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Reflections on absorbers

High frequency, broadband performance links recent improvements in EMI shielding components.

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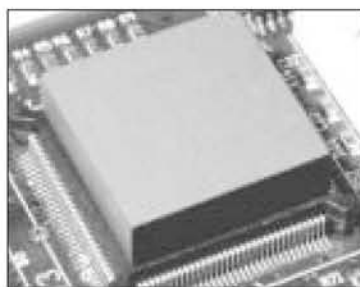
JUST AS THE ELECTRONICS INDUSTRY HAS EXPERIENCED exponential change over the past decades, EMI shielding components have undergone vast changes and improvements. Just ten years ago, many of today's widely-used gaskets, filters, ferrites, cables, and electronic enclosures had yet to be developed. Within recent memory spurious emissions at 100 MHz were typical; but higher microprocessor speeds and smaller, more compact enclosures have ushered in a whole new era with harmonic energy exceeding 500 MHz. However, one commonality links recent improvements in EMI shielding components—increased high frequency, broadband performance at less expense.

TYPES OF SHIELDING MATERIALS

Shielding products can be described as either discrete or comprehensive. Discrete

products target an individual component such as a ferrite RF absorber used on a microprocessor. In contrast, comprehensive types are used for an entire system, or at least groups of components. Examples of comprehensive shielding aids include gasketing on an electronic enclosure or a ferrite core on a cable harness (Figure 1). At times, either category of shielding product can be used as long as the overall goal of EMC compliance is achieved. Cost-effectiveness is usually a factor in choosing one category over the other, especially in mass production of electronic products.

Electromagnetic interference shields derive their shielding effectiveness (SE) from both reflective and absorptive properties (Figure 2). Reflection is the prevailing effect at higher frequencies and results from the conductivity of surface material of the shield, regardless of thickness. Usually, higher conductivity equates with increased effectiveness. Absorption, in contrast, is dependent on the thickness of the shield. Thicker materials result in increased effectiveness. However, the “thicker is better”



Discrete ferrite absorber on a chip



Comprehensive ferrite suppressor on cable harness

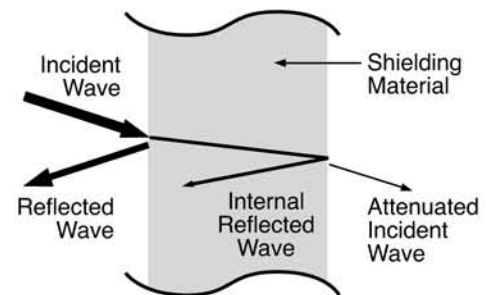


Figure 2. Plane wave shielding.

Figure 1. Discrete and comprehensive shielding.

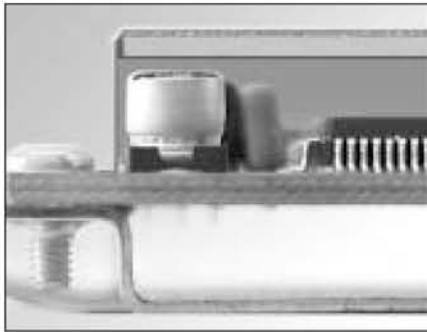


Figure 3. PCB in shielded enclosure.

approach has its limitations—namely, weight, cost, and feasible dimensions. Some new shielding materials address these obvious concerns and provide the designer with new options.

Radio frequencies emanating from discrete components, such as the printed circuit board (PCB) in Figure 3, are typically addressed in one of several ways. At times, no local or discrete shielding is required because the overall shielding of the outside enclosure provides the desired result. Alternatively, a reflective shield can be placed over the offending components, or an absorber shield can be used to “soak up” the RF energy, converting it to an imperceptible degree of heat. Obviously, each of these three approaches has its merits depending on the specific application. In situations in which RF energy is contained by shielding the entire electronic enclosure, a myriad of factors should be considered including the material and construction of the enclosure, gasketing, filters, and cabling.

Reflective shields are actually small electronic enclosures, sized to contain a specific component or group of components. This technique depends on some absorption by the material of the enclosure, but the primary dissipation of the RF energy occurs as the energy reflects repeatedly from the walls of the shield (Figure 4). The shield is a dome-like cover and is assembled over the components of the PCB. Effective board design should allow for optimum spacing and thermal transfer, factors that boost efficiency and durability. Still, there are instances in which components produce capacitive coupling and resonate at higher harmonic frequencies.

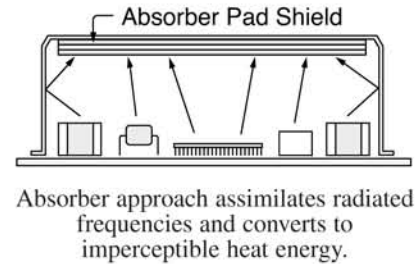
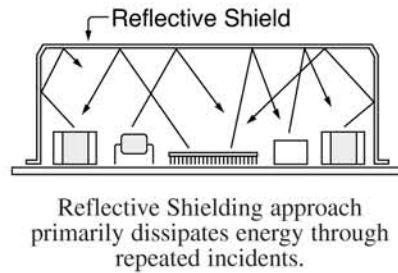


Figure 4. Reflective and absorptive shields.

INNOVATIONS IN ABSORPTIVE SHIELDING MATERIALS

Absorptive shielding materials in varying constructions have been available for many years (Figure 4). Essentially, these materials are engineered constructions of silicone rubber substrates with embedded mesh screens. Generally, they provide various levels of acceptable performance (up to approximately 1 GHz). Cost-effectiveness and manufacturing flexibility are usually acceptable. Die-cut shapes and ease of installation make these materials a practical option, especially in uses where flat shapes are needed and where conforming around curves and angles is not an issue.

More recently developed shielding materials use rubber-based substrates and various iterations of metallic particles in a matrix construction with the frequency-absorbing metal dispersed throughout the rubber. Suitable for a wider range of applications, these new materials offer increased attenuation and more engineering options as varying formulations target specific frequency ranges. Still, there remains a trade-off between physical flexibility the high level of metallic particle loading needed for high levels of attenuation.

Because of the necessary particle loading, attenuation does depend largely on thickness to obtain EMC compliance.

The most recent designs in shielding materials continue to use a rubber-based substrate but are much thinner and more flexible. The absorptive element is a multi-layered structure of homogeneous, screened coating matrices. Because of their homogeneity, any given cross section of the material affords identical absorptive characteristics. These absorptive layers are precise compounds, which can be combined in specific combinations to offer peak performance at given frequencies. Theoretically, the possible iterations are endless; however, commercially viable designs must offer significant broad-band range and a selection of constructions for EMC target frequencies. Additionally, these materials should be effective in dealing with harmonics beyond the tuned frequency. Absorption of about 15 dB at the target frequency is commonly available in selections for EMC applications (Figure 6). Similar, but more complex, commercial designs are available for microwave applications as high as 80 GHz. These newer materials ease packaging design and installation. Thinner cross-sectional design makes for easier die-cutting, forming,

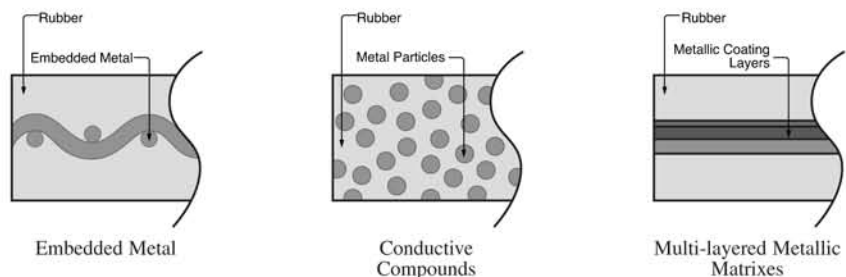
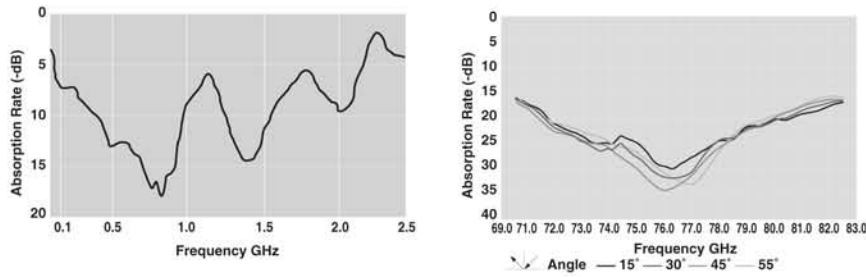


Figure 5. Absorber material types.



EMC Absorber tuned to 800MHz peak

Microwave Absorber tuned to 76.0GHz peak

Figure 6. Typical absorption rate profiles for EMC and microwave absorber materials.

and assembly.

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