EMI Shielding

Introduction

One of the most critical physical property requirements of an enclosure for electronic devices is the ability to act as a shield against electromagnetic interference (EMI). EMI is essentially the impairment of the performance of an electronic system or subsystem by an unwanted electromagnetic disturbance; RFI (radio frequency interference) is a type of EMI which extends over a relatively small portion of the overall frequency band.

Any circuit or device that carries an electrical current is a potential source of EMI. The objective in electronic system design is to achieve electromagnetic compatibility between the subsystems in an electronic assembly and between that assembly and other electronic devices that it will encounter in its operating environment.

Any barrier placed between an emitter and a susceptor that diminishes or attenuates the strength of the potential interference qualifies as an EMI shield. The shielding effectiveness of an enclosure is a function of both materials and design, as well as the service conditions. Thus, radiation incident upon a shielding barrier is either absorbed, reflected or transmitted. For metal shields and high impedance fields, most of the energy is reflected; if the magnetic field is dominant, absorption is the principal mode of attenuation. Table 1 shows the relationship between common measures of shielding.

TABLE 1
MEASURES OF SHIELDING

SHIELDING EFFECTIVENESS dB	ATTENUATION RATIO	PERCENT LEAKAGE THROUGH SHIELD
20	10:1	10.0
40	100:1	1.0
60	1,000:1	0.1
80	10,000:1	0.01
100	10^5:1	0.001
120	10^6:1	0.0001

Metals Versus Plastics

Most metals are inherently conductive and therefore reflect and absorb EMI to an appreciable degree. The amount of EMI shielding provided by a metal enclosure depends upon the nature and frequency of the radiation, the absorption and reflection components of the radiation, the conductivity and magnetic permeability of the metal, and the distance of the enclosure from the radiation source.

Since plastics are inherently insulative and thus transparent to electromagnetic radiation, plastic enclosures must rely on surface modification or incorporation of metal particles to satisfy shielding requirements. Both of these approaches carry significant cost penalties, with the latter also leading to decreased tool (die) life.

The current competition between plastics and metals for EMI shielding is dependent on both the inherent advantages and disadvantages of these materials in such applications and on the evolving aesthetic/electronic/mechanical requirements of the enclosures.

For metals as a group, the relevant advantages are:

1. Inherent conductivity and therefore inherent EMI shielding capability.
2. Low raw material costs.
3. Structural strength in thin-wall designs.
4. Durability in service.

As the design of electronic units moves toward more power in less space, the ease of fabrication and the heat resistance of metals also become more significant factors.

Advantages of Magnesium for Die Cast Shielding Enclosures

- Very low density, leading to light weight, portable units.
- Low heat capacity, a significant factor in achieving high production rates.
- Very low solubility for iron, providing a major basis for superior tooling life.

- Excellent fluidity, an important contributor to castings with thin walls, minimum draft and dimensional accuracy.

- For shielding applications dependent upon reflection, the weight saving benefit of magnesium enclosures extends over the full frequency spectrum.

- For shielding by absorption, die cast enclosures of magnesium and aluminum provide nominally equivalent shielding effectiveness on an equal weight basis. (The higher conductivity of the aluminum is offset by the lower density of the magnesium.) As frequency increases, however, the wall thickness required for a given level of shielding effectiveness becomes progressively smaller. Above approximately 1 MHz, the required thickness of the enclosure becomes defined by castability (fluidity) limits and structural integrity requirements. In this portion of the frequency spectrum, which encompasses most commercial applications, the thinner wall casting capability and lower density of magnesium provide significant advantages in weight and cost reduction over die cast aluminum. Figure 1 illustrates these considerations.

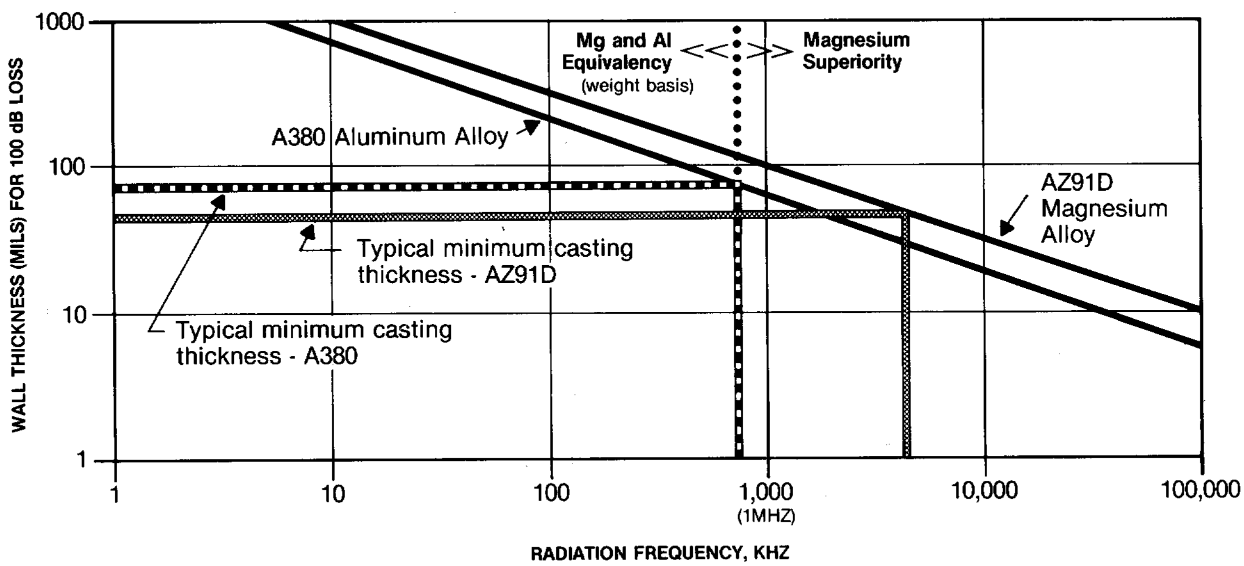

Figure 1. *Effect of frequency on the shielding thickness required to achieve 100 db loss.*

Shielding at Joints

Joints, cable entries and other openings in electronic enclosures represent important possible sources of radiation leakage. Gasketed joints require special attention, with the objective of maintaining a uniform low resistance joint over long service periods, sometimes in severely corrosive environments. Shielding of these joints normally involves the use of dissimilar metals in one form or another (fingers, mesh, conductive elastomers, conductive flanges, etc.). This creates the potential for galvanic corrosion and therefore the possible development of a high resistance joint.

The maintenance of low resistance joints starts with flange coatings, which vary with the enclosure metal and the service environment. These can include conductive conversion coatings, conductive epoxy paints or metallic plating deposits. Interior environments normally dictate only a conversion coating, whereas severely corrosive environments might require the use of duplex gaskets, viz., an inner conductive gasket to provide shielding and an outer non-conductive gasket to seal out the corrosive atmosphere. The conductivity of conversion coatings on magnesium tends to vary inversely with the corrosion protection value.

Summary

Die cast magnesium alloy enclosures for EMI shielding provide significant advantages over both plastic and alternative metal housings. Effective shielding at joints or openings is maintained through established protection measures.

References

Carlson, E. J., "An Overview: Corrosion Concerns in EMI Shielding of Electronics," NACE Paper No. 47, Corrosion 89, April 1989.

Magers, D. M., "Comparative Economics of Production of Magnesium, Aluminum, Zinc and Plastic Parts," Proceedings, 40th World Magnesium Conference, International Magnesium Association, 1983.