Introduction to Waveguides For RF Shielding Applications

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INTRODUCTION

Many shielded subsystems are used in the construction of an RF shielded enclosure or environment. Subsystems commonly used in the construction of a shielded environment consist of the shielding media, shielded doors, viewing apertures or windows, electrical filters and waveguides.

Each of these subsystems plays a very important role in providing the designed levels of shielding effectiveness. If the shielding media design is to provide shielding levels equal to or greater than 100 dB at 10 GHz, all other subsystems should also provide the same level of shielding effectiveness. If the RF shielding subsystem design is to provide 100 dB and subsystems that provide 60 dB are installed, the overall shielding effectiveness of the enclosure is reduced to 60 dB. Therefore, it is important to match the performance levels of all subsystems.

Waveguides can be used to match the performance levels of all subsystems.

WAVEGUIDES

The introduction of gases, fluids or fiber optics into or out of a shielded environment is accomplished by using waveguide-beyond-cutoff devices. A waveguide is simply a metallic device that exhibits the characteristics of an electrical highpass filter. A waveguide allows frequencies above its cutoff point to pass, and stops or attenuates frequencies below its designed cutoff. This is similar to a highpass filter that allows frequencies above its designed cutoff frequency to pass and stops frequencies below it.

For a waveguide to be effective, the largest cross section or internal diameter should not exceed one-half wave length of the highest frequency to be shielded. The length of the waveguide is designed so that it is five times this internal dimension (ID x 5 = length). This "industry standard" provides shielding levels greater than or equal to 120 dB up to the designed cutoff frequency of the waveguide. (Another ratio used is ID x 4 = length where the ID equals or is less than one-half of the highest frequency wavelength.)

To determine the cutoff frequency of a waveguide, the following equation can be used:

F(cutoff) = 6920/D

where

D = diameter in inches

F = frequency in MHz

Waveguides can be rectangular, square, circular or honeycomb-shaped matrix. For heating, ventilation and air conditioning, the honeycomb type matrix waveguide is used. The honeycomb can be fabricated in square, rectangular or round assemblies. Under proper conditions, a rectangular, square or circular waveguide can be used. Regardless

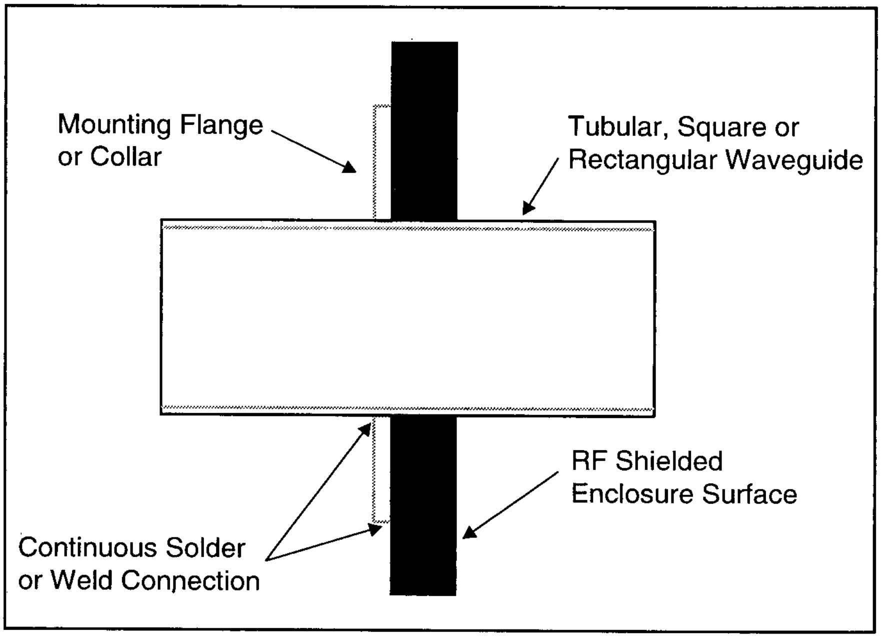

Figure 1. *Waveguide Penetration Cross-Section.*

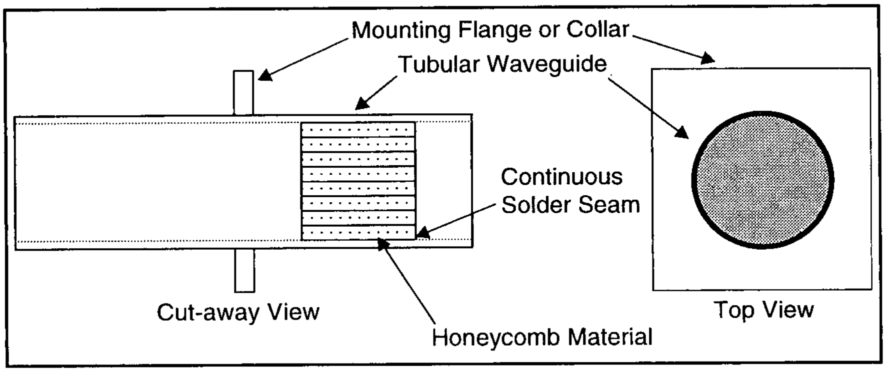

Figure 2. *Installation of Honeycomb Vent Material.*

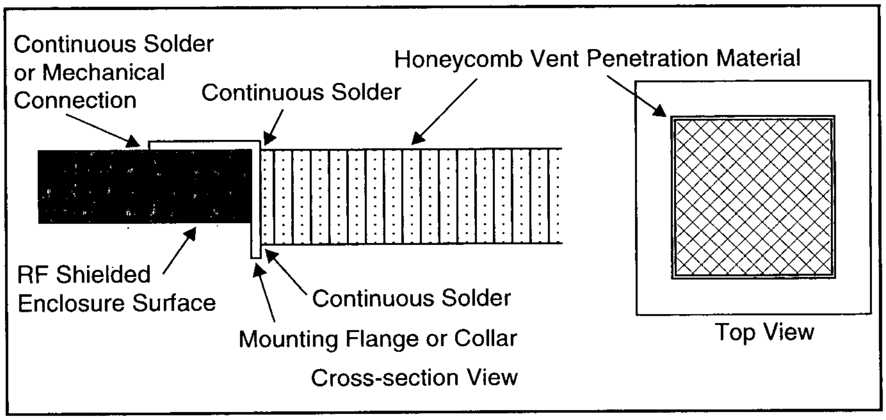

Figure 3. *Mounting Flange Method of Installation.*

of the type waveguide installed, it is important that the mating surfaces of the waveguide be bonded both electrically and mechanically to the RF shielded enclosure surface.

Waveguides that are used for fiber-optic cables, liquids and gases are typically tubular (Figure 1). Mounting of this type of device is accomplished by compression, welding, soldering or a mounting flange. The material used for this type of waveguide can be copper, brass, aluminum or steel. Waveguide material selection is based on the intended usage of the waveguide, such as copper for noncorrosive liquids.

Should the required diameter of the waveguide exceed the maximum diameter for the designed cutoff frequency, a section of honeycomb vent material is installed in the tubular waveguide (Figure 2). With the installation of the honeycomb material, the diameter of the tubular waveguide can be increased to any required diameter and still maintain a high level of RF shielding. If the honeycomb material is installed in a waveguide, the diameter-to-length ratio does not need to be maintained for the waveguide since the honeycomb will provide the diameter-to-length ratio.

HONEYCOMB MATERIAL

For the introduction of heat, ventilation, air conditioning or pressure stabilization, the most commonly used waveguide is the honeycomb vent penetration material. Commercially available honeycomb for RF shielding applications is available in cell sizes of 1/8" (3.18 mm), 3/16" (4.76 mm) and 1/4" (6.35 mm) and cell depths (or thicknesses) which range from 1/4" (4.76 mm) to 1" (25 mm).

Honeycomb material is available in brass, stainless steel and steel. In the fabrication process, these materials are coated with a layer of lead and tin (50/50) which fusion-bonds the cells together and provides a protective coating for the base materials.

Installation of honeycomb material to the RF shielded enclosure is accomplished by a mounting flange or collar (Figure 3). The honeycomb vent panel can be connected to the RF shielded enclosure by mechanical means such as screws and RF gasket material. The most common or preferred method is a fixed connection that is attained by soldering the collar or mounting frame to the RF shielded enclosure.

SUMMARY

In conclusion, regardless of the type of waveguide used, it is important that it be designed to match the performance or levels of shielding effectiveness afforded by the RF shielded enclosure. Care must be taken in selecting the proper material and the installation manner of the waveguides so that they do not degrade the performance of the RF shielded enclosure.

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