Design Considerations for Injection-molded Plastic Parts

Knowledge of coating processes and teamwork at the initial design phases of PC layout and box design are crucial to controlling EMI shielding costs.

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INTRODUCTION

The increasing need for EMI shielding should bring together designers of electronic devices and designers of plastic housings for the devices. Such teamwork can lead to significant cost reductions. One example is the common practice of mounting a PC in a plastic box by screwing it to stand-offs. Often, part of the circuit is included in the screw area. Instead of modifying the layout, the stand-offs are masked during the metallization of the box, which turns out to be an expensive Band-Aid.

Another common error is that of masking an area which need not be shielded simply because the design engineer indicates that in that particular area shielding is not required. What the designer neglects to say is that shielding in that area is optional. Some of these errors are exceedingly expensive, and only an overview of the entire process reveals the ramifications.

MASKING THE BOX

Even the configuration of the "box" is crucial for good EMI shielding. The modern look, featuring no sharp edges or radii, is preferable over sharp corners or small radii. When possible, large depth-to-width ratios should be avoided. The motto "the flatter the better" should be the design rule rather than the exception.

Another aspect of box configuration that is often overlooked is the difficulty of masking when the boundary of the mask does not lie in one plane. Most of the time this involves an arbitrary choice. For example, the edge of the gasket may be a natural choice as long it does not complicate masking precisely at that perimeter. Very often metallization beyond that perimeter poses no technical or cosmetic problems, and should therefore be allowed in the interest of cost reduction.

Form and function testing should be done with production masking to assure that cavities X and Y, for example, yield dimensional tolerances that allow for one mask-to-mask product from both cavities. Here again, the tolerance calculations must take into account the masking requirements. For example, a dimension, which in terms of form and function of the box is considered a reference, may indeed be critical in terms of a shadow mask.

Another obvious example is the contour of a key pad area, which in a phone may not be critical because of the resilience of the key pad. However, in a shadow mask the contour may be a critical factor since each key hole must be masked accurately, and the perimeter mask referenced to the key pad or vice versa. To have the key pad mask separate from the perimeter mask is costly both in terms of mask cost and in terms of handling.

One frequently encountered problem is a design in which an isolated small area is to be masked. This requires a mask that allows for a support member to locate the isolated mask piece while not shadowing the area to be coated. Maintenance costs of such masks are relatively high, and reliability is low. If at all possible, such design features should be avoided, and most of the time a layout change can get around such problems.

At the other end of the masking issue is the "coat all surfaces" requirement which allows for no attachment to any fixture. Here again, it is probable that the device need not be coated over its entire surface, but such a total coating is permissible. Here the challenge is simply to support a component in the coating process while not shadowing even a small area of attachment. A small hole into which a rod may be press-fit is all that is required, and yet, if the design does not provide such a hole, the cost of coating the entire surface may be very high unless a barrel process is possible.

An example of a component to be coated on all surfaces is an internal shield. Obviously such a shield need not be coated on all surfaces but will function equally well with all surfaces coated.

Viewed from the perspective of the PC layout, the complexity of shielding the box is not obvious. Viewed from the perspective of the box design, the shielding problems are not obvious either. However, viewed as a team effort to produce the lowest cost device, the problems described can easily, and often elegantly, be avoided.

PROCESSES

Several, if not all, of the EMI coating processes available in the marketplace are covered by what has been said. For example electroless and electrolytic processes require robust waterproof masking, while spray paint and evaporative processes have less demanding mask requirements. In fact, vacuum vapor deposition requires a line-of-sight or shadow mask, the simplest type of mask.

In the case of telephone shells or similar "electronic boxes," the cosmetics of the exterior are important and this aspect adds another complication in

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mask design, since all cosmetic issues require the mask not to scratch or "color" the surface the customer sees. Even with a well- designed mask, the handling of the box and mask requires a skilled assembler and adequate assembly lines with clean non-scratch tabletops.

A substantial advantage of vapor deposition over spray painting is the line-of-sight nature of vapor deposition, while spray paint, often responding to a vortex, oversprays at the exit side of a hole. In contrast, the metallic vapor does not cause a vortex as it passes a boundary in vacuum. For example, the vent grid in a monitor requires no plug mask in vacuum vapor deposition while in the case of spray paint, a plug mask is required.

These few examples show clearly how each process has its masking problems. And yet, these problems can be reduced dramatically if taken into account at the "box" design phase. For example, self-masking in open areas can be achieved by a "counter bore," i.e., a larger exit than the entrance port. In such a case, no plug is required if the device is vacuum vapor-coated.

SUMMARY

In conclusion, a cursory knowledge of coating processes and teamwork at the initial design phases of PC layout and box design are crucial for keeping EMI shielding costs under control.

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