Corrosion Control in EMI Design

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The perfect container for electromagnetic sensitive devices is a box made of superconducting metal with no openings in it. It is, of course, useless. To be useful, there must be openings; to strive toward perfection, the openings must appear electrically not to be there. How well this can be achieved in design is never quite predictable. It will depend upon a myriad of physical and electrical conditions which react with each other in unpredictable manners. One of these conditions is corrosion; corrosion between the material of the box and the material used to cover the openings in the box.

In its advanced stages, corrosion of metals is quite observable --the rusting of steel, the blooming and pitting of aluminum, the darkening and greening of copper. This type or stage of corrosion is probably of little more than secondary concern to an EMI-sensitive design, since the structural integrity of the device will have been compromised. What is of concern is a form of corrosion observable only by measurement of the surface ohmic resistance of the material or, more specifically, the change, with time, of the surface resistance of a material or between two materials. Table I gives some typical surface resistance measurements between commonly used enclosure materials. These measurements were made with a contacting pressure of 20 psi (0.138 MPa). The environmental exposure was 95% relative humidity at constant 40°C for the times shown. Reference 1.

These values show that for these construction materials a resistance increase can be expected. By knowing this increase, the corrosion effect can be dealt with on an EMI design. Increasing the surface area contact, increasing the contact pressure (increasing the material stiffness or the number of fasteners) and decreasing the humidity in the environment will minimize the increase in the resistance of a given joint. The data of Table I are limited and the measurement parameters used may not represent real design, but the fact is that no standard definition of this measurement does exist. The elements of such a definition will have to include:

(1) The area of measurement, i.e., 1 cm^2;

(2) The surface roughness and flatness, i.e., 1.6mm;

(3) The pressure of the mating surfaces at the time of measurement, i.e., 1.378MPa;

(4) The environmental exposure, i.e., 168 hours at 100% RH and 40°C;

(5) A pass/fail criteria, i.e., 2.5 milliohms.

These numbers are only suggested here, but they are the values which will be used for coordination in a standard definition of the measurement being proposed for Section II of APR 1481, "Corrosion Control for Electronic Enclosures," to be published by the SAE Subcommittee, AE-4.C.7. When adopted, this document will become an international standard for the generation of this kind of data. This will help predict and control corrosion data for future EMI designs.

Dissimilar Materials

Table I was developed using overlapping materials for the basis of measurement. These were either the same material or the finish was the same. In real design, overlapping materials are not always the same. When they are not, the problem of dissimilar materials becomes very real in EMI design. For structural design, the old unimpeachable ground rule that "dissimilar materials shall not be used in intimate contact" works, if not conveniently, at least satisfactorily. These joints can be painted, insulated, anodized, phosphatized, etc., to eliminate the battery galvanic coupling created between two materials of different standings in an electromotive series, when the materials are immersed in a conducting medium-wet enviroment. With structure in mind, dissimilar material (metal) tables have been generated. These are based on the theory that if the battery voltage created between the two metals is low enough (1/4 to 1/2 volts) the galvanic corrosion will not be severe enough to cause damage. True, but for EMI design, which is dependent on a surface resistance change, this is not good enough. Any galvanic current which flows may be enough to increase the resistance. With