Groove Mounting Techniques for EMI Gaskets

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INTRODUCTION

EMI gaskets are used extensively by the electrical/electronic design engineering community to assist in complying with the many EMI, EMC radiated and/or susceptibility requirements. The gaskets work by creating a low impedance path across a joint in a shielded cabinet or enclosure. The intensity of the field emanating from the joint is proportional to the impedance of the joint. The impedance of the gaskets on the market varies by as much as 120 dB (one million times). The cost of the gasket material is usually directly related to its impedance (i.e., the better the shielding properties, the more expensive the gasket). However, the method of using the gasket (i.e., the type of groove) can often offset the cost of the gaskets.

The choice of an optimum groove mounting technique can often offset the cost of EMI gaskets.

All of the groove mounting methods recommended by the various manufacturers of EMI gaskets begin with a typical o-ring groove. However, the width to depth relationship varies greatly as do the final configurations. The costs associated with the different grooves include the cost of manufacturing the groove, the number of screws or fasteners required to obtain the seal, and the cost of installing and replacing the gaskets. Most of the grooves can be molded or cast in place for high production runs. However, the screw spacing for the recommended grooves can vary from 3/4" to several feet. This difference in the number of required fasteners more than offsets the cost of the gaskets and method of fabricating the groove.

GROOVE TYPES

There are basically four groove types. These are (1) wide o-ring grooves, (2) narrow o-ring grooves, (3) wide o-ring grooves with pinch bosses, and (4) dovetail grooves. The first three types of grooves can be die cast or molded in a lid or chassis for high production runs. The dovetail groove can be machined, extruded or made with investment molding procedures. The advantages and disadvantages of each type of groove are illustrated below.

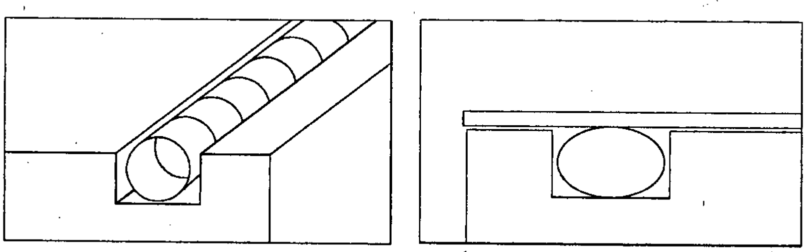


FIGURE 1. Wide O-Ring Groove with Gasket.

WIDE O-RING GROOVE

The wide o-ring groove can be machined, molded, cast or extruded (Figure 1). The width of the groove is approximately 35 percent larger than the diameter (or width) of the EMI gasket and the depth is about 75 percent of the diameter (or thickness) of the gasket.

ADVANTAGES

The wide width allows the gasket to expand laterally as it is deflected down. Because the sides are not constrained, the force versus deflection ratio is fairly linear. This in turn means that fastener spacing can be calculated fairly accurately. There are numerous products on the market that will allow fastener spacing of two feet or more under the right conditions. The groove can be cast or molded in a cover or chassis for large production runs. The groove facilitates low maintenance costs.

DISADVANTAGES

The EMI gaskets can fall out of the groove during manufacture and maintenance. This disadvantage can be offset by using small adhesive beads every three to four inches (Figure 2). The adhesive

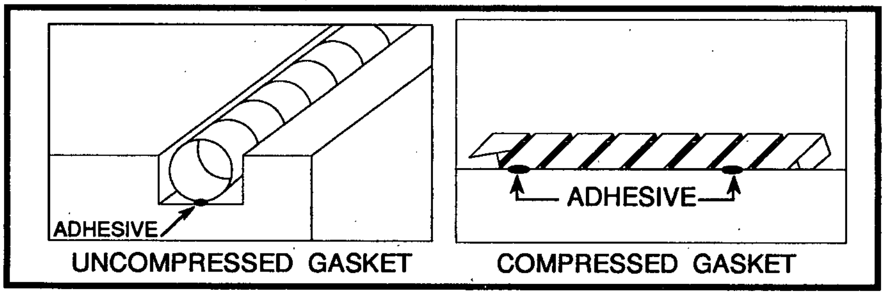


FIGURE 2. Gasket Held in Place by Dots of Adhesive in Wide O-Ring Groove.

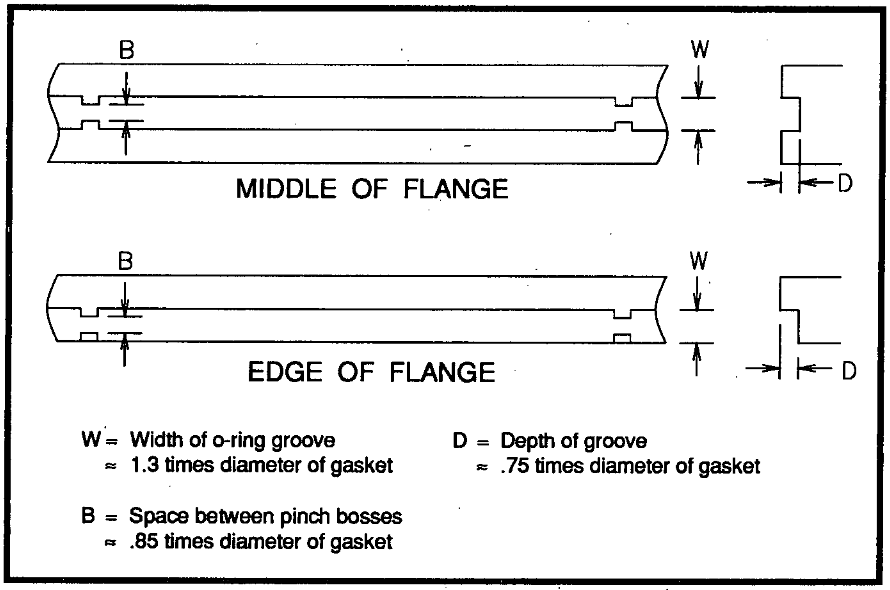


FIGURE 3. Wide O-Ring Grooves with Pinch Bosses.

beads will degrade the shielding slightly. However, in most cases, the resultant shielding is more than adequate as illustrated in Appendix A.

WIDE O-RING GROOVE WITH PINCH BOSSES

This groove is recommended for high production runs, because it can be molded or cast in place and has proven to be the least costly of all the grooves to use. The o-ring groove can be placed in the middle of a flange or at the edge of a chassis flange or cover if space is limited (Figure 3). The pinch bosses are used at both ends and along the length of the gasket to hold the gasket securely in place. At high frequencies, use of the pinch bosses results in slightly degraded shielding. However, with proper design, the shielding quality of the subsequent joint can exceed 100 dB, as illustrated in Appendix A.

ADVANTAGES

The gaskets can be snapped in place requiring very little manufacturing time. The pinch bosses secure the gasket in place. The wide groove allows fairly wide fastener or screw spacing. The groove can be cast or molded in a cover or chassis. Low maintenance costs are another advantage.

DISADVANTAGES

The use of the groove causes a gap in the gasket of about 3/8" at every pinch boss. These gaps will reduce the shielding quality of the joint (Appendix A).

NARROW O-RING GROOVE

The narrow o-ring groove is the groove recommended by most of the manufacturers of EMI gaskets and is the most expensive to use. Like the wide groove, the depth is about 75 percent of the diameter (or thickness) of the gasket. The width is the same or less than the diameter (or width) of the gasket (Figure 4). The high incidence of recommendation is due to the fact that the groove holds the gasket in place and reduces the compression set associated with mesh and conductive elastomeric materials. The manufacturers of the elastomeric gasket material also recommend this groove because the high force required to compress the material into the limited space increases the conductivity (or shielding quality) of the gasket material.

ADVANTAGES

The groove can be machined, cast or molded. It facilitates low maintenance costs. The groove holds the gasket in place while it reduces the compression set associated with mesh and conductive elastomeric gasket materials.

DISADVANTAGES

The o-ring groove can require screw or fastener spacing of as little as 3/4". Also, it can reduce the life of a gasket.

DOVETAIL GROOVE

The dovetail groove can be machined, extruded or cast using investment casting methods (Figure 5). The groove holds the gasket in place during manufacturing and maintenance procedures and allows the gasket to expand laterally without constraining the sides. This allows the use of fairly large fastener spacing. The cost to machine the groove is about 30 percent more than the cost to machine a regular o-ring groove.

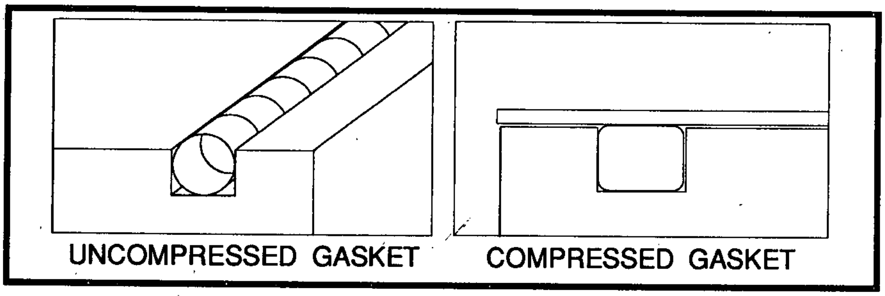


***FIGURE 4.** Gasket in Narrow O-Ring Groove.*

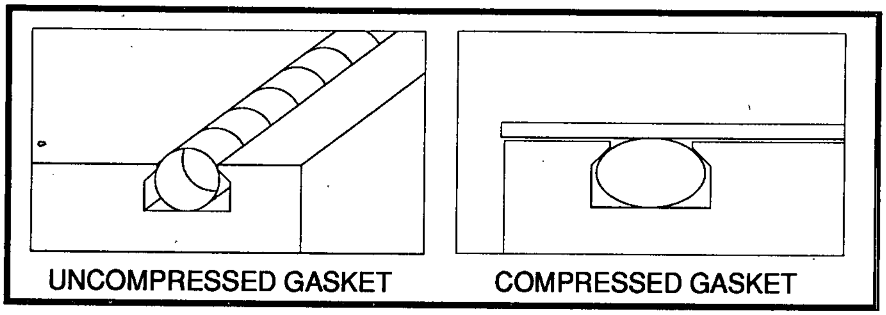


***FIGURE 5.** Gasket in Dovetail Groove.*

ADVANTAGES

The groove allows the gasket to expand laterally as it is deflected down. Because the sides are not constrained, the force versus deflection ratio is fairly linear. This in turn means that fastener spacing can be calculated fairly accurately; spacing of several feet is possible. The groove holds the gasket in place during manufacture and maintenance procedures, and facilitates low maintenance costs.

DISADVANTAGES

The groove cannot be die cast in place to facilitate large production runs. Therefore, the cost to machine the groove is about 30 percent more than the cost to machine a regular o-ring groove.

SUMMARY

The cost of meeting the various DoD and/or commercial EMI/RFI radiated emissions and susceptibility requirements can vary significantly. If properly used, an EMI gasket can significantly reduce these costs. However, to properly use an EMI gasket, the advantages and disadvantages of each method must be understood. The o-ring groove-mounted gaskets are one of the most popular types of gaskets on the market. There are four common types of grooves. The grooves and applications are as follows:

- **Wide O-Ring Groove.** Least costly of the grooves to manufacture and use. The inability to hold the gasket in place can represent a significant problem. This problem can be overcome by placing small adhesive spots in the groove 2 to 4 inches apart. However, applying the adhesive can add significant manufacturing and maintenance costs.

- **Narrow O-Ring Groove.** This method is the most widely used because the groove is inexpensive to manufacture and facilitates production. However, it is the most costly due to low life of the gasket and the high number of fasteners (or screws) required to obtain the pressure necessary to get the shielding required.

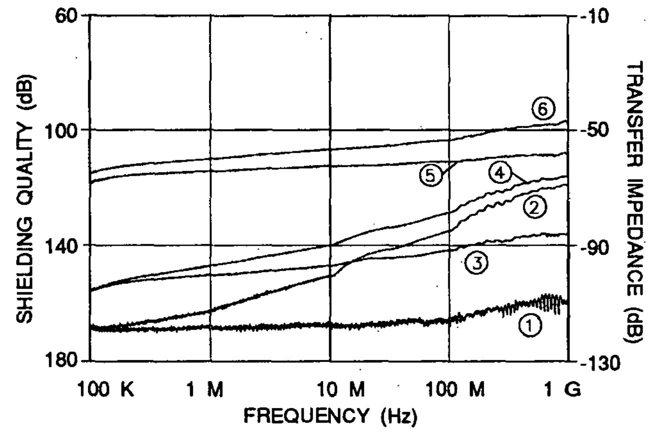
- **Wide O-Ring Groove with Pinch Bosses.** Used for high production equipment which utilizes die casting and molding techniques. The gasket material is inexpensive to apply and maintenance costs are low. There is a loss of shielding quality of the gasketed joint. However, 100 dB of shielding is usually achievable.

- **Dovetail Groove.** This groove provides flexibility, ease of use, high level of shielding and extended gasket life. However, it is primarily limited to relatively small production quantities where machining is an appropriate manufacturing method.

The shielding quality of an EMI gasketed joint can vary significantly as a function of the gasket configuration, gasket material, joint surface, joint surface finish, and method of employing the gasket.

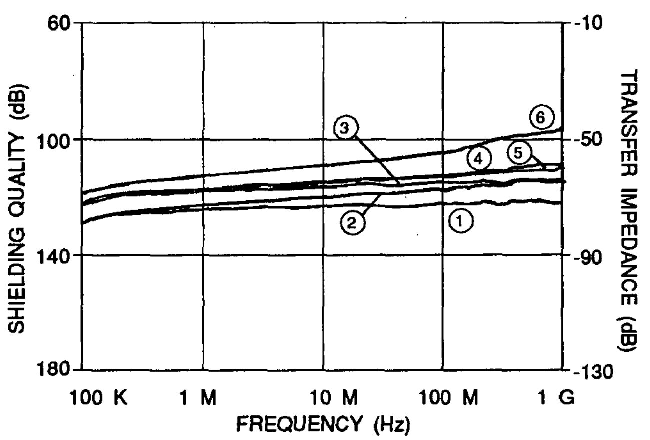
APPENDIX A

The shielding quality of an EMI gasketed joint can vary significantly as a function of the gasket configuration, gasket material, joint surface, joint surface finish, and method of employing the gasket. Figures A-1 and A-2 illustrate the shielding quality characteristics of some of these variables.



1 Gasket against gold.
2 Gasket against gold, held in place with pinch bosses.
3 Gasket against aluminum.
4 Gasket against aluminum, held in place with pinch bosses.
5 Gasket against stainless steel.
6 Gasket against stainless steel, held in place with pinch bosses.

FIGURE A-1. *Shielding Quality of Tin-plated Gasket Material.*



1 Gasket against gold.
2 Gasket against gold, held in place with pinch bosses.
3 Gasket against aluminum.
4 Gasket against aluminum, held in place with pinch bosses.
5 Gasket against stainless steel.
6 Gasket against stainless steel, held in place with pinch bosses.

FIGURE A-2. *Shielding Quality of Stainless Steel Gasket Material.*

Figure A-1 illustrates the shielding quality of a tin-plated gasket material against gold plated, aluminum and stainless steel surfaces. It also illustrates the loss of shielding quality of the gasketed joint due to a nonconductive gap of about 3/8", which occurs when pinch bosses are used to hold the gasket in place. The significant findings are as follows:

- The shielding quality of the gasketed joint at 1 GHz can vary by 63 dB, as a function of the joint surface and method of application used.

- The degradation of the shielding quality of the gasketed joint at 1 GHz varies from 40 dB using gold joint surfaces to about 7 dB using stainless steel joint surfaces. This is due to using pinch bosses to hold the gasket in place.

Figure A-2 illustrates the shielding quality of a stainless steel gasket material against gold plated, aluminum, and stainless steel surfaces. It also illustrates the loss of shielding quality of the gasketed joint due to a nonconductive gap of about 3/8" which occurs when pinch bosses are used to hold the gasket in place. The significant findings are as follows:

- The shielding quality of the gasketed joint at 1 GHz can vary by 25 dB, as a function of the joint surface and method of application used.

- The degradation of the shielding quality of the stainless steel gasket material at 1 GHz is approximately 6 dB using any of the three finishes. This is due to using pinch bosses to hold the gasket in place.

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