Workstation Voltage Detection Systems

New Weapons in the Battle Against ESD

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As the fundamental structures of electronic devices become smaller, their ability to withstand the damage inflicted by electrostatic discharge (ESD) becomes less as well. Five years ago such damage typically began occurring at charge levels of 20 nanocoulombs. Device geometries have shrunk so much that today damage begins at 0.2-0.5 nanocoulomb, a 100-fold increase in sensitivity. Of course, the trend will continue.

The enormous costs associated with not taking the effects of electrostatic charge (ESC) seriously are becoming more obvious by the day. Avoiding ESC at workstations has become a formidable challenge. As a result, new technology and a more profound understanding of workplace electrostatics are required..

In addition, operator efficiency during the workday is being scrutinized as well. Manufacturing facilities now are beginning to consider the labor dollars (i.e., time) associated with testing ESD-related products when they enter the production facility. Time wasters include "traffic jams" caused by current equipment testing techniques, deliberately incorrect testing to "fool" the test equipment or operators just skipping the test procedure altogether.

With this in mind, potential users are considering the capital dollars required for newer real time testing at the workstation a worthwhile tradeoff, with payback achieved in a relatively short period of time. Workstation voltage detection systems currently available will provide real time monitoring to take the user through the next few product generations. This scenario helps justify the cost of placing ESC monitors at each critical workstation.

Sacred ESD Truisms Fail in Submicron Space

With the advent of such hypersensitive devices such as magneto-resistive heads in the disk drive industry and submicron structures in semiconductor devices, a number of previous ESD truisms are being overturned at these smaller geometries. Consequently some of the traditional ESC/ESD protective workplace practices, taken for granted for years, are no longer valid at these levels.

For example, mere "spot checking" of ionization balance and neutralization of charge is no longer considered acceptable for critical environments. With the control requirements of today's products and even tighter requirements forecast in the next 12 to 18 months, real time ionization monitoring at a specific product workstation is considered a "must." No longer are manufacturers willing to assume that the ionization system is performing properly between calibration checks. They require real time monitoring to ensure proper operation of the ionization system and the integration of this information with data collected for temperature, humidity, particle count, etc.

In addition, low frequency electrostatic fields from power distribution wiring in the workplace are beginning to command serious attention. Peak field strengths of several hundred volts per meter appear to be very common in most workplaces. This level is more than sufficient to cause device failure by electrostatic induction.

Third, wrist straps and conductive footwear as we know them today are not able to keep the electrostatic potential below the now required levels. Even more alarming, certain wrist strap monitoring schemes are suspected of actually contributing to the degradation failure of sensitive devices. This happens because certain wrist strap monitors apply measurement voltages to split-conductor wrist straps to establish the integrity of the wrist-strap-to-ground path. This procedure may charge the wrist-strap wearers to levels which exceed the capabilities of sensitive structures to withstand damage, or at a minimum, not allow the system to detect voltage at the lower levels now required by some users.

A New Approach Arrives

One approach to the ESC/ESD problem has been so successful that it is being included on the agendas of ESD standards committees and also is being "designed in" by disk drive and semiconductor manufacturing facilities. The approach is twofold. First audit an entire work area, station by station, while also testing new additions to the ESD protective arsenal. This should be done not only to verify that ESD protective devices actually are performing their intended function, but also to discover other potential ESD problems which may be hidden from obvious consideration. (See Evaluation Engineering, "Charge Is the Real Enemy," July 1996, pp 54-55.) A complementary approach is to install permanent ESC monitors (as shown in Figure 1) at each critical workstation to provide continuous voltage detection. This will provide an immediate alert whenever a pre-set voltage threshold is exceeded and also provide a permanent record of variations and deviations when connected to a data acquisition system for later analysis.

Like conventional equipment these devices also use split-conductor wrist straps. In this case, however, no measurement voltages are applied to do capacitive- or resistive-type measurements between the two isolated sections of the wrist strap. Here half of the wrist strap is used to connect the wearer to ground in the traditional manner, whereas the other isolated half is used to measure the body voltage of the wearer. If the measured body voltage exceeds a pre-determined level (typically 2 to 5 volts for sensitive structures), an alarm sounds.

In addition, a "proximity" channel, together with a sensing antenna, allow for detection of an approaching charged human body. Such human intruders into a workspace area are a major contributor to device damage via electrostatic induction. This same "proximity" input also can be used to do general purpose +/-5 kilovolt contact electrometer measurements. The inclusion of current loop and analog voltage outputs satisfy the recent trend of connecting individual workstations together through data acquisition and facility monitoring systems.

Such plant-wide environmental data acquisition systems have been used in wafer fabs for some time. However, the parameters usually reported have been temperature, humidity, gas pressure and gas flow. ESC/ESD now has been recognized and added as an environmental variable. ESC/ESD data acquisition systems will lead to a better understanding of the total effect of electrostatic variables and related protective devices (as shown in Figure 2). This is combined with the calculation of the costs associated with ESC/ESD protective measures, or conversely, the costs of the lack of these measures. These systems also will allow for proactive oversight in the manufacturing process, since it will be easier to track, recognize and isolate batches of devices that might have been exposed to potentially damaging levels of ESC.

Another recent development in this arena is the static event detection and protection device. This is basically a magneto-optic detector on a chip that can be incorporated in an ESD path, either as a discrete device or integrated into the input/output structure of another integrated circuit. When an ESD current flows through the detector, a number of tiny domains or pixels will be "switched on" optically, each domain corresponding to a certain current level and polarity. The status of the domains can be read out either optically with a polarized microscope, or electrically with adequate circuitry. The device can be reset externally and, provided it was not destroyed by excessive ESD current, can be reusable indefinitely. The device is relatively simple and rugged. Availability is in die form or in a variety of packages with optical windows.

What ESD professionals need to focus on today is the "net result" of the performance of the individual ESD-protective products, and its effect on ESC control at the workstation. This is a redirection in philosophy, but is the next step in full understanding of workstation control. The performance of one ESD-related product at the workstation is not as important alone as its contribution to the entire ESC/ESD protection equation

The battle against ESD/ESC goes on, and the weapons become more ingenious, sophisticated and refined. Still one important message must be repeated again and again -- No ESC means no ESD! Since ESC is the root cause of ESD-related damage, that's where most of the firepower must be directed.

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