ESD SUSCEPTIBILITY TESTING OF ELECTROEXPLOSIVE DEVICES

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GENERAL

Electroexplosive devices are electrically initiated detonators used to fire an explosive charge or to operate a mechanical device. These explosive devices undergo functions such as assembly, handling, shipping and final installation that may expose them to an Electrostatic Discharge (ESD).

There are basically three types of ESD events that can occur:

1. Human Body Discharge – This ESD event occurs when a person becomes charged by movement or by handling objects that can build up a static charge and be transferred to the person, and then discharges to the device by touching it. The Human Body Model (HBM) can be anywhere from 60 to 500 picofarads discharged through 500 to 10,000 Ohms depending on the application. For explosives testing a 500 pf capacitor discharged through 5,000 Ohms is specified in such standards as Mil Std 322B-1984, Mil Std 1512-1972 and Mil Std 1576-1984. The test voltage is specified at 25 kV. Depending upon the specific standard used the ESD pulse is applied to pin-to-pin and to pin-to-case.

   A common variation of the HBM is the model specified in IEC 801-2-1991. This model simulates a person holding a metal object such as a screwdriver and discharging to the device. There are many variations specified in corporate specifications, but the model specified in 801-2-1991 is 150 pf discharged through 330 Ohms.

2. Machine Discharge – This ESD event occurs when a charged metal object discharges to the device. While not specifically defined in Mil Std 1576, a Machine Model (MM) test is also specified using 500 pf discharge through 0 Ohms. A MM discharge at a given voltage is more sever than an equivalent HBM discharge.

3. Charged Device – This ESD event occurs when the electroexplosive device becomes charged either individually or when installed in a system that is not grounded. The intrinsic capacitance of the device itself or assembly it is installed in becomes the capacitor of the Charged Device Model (CDM). The discharge resistance is usually 0 Ohms. This is the most severe of the three models at a given voltage level.

To properly evaluate a device for ESD susceptibility all three models should be used. For example, devices that passed the 25 kV HBM requirement failed when tested in the CDM mode at only 1.5 kV.

DEVICE TESTING

There are a number of ways to evaluate a device. The above Mil Stds. specify pin-to-pin and pin-to-case testing. However, other tests including grounded devices, totally isolated devices and devices that are isolated, but in proximately to ground so that an arc over can occur should also be performed.

Preliminary testing should be performed to determine the general voltage level that will fail the device. A good place to start for HBM testing is 15 kV and then increment up to 25 kV in 5 kV steps. If a failure occurs then perform the testing starting at 5 kV below the failure level and then increment the voltage up in 1 or 2 kV steps. Both single and multiple discharges, at least 1 second apart, should also be used.

1. HBM and MM Testing

Both of these tests are similar as it pertains to the test set-up. The only difference is the HBM test has a series resistance such as 5,000 Ohms and the MM test has no series resistance (0 Ohms).

To simulate an air discharge connect, mount the output cable some fixed distance such as 0.25” from the device leads or case. When a discharge is initiated it will jump the air gap and discharge to the device.

1.1 Pin-to-Device - Connect the output of the gun to the device leads twisted together using the 24” red output cable. Connect the device case to the ground jack on the capacitor module using the 24” black cable. Initiate a discharge.

Repeat the above but connect only one lead to the gun output.

1.2 Pin-to-Pin – With the device isolated, connect one lead to the gun output and the other lead to the ground jack. Initiate a discharge.

Repeat the above with the device case grounded.

CDM Testing

CDM testing should be performed with the device case isolated, grounded and isolated, but in close proximately to ground so that an arc over will occur at different test voltages. Preliminary testing should start at 5 kV and

then adjusted upwards or downwards depending on whether a failure occurred.

For proximity testing the device should be mounted on an insulator and a grounded lead should be secured at a fixed distance such as 0.25” from the device.

CAUTION

All CDM testing requires the output of the high voltage power supply to be connected to the device. Extreme care must be used when handling the special H.V. cable provided. Voltages up to 30 kV at 250 µamps can be present.

2.1 Isolated Case-to-Pin – Plug the CDM cable supplied into the Capacitor Module input connector. Connect the CHARGE lead (square portion of HV connector) to the device case. The other one (round portion of HV connector) is the ground lead. Plug in the 0 Ohm resistor with the banana jack adapter attached. Connect the device leads to the banana jack via the 24” cable. Starting at the lowest voltage in the 30 kV range slowly charge the device up to the desired voltage level. **NOTE: If the Charging Voltage meter reads 0 or will not increase as the Voltage control is increased, this indicates a dielectric breakdown within the device. The device, therefore, cannot be charged in this test mode and the test should be ended.** If the device can be charged then initiate the discharge switch after the desired voltage level is reached. In this configuration the device acts as the capacitor and the discharge function completes the case-to-pin circuit. To go to the next voltage level return to the minimum setting, arm the system and then slowly increase the voltage. Repeat this procedure for each voltage step.

2.2 Isolated Device-to-Gnd.- Connect the CDM cable to the device case. Connect the Output cable to ground. Charge the device as described above then initiate the discharge function. The charged device will then be discharged to ground through the 0 Ohm output resistor.

2.3 Isolated Device Air Discharge-to-Gnd – This test is a variation of 2.2 above. Connect the device as above. Secure the wire so it is at a fixed distance from a ground point (0.125”, 0.25” 0.375” etc.). Slowly charge the device as described above. At a given spacing and voltage level an air discharge between the wire and the ground point will occur. As the spacing between the wire and the ground point is increased the voltage level required for an air discharge to occur will also increase.