PLASTIC HOUSING DESIGN AND EMI SHIELDING

An aluminum deposition process applying high vacuum technology was developed in West Germany to meet the shielding standards established by the VDE. With this process, a highly conductive layer of aluminum is evaporated in a controlled vacuum environment onto the inside surface of plastic housings after molding. The aluminum layer is both dense and ductile, may exceed 6 microns in thickness, has excellent electrical and mechanical properties, and may be applied to most plastic materials currently used in the manufacturing of housings. A detailed description of this process was presented by Dr. W.A. Schaller in an article titled "Conductive Coating by Vacuum Metallization", which was published in ITEM 83.

In the past, vacuum deposition of aluminum has been maligned for shielding applications because this thin aluminum could not withstand environmental testing without a topcoat, an expense which rendered the process impractical. The special deposition process, while utilizing certain vacuum metallization techniques, produces an aluminum layer 10 to 100 times thicker than the conventional metallizing process. The aluminum layer can withstand severe environmental tests while providing extraordinary conductivity for shielding effectiveness.

During the metal spraying process, an alternative method, metal is formed into droplets and blown by inert gas onto the surface of the plastic substrate. As the droplets coalesce on the surface, a somewhat porous metal coating forms. This coating may contain large pores and/or several loose particles. These particles can dislodge, flake off, and fall into the electronics, presenting a risk of equipment damage. It may be necessary to brush off loose particles and/or seal the layer with lacquers to prevent further problems. Additional concerns with metal spraying are: induced stresses set up in the substrate from the thick layer buildup; thermal stresses introduced during processing; and thermal expansion differential between the substrate and metal layer.

To achieve good attenuation when designing electrical equipment, several functional elements must be considered: electrical contact between individual parts of the housing; arrangement of vent positions; position and size of required openings; positioning of various electronic components within the equipment; cable ducts and cable screening within the equipment; and bandwidth frequency of operations of the equipment.

The design of any new piece of electrical equipment faces numerous considerations. Although various requirements have different priorities in the design phase, ultimately they must all be satisfied. Secondary priorities, such as screening, are often set aside in the mistaken belief that minor adjustments to the equipment will eventually solve the problem. Yet, experience too often shows these minor adjustments may result in additional costs or possibly the reduction of the performance rating to comply with governing regulations.

Equipment that is designed with consideration for subsequent shielding may have an initially greater tooling cost although eventual overall expenses will be most cost effective. For example, housings should be designed so that subsequent surface coatings are possible without excessive costs.

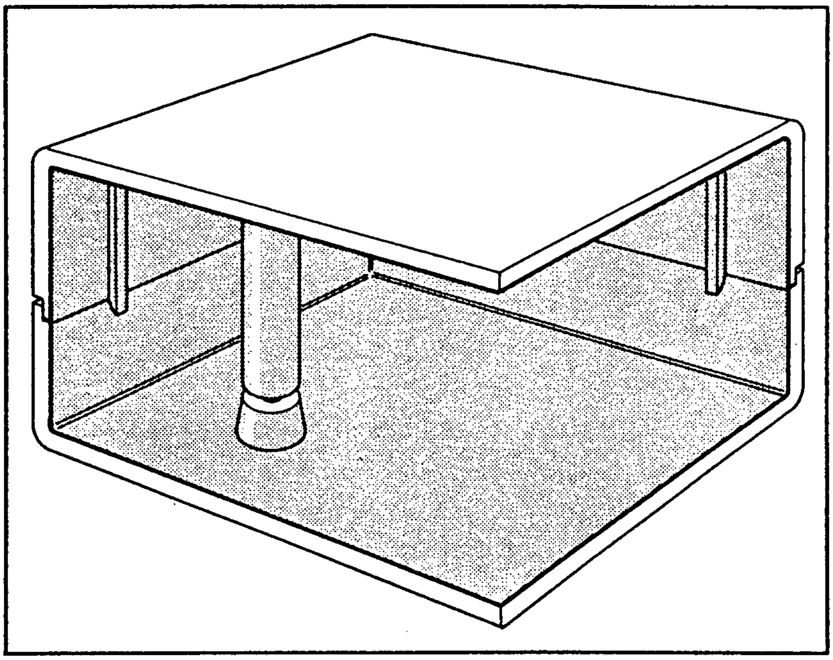

Figure 1. Incorporating compression joints, snap connections, and spring contacts into molding.

The following principles should be maintained to help ensure EMI shielding in housing designs. Good electrical contact should be provided between the individually coated housing components. Necessary static insulation should be provided. Vent holes should be designed, such that the vent hole area may also be coated (offset slots or double-level construction). Large openings such as holes and uncoated surfaces should be avoided. Contact areas should be provided for connections with the housing face; more than one may be necessary for large surface areas. Housings should be designed without undercuts or ribs which may be either difficult or impossible to coat. The above principles may be addressed by utilizing the process and functional characteristics of aluminum deposition on the inside housing surface, which forms a dense, highly conductive layer for shielding purposes.

General standards for proper shielding designs are not possible because different plastics with varying properties require different measures. More design possibilities exist with dense injection molding which offers greater elasticity than structural foams. Compression joints, snap connections, and spring contacts can be incorporated into the molding. (See Figure 1.) The molding may also produce the desired finished color and surface textures.

It is important that the shielding technique selected does not soil an otherwise finished part. Soiling can be prevented by the dense depositions of aluminum process, accurate masking and jigging. With foam moldings that may require finishing by painting, the aluminum layer may be applied either before or after painting.

A good means to achieve electrical contact between several housing parts is by using half lap joints. (See Figure 2.) While the inside surface of the housing may be uniformly coated for shielding, aluminum is not visible on the joint lines of the exterior surface. Only slight pressure is necessary to make electrical contact with the aluminum layer, although it should be distributed evenly over the entire contact surface. Screwed joints or snap connections should be mounted at certain intervals within the walls rather than be part of the side walls. In Figure 1, the opposite screw bosses do not contact each other, thus allowing for the even transfer of pressure on the side walls. Molded fingers, as shown in Figures 1 and 2, also aid electrical contact between the two housing sections. The fingers best utilize the elasticity properties in plastics.

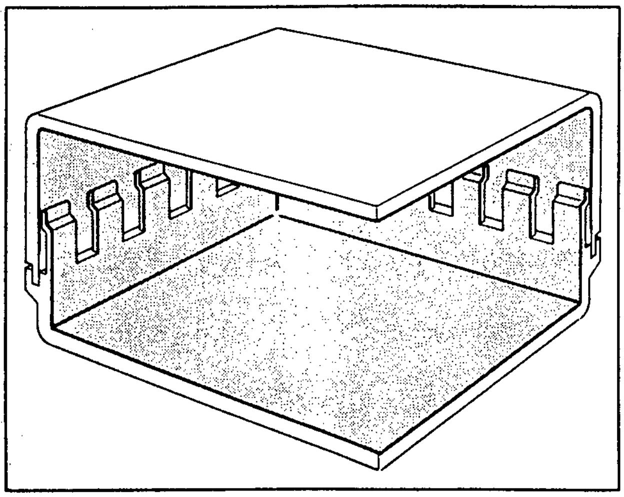

Figure 2. Use of half lap joints and injection molded contact fingers to achieve electrical contact.

It may be necessary to keep a certain insulation distance around the housing joint for electrostatic reasons. Bridging of the insulation distance is done with the aid of injection molded contact fingers. (See Figure 2.) The elasticity of the material keeps the fingers in contact with the inside face of the mating part. With foam molded housing, contact is achieved by mechanically attaching metallic contact springs.

In a keyboard housing, the choice may be between incorporating a safety distance for electrostatic protection or not coating this area at all. A safety distance may be achieved by increasing the rib height and coating only the top face. (See Figure 3.) With this design, the keyboard screens can be in contact with the screened housing.

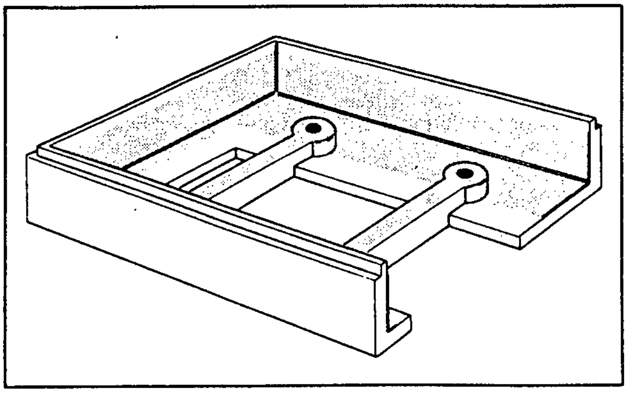

Figure 3. Increased rib height for ESD protection.

A suitably designed boss is best utilized when screw on connections to the housing body are required. (See Figure 4.) The threaded bush is either pressed or molded with dense injection molding. An even coating is achieved on the boss by providing slightly rounded edges and corners. The cable or contact tag is screwed onto the face of the boss. It is important to note that when using self-tapping screws, the point of entry of the screw is recessed from the contact area. This allows for the contact tag to seat firmly onto the contact area. (See Figure 4.) The recess is necessary so that the burr caused by the tapping does not hold the contact tag away from the contact surface.

The designs of suitable vent holes present different sets of considerations. The free cross-sectional area of the vent holes should be as large as possible to achieve satisfactory cooling without forced circulation. It should be noted, however, that there are clear demands to restrict the size of the slots.

The physical size of the vent holes is limited by the mechanical strength of the plastic material as well as by the restrictions that no items be allowed to fall into the equipment. Free openings may be covered by additional screens so that small objects such as paper clips cannot fall into the equipment. One means of protection is to heat stake metal screens on the inside of the molded housing.

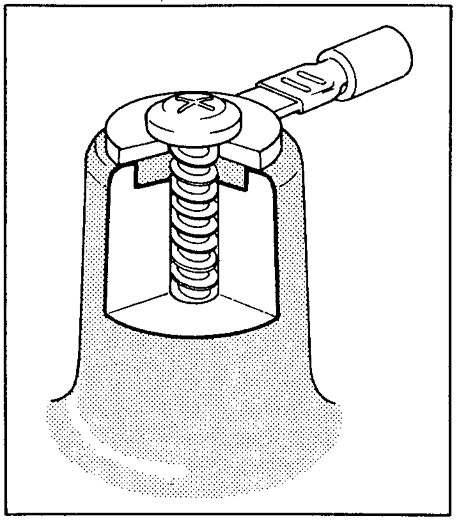

Figure 4. Contact tag seated firmly on the contact area.

It is possible to eliminate this additional screening during the initial design of the vent holes. A two-level construction may be used to provide edge ventilations at the slots. (See Figure 5.) Viewed directly in line with the vent, closed surfaces are apparent from inside or outside. The entire surface of this construction may be coated without the outer surface being soiled. The mechanical strength of the housing is not weakened using this manner of design.

These examples demonstrate some of the primary considerations in the design of properly protected equipment. Each individual case necessitates evaluation of appropriate requirements; however, good shielding is usually achieved by simple means. The original equipment design concept need not be compromised. Finally, because remedial action always requires additional costs, it is more cost effective to plan for shielding during the initial design phase.

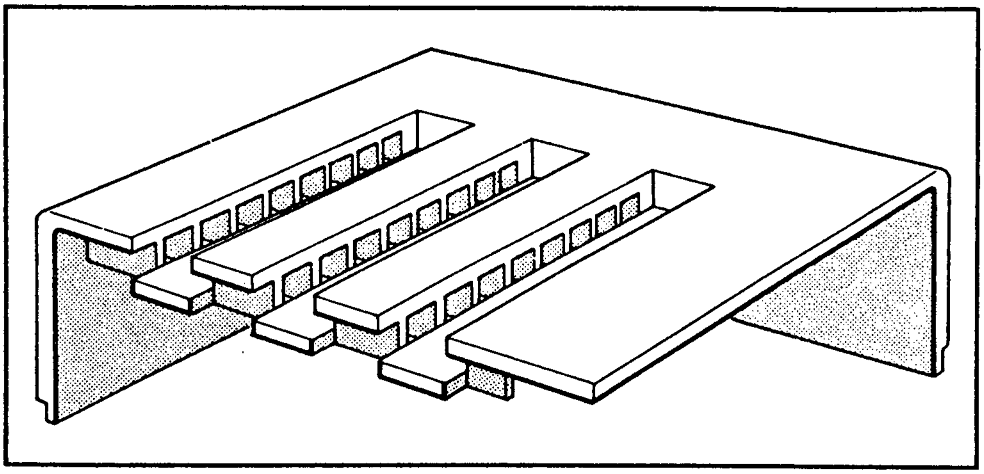

Figure 5. 2-level construction to provide edge ventilations.

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