EMC Solutions for Enclosures and Racks

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With faster high-performance electronics inside today's enclosures, electro-magnetic compatibility (EMC) is more important than ever. Attentuation reaches very high levels. To reduce the effects of EMC, there are many methods that can be employed for the enclosure.

The 60 DB Challenge

In a recent application at Optima EPS, An Elma Company, the customer required a minimum electric field attenuation of 60 DB of shielding effectiveness from 100 KHZ to 1 GHZ decreasing to a minimum of 46 DB at 10 GHZ. This application is for network-centric communications and satellite control with the use of various X- and Ka-band antenna and terminals. The rack goes into fixed and mobile shelters and requires a high level of shielding to protect against internal and external electromagnetic interference.

Properties of Stainless Steel, Metals and Conductive Materials

Metal properties (conductive materials)	Electrical Conductivity (10.E6 Siemens/m)	Electrical Resistivity (10.E-8 Ohm.m)	Thermal Conductivity (W/m.k)	Density (g/cm3)
Silver	62,1	1,6	420	10,5
Copper	58,5	1,7	401	8,9
Gold	44,2	2,3	317	19,4
Tin	8,7	11,5	67	7,3
Bronze	7,4	13,5	85	8,8
Carbon Steel	5,9	16,9	90	7,7
St. Steel 316L EN1.4404	1,8	55,6	15	7,9
St. Steel 304 EN1.4301	1,37	73,0	16,3	7,9

Figure 1: This chart shows the conductivity of various metals. Tin was used as it is more practical and cost-effective than silver or copper, while offering much better conductivity than steel.

With a significantly large enclosure of 48" by 36", a way was needed to solve the EMI problem and without breaking the bank. The decision was made with the customer to utilize a tin-plating process for EMC. By using a surface with superior electrical continuity properties, it could help reduce offending radiated emissions. For lower levels of EMC, Optima's typical enclosure would use zinc over steel. The process is a simpler and more cost-effective solution. Of course, plating with copper or gold would be far too expensive. So, tin (roughly 5 percent) over nickel (approx 95 percent) on the steel construction was a good choice. See Figure 1 of metal conductivity chart. However, this plating process in not easy for all manufacturers to handle. It takes a special skill-set and experience to work the process.

Tin-plating for EMC Compatibility

The process for the plating has four steps. Step one is to etch the metal. The acid-based chemical primes the metal and prepares it for plating. Step two desmuts the metal. Step three is to apply the nickel plating. Step four is the application of the tin. Low voltage is applied to a covered graphite probe for each of the step of the process. A positive polarity is utilized for step 1 and 2 and negative polarity for steps 3 and 4. The enclosure is finished with various types of steel wool and other pads to remove any remaining barbs and residue while providing a keen shine. Figure 2 shows the cabinet after Step 4. With the core of the enclosure tin-plated for electrical continuity, the next step was looking at the covers and gasketing.

Gasketing, Panels And Doors

Figure 2: Photo of the cabinet enclosure going through the tin-plating process. The plating was applied with graphite probes.

Various types of gasketing can be employed in electrical enclosures. They can be stamped into the sheet metal, metal finger gaskets can be added and foam strips versions can be applied. In the 60 DB project, the next step was to add wire-mesh gaskets along the seams. These gaskets have two layers of double-knit tin-plated copper mesh mounted to NEMA 12/UL 508 gasket. They have dynamic mechanical properties that yield a high deflection range and eliminate compression set so the gasket won't lose its form.

In addition, the enclosure utilized 6 EMI filters. These were also tin plated, but since they are not very large, they were dipped into tanks rather than using a probe for application. The honeycomb filter would allow significant air intake/exhaust for cooling was suppressing EMI. The filters were located above and below the unit as well as on the front cabinet door.

Now that the rack has EMC protection for its main construction, strip gasketing for seams, and several EMI filters, it was time to fine-tune the cabinet. Extra gasketing was applied to any susceptible areas, including the door handle which tended to act as an antenna. So, an O-ring was applied to the handle which solved the problem.

By using enhancing electrical continuity with the tin process and adding gasketing in key areas, the enclosure was able to pass the 6O DB requirements. In addition, utilizing tin plating on the EMI filters and fine tuning areas such as the door handle were keys to solving this shielding challenge.

Gasket Fingers, Stamping

Metallic gasket strips were not used in the application, but they are commonly used for medium to advanced levels of EMC in many enclosures. Figure 3 shows a metal gasketing for a cabinet enclosure requiring 46 Db shielding effectiveness. Meeting FCC Part 15, Subpart J (class A & B), this design goes around the bezel edges. For smaller enclosures, similar strips can be applied around the inside of the enclosure in susceptible areas. However, for desktop cases where the customer is often assembling the enclosure along with their boards/components themselves, separate gasketing can add a level of assembly. To save assembly time and costs, the stamping can be incorporated directly into the sheet metal/aluminum. In Figure 4a, Elma's patented EMC spoons are stamped into the metal before the edges are bent, saving the customer precious time. In fact, the enclosure in Figure 4b is designed to act as EMC protection and a mounting kit in one. Also, the covers are removable for easy access and folded over the frame, which helps eliminate openings. All of these factors allow quicker assembly time while incorporating advanced shielding.

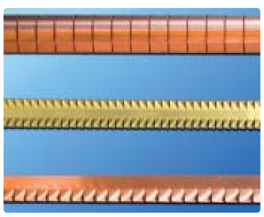

Figure 3: Stamped or formed EMC gasketing can be applied directly into the sheet metal or aluminum. Strips offer flexibility of location, while forming can mean less individual parts and assembly.

Figure 4: 4a (above) The gasket "spoons" are stamped into the metal before being bent, saving assembly time and offering a rugged/shear-resistant solution. 4b) Utilizing stamped spoons, the enclosure frame acts as a mounting kit and shielding solution in one.

Alodining for Electrical Continuity

As briefly mentioned earlier, enclosures such as instrument cases can use other processes to maintain various levels of shielding. In front loaded enclosures, often the front panels for boards or fillers for empty spaces can be alodined. This conductive clear chromate chemical conversion per MIL-DTL-5541 provides more electrical continuity across the front of the case.

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