Chassis Finish Considerations for EMI

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ABSTRACT

It is a known fact that the electrical contact of the seams in a chassis containing high-frequency switching signals must be sealed in order to provide EMI containment.

This report describes the issues and *pitfalls* created by the metal finish and the design of the chassis mating surfaces (seams).

Metal Finishes:

Painted Surfaces:

It should be obvious that a painted surface is a poor conductor of electricity. Generally, even electrically conductive paint will have difficulty maintaining good conductive properties at RF frequencies.

In consumer equipment, paint is generally used only on exterior surfaces, to protect the exterior surface and provide atheistic appeal. Frequently, interior mating surfaces are not properly masked and contain varying amount of overspray from the painting process. Occasionally, the pigment is not visible in the overspray. This fact makes assessing conductivity problems more difficult.

The procedure for measuring surface resistance of chassis mating surfaces will be discussed later in this document.

Plated Metal Surfaces:

The most common material used in the manufacture of chassis for consumer audio equipment is electro-galvanized cold rolled steel. This material has the capability of providing adequate electrical and mechanical strength for many applications.

Electro-galvanized steel is plated with zinc. Zinc will oxidize and produce a white powder (zinc oxide) and ultimately the zinc will become thin enough to allow the substrate material, steel, to oxidize (iron oxide or rust). Both conditions are unacceptable; therefore, the surface of the zinc plating must be passivated.

A simple explanation of surface passivation is that some of the free electrons are removed, in this case by a chemical bath. This process sounds somewhat benign, but when surface electrons are removed the material become less electrically conductive (more of an insulator). Of course, with poor electrical conductivity, the surface resistance of the chassis mating surfaces increases and they lose their shielding properties for EMI (and ESD).

There are two common materials used for surface passivation, chromate and phosphate. Chromate passivation will passivate the zinc and remove fewer surface electrons than phosphate passivation. It is the material of choice for good EMI and ESD shielding properties; however, there the *good news* ends. Waste material from the chromate passivation process is considered hazardous by the EPA and other regulatory agencies; therefore, electro-galvanized steel with chromate passivation is very difficult to obtain.

The most common electro-galvanized steel is passivated with phosphate. Phosphate removes a larger percentage of the surface electrons and also makes the material easier to paint. The problem is that the surface of the material is less conductive; therefore, EMI and ESD compliance is more difficult. However, from the standpoint of material procurement, this will be the material of choice.

Slot Antennas

EMI and ESD compliance is possible when phosphate passivated material is used, but this makes the fit of the chassis seams more of an issue. Chassis mating surfaces are not mechanically perfect (i.e., totally in mechanical and contact). This is a condition referred to as *casual contact*. Therefore, mechanical fit and surface finish cause sections of the chassis seams to be electrically open circuits. The openings are referred to as slot antennas.

As we know from antenna and wave guide theory, when an electrical field is applied to an open conductive area in a conductive medium radiation occurs. These openings are referred as leaks, and are one source of EMI and ESD problems.

Additionally, input and output connectors that are attached to PCBs inside of the chassis should have good electrical contact with the chassis. If there is paint overspray on the inside wall of the classis where connectors are located, they will not have an adequate connection to ground and EMI/ESD problems will occur. Paint overspray on the inside wall of the chassis where connectors are attached must be eliminated by masking before painting or removal after the painting process.

Measurement Technique

There are many ways to measure sheet metal surface resistance. The best would be an RF measurement instrument; however, they are expensive and difficult to use. A simple method is to use an ohmmeter that has a low resistance scale.

When taking the measurement, the sides, not the points of the meter probes are applied to the chassis surface being tested. Only light pressure is used and care must be taken to ensure that the surface material on the chassis is not penetrated.

The chassis seams should be evaluated and also the areas where connectors are to be attached.

Generally, measurements are taken at 2.5 cm intervals and the resistance readings should be less than 0.2 ohms for all of the readings.

Conclusion

The purpose of this paper is to point a possible issue in EMI/ESD specification compliance. If the topics discussed in this paper are implemented, EMI/ESD compliance will be facilitated.

Finally, it is not being suggested that every chassis be evaluated with the above mentioned technique. Early prototype evaluation and then subsequently specifications given to chassis vendors and verified by sample checks be the Incoming Quality control department.

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