Quiet Advancements in EMI Shielding Gaskets

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INTRODUCTION

Electromagnetic interference (EMI) is receiving more urgent attention as electronic components and assemblies become smaller and more sensitive. Increased internal frequencies produce clock speeds surpassing 100 MHz and sub-nanosecond rise times. There are also increased external noise sources such as wireless devices, notebook and personal computers, and other new products which incorporate microprocessor-based devices.

A recent front page article in the *Wall Street Journal* reported that "...the FDA [Food and Drug Administration] has received reports of EMI being involved in more than 100 frightening and occasionally fatal failures of medical equipment..." [1] The reaction has been to initiate tighter U.S. and international regulations to control damaging emissions and to provide for greater immunity of electronic devices. For example, on January 1, 1996 the European Community plans to impose mandatory standards for all electronic devices, including medical equipment, to ensure that they are immune to low-level EMI.

Advances in EMI shielding gaskets enable designers to meet increasingly strict regulations, while satisfying the commercial demands associated with time-to-market, style, and cost effectiveness. This is important since each failure of an EMI test can easily cost $20,000 to $45,000 for rework and retest.

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WHAT IS EMI SHIELDING?

Shielding is the use of conductive materials to reduce radiated EMI by reflection and/or absorption. Effective placement of shielding materials reduces the level of electromagnetic energy radiated by or coupled into electronic equipment. Shielding effectiveness (SE) is a measure of the performance of a shield, typically expressed in decibels as

- the ratio of the energy incident on the shield to that emerging on the other side,

or

- the ratio of energy emitted by an unshielded sample to the energy emitted by the same sample after it is shielded.

The decibel value is the ratio of two measurements of electromagnetic field strength taken before and after shielding is in place. Every 20 dB increase in SE represents a tenfold reduction in EMI leakage through a shield. A 60 dB shield attenuates field strength by a factor of 1,000 times (e.g., from 5 volts/meter to 5 millivolts/meter).

The overall expression for shielding effectiveness is written as

$$SE = R+A+B$$

where

SE is the shielding effectiveness,
R is the reflection loss,
A is the absorption loss, and
B is a correction factor for back-surface reflections.

Housings for consumer and business electronic equipment are typically made from thin sheet metal, cast metal, metallized plastic, or nonconductive plastic shielding with metal foil laminate shields. Open gaps (seams) at panel junctions and other enclosure openings provide a pathway through which EMI can both escape (radiate) and enter. Effective shielding enclosure seams (to meet FCC and similar standards) commonly require EMI gaskets which can provide the necessary level of shielding effectiveness across a desired frequency range.

FEATURES IMPORTANT TO GASKET SELECTION

Unless current continuity can be preserved across shielded enclosure seam gaps, electromagnetic fields will be allowed to couple from one side of the shield to the other. Conductive EMI gaskets conform intimately to the enclosure mating flange surfaces and provide current continuity by reducing resistance across the seams. The most critical features to consider when making a gasket selection are shielding effectiveness, ability to meet mechanical requirements, electrical conductivity and stability, and installation cost.

*See Advertisement on Page 95.

SHIELDING EFFECTIVENESS

Shielding requirements for commercial electronics generally range from 40 to 60 dB. Finding the shielding requirements for an overall system involves determining the radiated emission spectrum of the equipment, and the specifications the unit must meet (e.g., FCC Part 15). When testing the immunity of electronic equipment, the EMI shielding gasket must reduce the high ambient electromagnetic environment to a level that does not impact equipment performance.

CONDUCTIVITY/ STABILITY

EMI gaskets provide conductive pathways that electrically bond system components to a common ground. The gaskets serve as low-impedance conductors to ensure the stability of an enclosure's shielding. Gasket conductivity and electrical stability are critical to system performance and shielding integrity.

MECHANICAL REQUIREMENTS

The primary goal of a shielding gasket is to seal openings in an electronic enclosure to prevent the transmission of EMI. Improper design of the seal or enclosure mating flanges can result in failure to meet this goal. Several mechanical design issues must be considered for the proper mating of an EMI gasket with the flanges of an electronic enclosure. Among the most important are compression set and compression deflection.

COMPRESSION SET

If a gasket material is subjected to a compressive force for an extended time, some deflection remains when the load is removed. Compression set is an important property in designs where the gasket will be repeatedly compressed and released, such as in enclosure doors and access panels.

COMPRESSION DEFLECTION

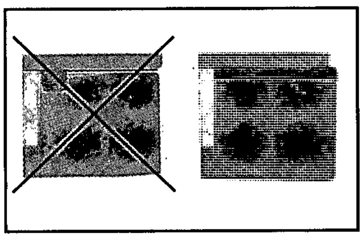
EMI gaskets require some amount of compressive force to function properly. As a result of this load, the material will decrease in height (deflect). The magnitude of the decrease is proportional to the applied load up to the elastic limit, or the point at which the material breaks or ruptures. Many commercial-grade gaskets must deflect 30% to 40% under low closure forces to properly maintain contact with mating flanges.

INSTALLATION COST

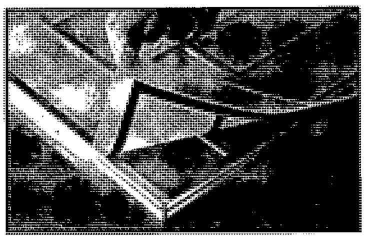
The method of installing an EMI gasket can be a major factor in

GORE-SHIELD™ EMI/RFI

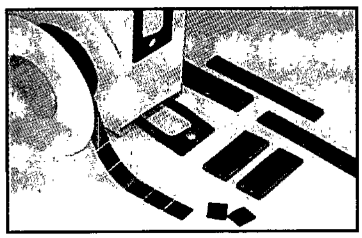
Driving The Cost O



Soft conformability cuts design time by eliminating grooves as well as cuts and scrapes



PEEL'N SHIELD ™transfer system reduces installation time and material cost



Cut-to-Length Strips, and user friendly dispensers minimize waste and improve installation efficiency

GORE is committed to reducing the cost of EMI shielding. Not just the price per part, but the entire installed cost! We started by making GORE-SHIELD™ material soft and conformable to eliminate costly groove requirements and other metal surface finishing expenses. Then we reduced installation time with our innovative PEEL'N SHIELD™ transfer system which offers easy, accurate gasket alignment.

GORE Cut-To-Length pieces and convenient dispenser packages further reduce cost by delivering precut gasket lengths eliminating waste. These are also available for both standard or microwave connector gaskets.

Still driven to reduce cost further we now offer rapid turnaround , custom tooling for full or semi-automated installation of the EMI gasket directly to your cover or circuit board. The result is the best price/ performance ratio of any gasket. All this plus environmental sealing and EMI shielding.

Let GORE drive the cost of EMI gasketing out of *your* system.

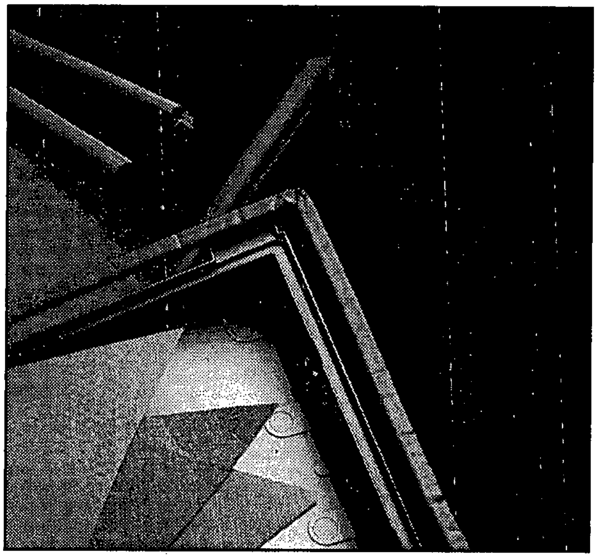


Figure 1. *Profile of an EMI Enclosure Gasket .*

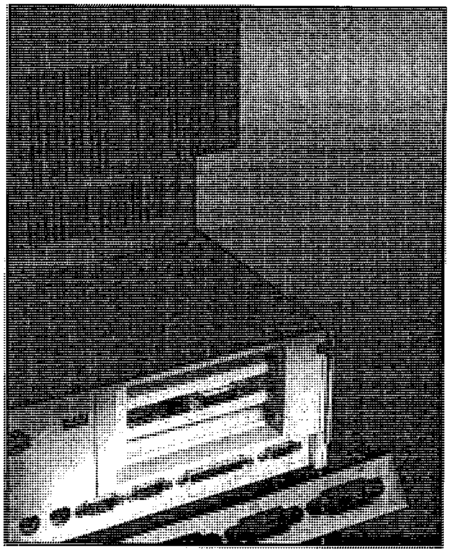


Figure 2. *Input/Output Port Gasket.*

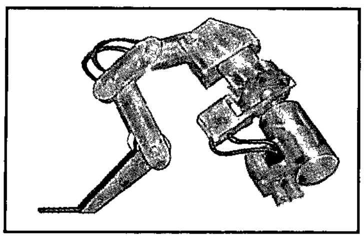
determining EMI shielding cost. Gaskets can be installed using clip-on strips, pressure-sensitive adhesives, push-in fasteners, rivets, screws, or epoxies. Some gaskets can be press-fit into grooves or designed to form-fit on enclosure walls. The installed cost for an EMI gasket includes the cost of the shielding material, labor, and other manufacturing costs. A gasket applied without fasteners or adhesives, for instance, may offer lower installed cost than an EMI gasket purchased at a lower price.

Doors, cable ports, vents, windows, access panels, and other openings in an otherwise shielded electronic package are pathways for radiated EMI (Figures 1 and 2). Gaskets are a good solution in these situations. The amount of EMI radiated through an opening is a function of the maximum dimension of the opening. A long, narrow slit, like the gap around the edge of a door, will leak much more radiation than a round hole of the same area (Figure 3).

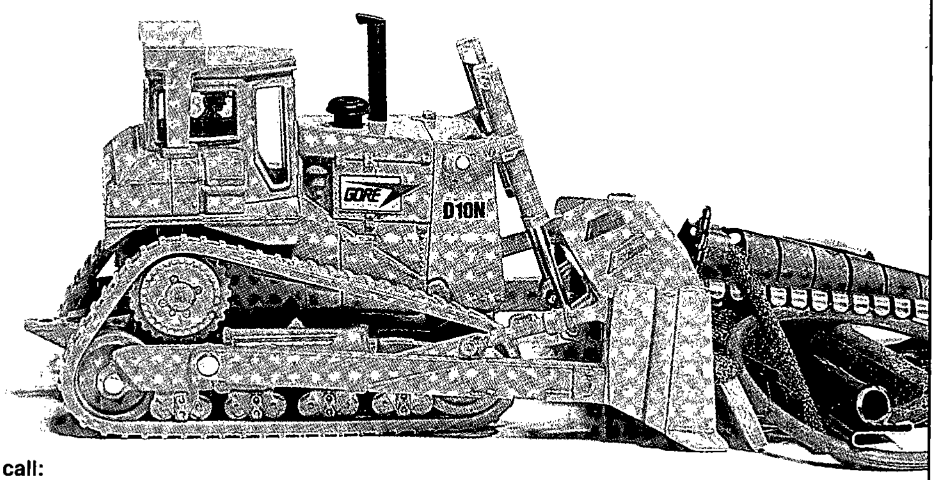
The imperfect joints between panels or covers and enclosure walls are typical "slots" through

Gasketing Solutions

ut of EMI Shielding



Automated installation fixtures, and direct application services reduce assembly time and cost



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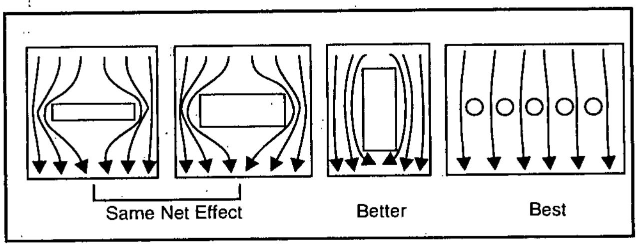

Figure 3. *Opening Sizes and Orientations.*

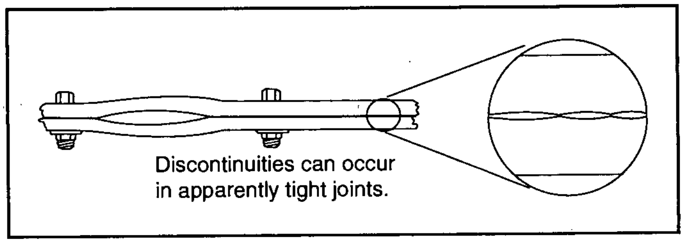

Figure 4. *Shield Discontinuity.*

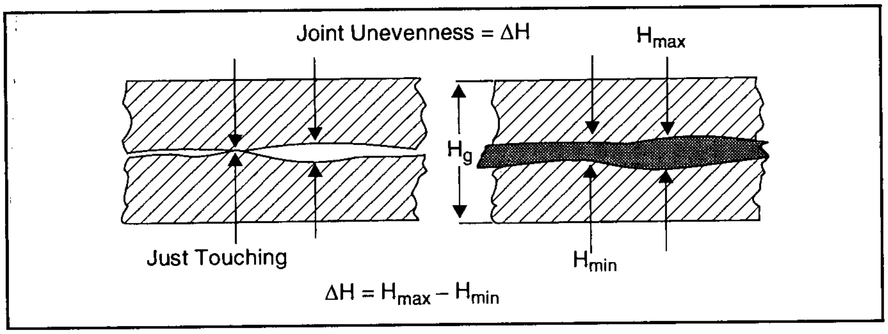

Figure 5. *Joint Discontinuities Eliminated by a Gasket.*

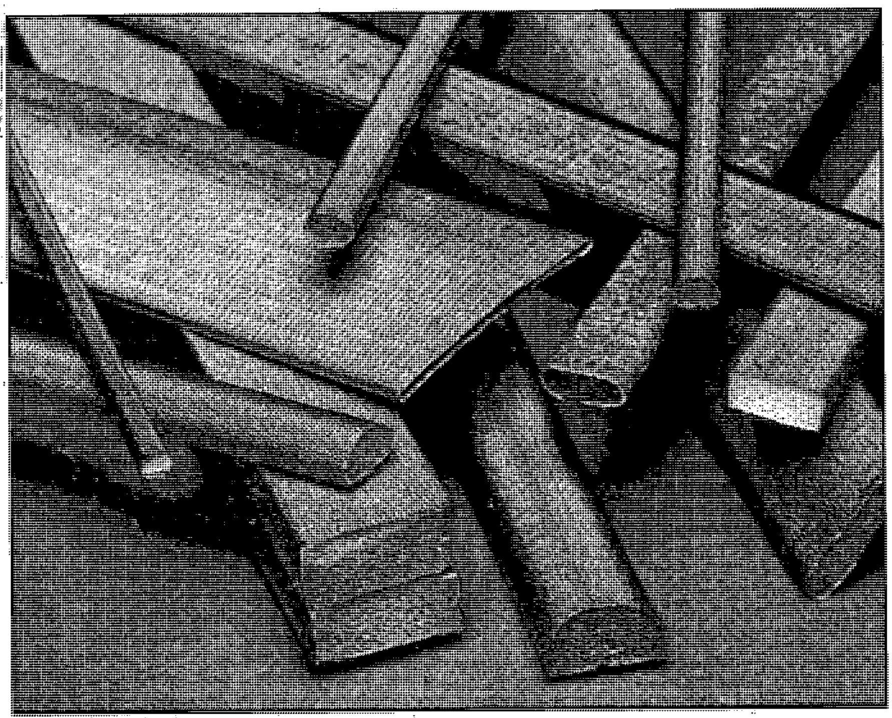

Figure 6. *Metallized Fabric Gaskets.*

which EMI can efficiently escape or enter a shielded enclosure, thereby degrading shielding effectiveness (Figure 4). Conductive EMI gaskets inserted between panel mating surfaces will provide low resistance across the seam and thereby preserve current continuity of the enclosure (Figure 5).

GASKET TYPES

There are four popular types of EMI shielding gaskets: stamped metal, wire mesh, conductive elastomers, and conductive fabric over foam. Each has pros and cons, depending upon the final application (Table 1).

A new type of fabric-over-foam gasket offers the shielding effectiveness of stamped metal (beryllium copper), but at a lower cost. These EMI gaskets use metallized fabric which utilizes a patented technology to apply thin metal coatings of nickel over copper deposited on woven or non-woven polyester fabric (Figure 6). This results in a corrosion-resistant material, unlike silver-plated fabric which can corrode over time, and a shielding effectiveness of over 80 dB (Figure 7). Also, the flexibility and conformabililty inherent in the combination of foam and fabric eliminates the problems associated with beryllium copper fingers, which can have a tendency to break or fall off, and cause short circuits when they fall onto PCBs.

In addition to improved fabric, a non-wicking, closed cell neoprene foam can be substituted for earlier types of fabric-over-foam gaskets which used TPE (V2) foam (Figure 8). Neoprene offers a UL 94-VO rated base material with compression features of less than 10% memory loss at 70 degrees C. It also offers resistance to moisture and salt spray, while exhibiting no abrasion change after thousands of cycles (Table 2).

CONCLUSION

The evolution of shielding gaskets provides today's designers a new level of virtually unlimited design capabilities not previously enjoyed. Advancements in EMI gaskets enable designers to meet the strict demands of an increasingly complex and noisy electronic environment.

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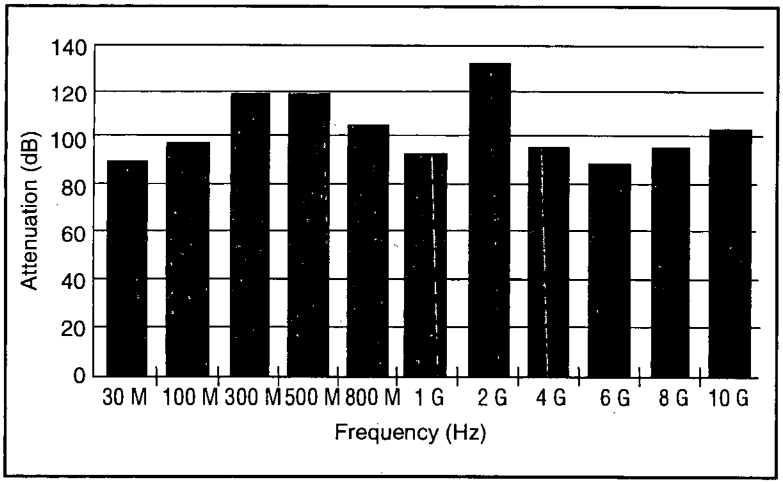

Figure 7. *Shielding Effectiveness.*

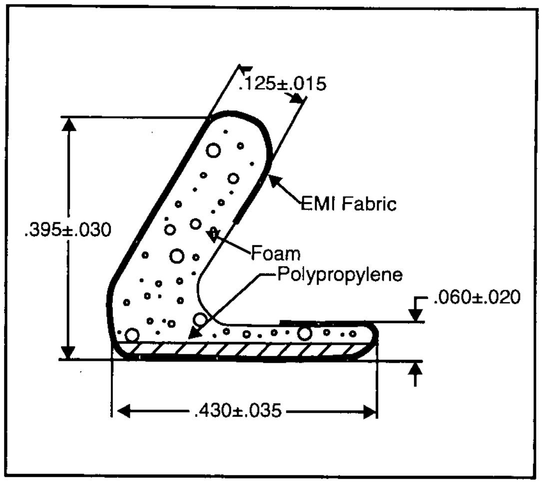

Figure 8. *A Non-wicking Closed Cell Neoprene Foam Gasket.*

Product	Strengths	Disadvantages
Metallized Fabric	Low price Flexibility Low compression forces Conformability Tear resistance	Weaker environmental seal
Beryllium Copper	High shielding effectiveness Low compression forces Good corrosion characteristics Very high conductivity	High cost Slow prototyping Vulnerable to damage No environmental seal
Conductive Elastomer	Good environmental/EMI seal Low compression forces	Very high cost Galvanic corrosion issue
Knitted Metal or Synthetic Fiber	Low price Durability/flexibility	Poor high frequency shielding Takes set Mod. to high compression force No environmental seal
Carbon-loaded Expanded Teflon	Very conformable Automated assembly Corrosion resistance	High price Shape limitations

Table 1. *Comparison of Gasket Materials.*

Test	ASTM Test	Performance	
Shielding Effectiveness, dB		V0 75-100	V2 75-100
Compression Set %	D3574	7.9	10
Compression Load Defection, PSI	D3574	15	5
Water Absorption (Foam Only %)	D1667	5.8	46.6
Abrasion Resistance, 3,000 Cycles	D3885	Excellent	Excellent
Ultraviolet Exposure	D750	No Visible Change	No Visible Change
Fungus Exposure	G21	Small Growth	Small Growth
Operating Temperature °C	D746	-40 to +90	-40 to +70
Flammability Rating	UL94	V0	V2
Conductivity, Ohms/Sq.			
Unexposed		.2	.2
Weathered (100 Hrs.)		.3	.3
Fungus		.2	.2
Salt		.2	.2

Table 2. *Performance Characteristics.*

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