Re: Some ESD protection questions (spark gaps, earth/ground connection issues)

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On Aug 27, 2:20 pm, Christian Walter <wo...@xxxxxx> wrote:

> Hello,
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> I just wanted to ask the more experienced people here for some advice. I am currently working on a redesign of an existing board and I want to improve some ESD aspects of the board because we had some problems in this area in the past. The system is built from two components where the PCB in questions contains some micro controllers and a USB equipment and the other PCB is the power supply unit and contains additional internal modules.
>
> I have to protect some I/O ports and an USB interface. I have chosen to use a TVS Diode Array (Littlefuse SP0502BA). I have chosen to place the diode array as near as possible to the I/O connectors of the system. What I am unsure about is whether to connect the common pins of the diode array. My first choice would be to use the earthing because if I connect it directly to the ground plane any discharge current will take the path from the I/O connector over the diode. From there to the ground plane and the PCB FCC connector cable to the power supply board and then to earthing. In my opinion this can cause some signal and system stability problems although the device on the PCB will not be damaged. Does anybody support this claim?
>
> The next question I would like to ask what you people think about spark gaps as a cheap alternative ESD protection for onboard I/O ports. That is I would add add a signal layer which surround the PCB connections using a very short distance (maybe 8 thou which is easily doable in a manufacturing house) and connect this to plane to the earthing. This would effectively limit the voltage to maybe 1−2kV.
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> What I have also read is that a small guard ring at the edges of the PCB (connected to ground) can help to improve ESD performance. Has anybody used and tried this?
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> I would be very grateful for some advice because I am still a bit new in the field. Another question is how I can verify my ESD protection without having to go to a special laboratory because of costs.

Kind regards,
Christian Walter

Envision a complete circuit between the ESD source and your product: This must include a complete return path. Often, this involves the protective 'earth' or grounding system. Your goal is to divert as much of the ESD energy as possible away from your circuits, both to protect circuit elements and to prevent disruption of equipment operation. If you insulate your product completely, there will be no ESD to the equipment, but this is impractical in cases where conductive parts must be exposed, particularly if those conductive parts cannot be connected to earth ground. The best defense, then, is to provide deliberate adjacent paths to ground, for example, the grounded 'ring' around the perimeter of a circuit board. If possible, design the product so that grounded conductive parts extend out in such a way that any ESD conducts to ground rather than into your circuit.

For any ungrounded paths into your circuit that may still take an ESD hit, you have these basic defenses to consider:
a) series resistance
b) series inductance
c) shunt resistance and shunt breakdown devices such as zeners, transils, MOVs, spark gaps
d) shunt capacitance

For high speed signals, it may be impossible to incorporate any appreciable amount of series resistance or inductance or shunt capacitance without degrading the signal, so you're left with the low−capacitance tranzorb solution. The common terminal of the tranzorb(s) should be connected to earth ground with the lowest possible impedance. If this doesn't do the job, reconsider how you might prevent direct ESD to signal nodes: shielding, shrouded connectors, etc.

Keep in mind that the high currents and fast risetimes associated with ESD will develop high potentials across stray inductances in the return path, AND there may be significant magnetic field coupling of ESD currents to adjacent circuitry. Therefore, loop area of the complete ESD current path should be considered.

Circuit board spark gaps will produce widely varying results depending on humidity, dust buildup, and other factors, and I think your estimate of 1 to 2 kV for 8 mils is probably a bit low for most conditions. Spark gap tubes have the advantage over semiconductor devices of maintaining relatively shunt voltages even for very high current levels, so they are often used to absorb more powerful transients such as those resulting from indirect lightning strikes.

In Summary:

1) Design packaging so that product is either totally insulated from ESD or any discharges go preferentially to grounded structures, shunting all ESD current away from internal circuits.
2) Series and and shunt any remaining filter nodes that must take a direct ESD hit.

As you get farther into this subject, you'll also discover the difference between insulating systems that dissipate vs collect static charge and between deliberate low−impedance discharge of ESD versus dissipating or bleeding off charge to prevent high amplitude ESD.
Paul Mathews

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