the effects of HBM static control measures mandated by S20.20 have been successful, additional static control methods are needed to address these other damage mechanisms. The 2014 version of S20.20 has started this process by directing the attention of static control methods towards the environment of the individual devices, rather than the work environment as a whole.

S20.20 now makes references to protecting devices from CDM damage, and to eliminating highly charged isolated conductors that might contact devices. Previous versions of S20.20 specified that objects charged to greater than 2000 volts/inch needed to be kept at least 12 inches away from ESD sensitive product, or that ionization must be used to reduce the charge and resulting field below 2000 volts/inch. The current version now also specifies that objects charged to 125 volts/inch must be kept at least 1 inch away from ESD sensitive devices. When you consider that the most common object to be charged is the package of the device itself, separation of 1 inch will be impossible and ionization will be needed to reduce the charge level. Similarly, S20.20 now includes a requirement that voltages on isolated conductors be maintained below +/-35 volts. Once again, the most common isolated conductor may be the lead frame of the device itself. Maintaining this low a voltage requires using ionizers whose offset voltage (balance) should not exceed 35 volts, and +/-20 volts or less would be desirable. S20.20 now contains a specification requiring point-of-use ionizer offset voltage below +/-35 volts.

But in changing the focus to the individual device, S20.20 has deleted the specification for room air ionization, and now only contains a specification appropriate for point-of-use ionization. Prior versions of S20.20 specified that a room ionization system must meet a +/-150 volt offset voltage specification. Room ionization meeting the +/-35 volt offset voltage specification would be very inefficient in neutralizing static charge. As discussed above, there are two very important applications of room air ionization; equipment operation problems and particle attraction. Solving these problems does not require room ionization to be balanced better than +/-150 volts. The question then becomes how to continue to incorporate effective room ionization in the S20.20 static control program.

Including Room Ionization in the S20.20 Program

It has been established that a point-of-use ionizer, typically a bench top or overhead ionizing blower, produces a much higher volume of air ions than a room ionization system at much lower offset voltages. When both types of ionizers are present in a work area, measurements of ionizer performance will almost entirely depend on the characteristics of the point-of-use ionizer.

This suggests the scenario in which the room ionization is useful for mitigating static problems in the work environment as a whole, while point-of-use ionization is used to protect individual devices from ESD.

S20.20 contains a requirement that the electrostatic field measured on an object must be less than +/-125 volts/inch, or that ionization must be used to neutralize the charge. It would be possible to reduce the offset voltage of a room ionization system to +/-100 volts and meet this specification, while still having an ionization system that effectively neutralized static charge. However, the additional requirement that any isolated objects that might contact the device must measure less than +/-35 volts might not be met with the room ionization adjusted to +/-100 volts. The simplest means to assure that this specification is met is to include point-of use ionization at any location where at-risk devices are present.

One of the principles of a complete static control program is to assure that all conductors are connected to ground. In the room environment this means that there should be relatively few ungrounded conductors, particularly those that might contact sensitive electronic devices. Adding point-of-use ionization for the few remaining places where for some reason a conductor cannot be grounded should be reasonably easy. This still leaves the ungrounded leads of the device itself. Safe handling of a device would always include making sure that the device leads never touched, or were touched by, a conductor. The leads should always contact a static dissipative material rather than a conductor to prevent damaging ESD events. When this is not possible, point-of-use ionization must be included in the area where contact is occurring to remove any charge on the device leads and maintain voltages below +/-35 volts. This ionization will assure that the proper voltage levels are maintained on isolated conductors at critical locations, even with a room ionization system present.

Tailoring the S20.20 Program

One of the features of the S20.20 static control program is the ability to change or “tailor” the program to meet the static control needs of a specific facility. S20.20 states, “Tailoring decisions, including rationale and technical justifications, shall be documented in the ESD Control Program Plan.” The following options are possibilities with regard to including room air ionization in an electronics manufacturing facility.

Option 1 – Omit the room ionization system from the static control program but continue to use it for contamination control or control of ESD-related equipment problems. Make sure that there is sufficient local point-of-use ionization to assure that the requirements for field measurements less than 125 volts/inch at one inch and isolated conductor voltages less than +/-35 volts are satisfied. An optional recommendation might be that the room ionization system be adjusted for +/-100 volt offset voltage levels. Separate maintenance and calibration instructions for the room ionization system will need to be well documented as they would not be part of the ESD audit program.

Option 2 – Include a tailoring statement in the S20.20 program document. The statement should specify that the room ionization system is included specifically to control contamination or ESD-related equipment problems at ionizer offset voltage levels higher (e.g., +/-100 volts) than needed to protect electronic devices. Additionally, the tailoring statement should specify that if there is a need for ionization for control of process required insulators (to less than 125 volts/inch at one inch), or isolated conductors (to less than +/-35 volts), local point-of-use ionization will be used. As part of the ESD control program, all ionization including the room ionization system will be audited and maintained at appropriate intervals.

Example Tailoring Statement: A room ionization system with an offset of +/-100 volts is used in this EPA. This is primarily for contamination control and not for ESD control of process required insulators or isolated conductors. If ionization is required for process required insulators or isolated conductors that exceed the requirements in the ESD control program, and if local ionization is used, then the ionizer will meet the offset requirements of +/- 35 volts.

Conclusion

The ANSI/ESD S20.20 standard will continue to evolve and change in ways to successfully eliminate the hazard of ESD damage to electronic devices. Future changes will more fully address CDM, CBE, and CDE damage mechanisms. A change in the 2014 edition has deleted the previous specification for room ionization. Complying with the standard will now require minor changes in the way that room ionization systems are specified and used.

About the Author

Arnold Steinman is currently a consultant in electrostatics with Electronics Workshop and Dangelmayer Associates, specializing in static charge control, and ionization. Prior to this, he served as Chief Technology Officer for Ion Systems (now Simco-Ion Technology Group) in Alameda, CA. He holds four patents covering air ionizer technology. Steinman graduated from the Polytechnic Institute of Brooklyn, receiving both BSEE and MSEE degrees.

Steinman served as a member of the Board of Directors of the ESD Association and a past chairperson of the Ionization Standards Committee. He is an ESDA certified Program Manager and an iNARTE certified ESD Engineer. For 20 years he has served as leader of the SEMI ESD Task Force, which has produced several standards for controlling ESD and electrostatic attraction (ESA) in semiconductor manufacturing facilities.

Steinman has contributed technical articles to numerous industry publications and made technical presentations at the ESD Association Symposium, the IEST annual technical meeting, the International Committee of Contamination Control Sciences (ICCCS) conferences, SEMI technology forums, and for many other national and international industry groups.

SIMCO ION™
An ITW Company

Technology Group
1141 Harbor Bay Pkwy, Ste 201
Alameda, CA 94502
Tel: +1 (800) 367-2452 (in USA)
Tel: +1 (510) 217-0460
ioninfo@simco-ion.com
www.simco-ion.com

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