EMI/RFI Shielding on VDTs

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BACKGROUND

EMI/RFI shielding is most efficient and cost-effective if incorporated at or near the PC board level. This method requires application and planning insight during the product's early design and manufacturing stages. Although most frequently preferred, this approach is not always possible because last minute design changes are needed; product development is already past the board level stage; or existing products must be upgraded to meet emissions specifications.

If there is electronic noise created by the product or if the product is susceptible to electronic interference and it cannot be shielded at the PC board level, then the next logical step is to shield the enclosure. This can easily be accomplished through conductive paints, molding/trim materials, gaskets, etc. However, there is one area of the instrument that can still cause a problem: the display window.

With the use of a display window, there is typically some type of cutout in the housing to allow the graphics or images of the display to be visible to the operator. It is through this cutout, or opening, that damaging emissions can be radiated or received. To correct this problem, a display filter with good optical characteristics and shielding effectiveness can be used to achieve shielding attenuation.

Display filters or windows have been used on electronic equipment for years. They can perform various functions, including protecting the display from scratches or breakage, providing contrast enhancement, or minimizing glare from the display. Display filters can be made from various materials, including glass, polycarbonate or acrylic.

Shielding requirements for windows can vary depending on the application and the compliance standard that pertains to the equipment. Other factors, such as the source of the radiated noise, operating environment, and affected frequencies, must be considered when defining the shielding criteria for the display filter.

Once a determination has been made that shielding is an absolute requirement for the display window, there are several methods available to achieve attenuation. The most common methods utilize some type of conductive metallic mesh or a conductive transparent film. These materials can be laminated to the display filter.

The two key elements that determine the shielding materials selected are attenuation requirements and the type of display being used. In addition, there are important cost factors associated with the type of shielding materials used.

DISPLAY TYPE

The display being used influences the type of shielding material selected. Not only is shielding attenuation a consideration, but its effect on display clarity requires careful consideration. Electronic (emissive) displays, such as electroluminescent, vacuum fluorescent, plasma, CRT and LED, tend to have the widest compatibility with all shielding options. However, care should be taken when passive displays such as LCDs are used because the shielding medium has a greater impact on the clarity and overall performance of the display.

For example, if a vacuum fluorescent display is being used, a display filter that includes contrast enhancement properties is usually appropriate. If shielding is required, the material in the filter that is used to improve the contrast will generally hide plain stainless steel wire mesh. It is barely perceptible to the end user. In this case, excellent shielding attenuation is provided with minimum interference to the display. It is also effective from a cost perspective.

On the other hand, this same mesh would not be appropriate to use with a reflective LCD. The strands of the mesh would optically interfere with the display. For this application, there are other options. If the high attenuation level of mesh is required, the mesh can be first silver-plated, then blackened. This added process eliminates reflectance from the mesh while adding a subtle contrast enhancement to the display. In general, this approach carries a higher price because of the additional processing and handling of the mesh (Figure 1).

As an alternative, a conductive transparent film (5 to 300 ohms/square) can be used. There are minimal effects on the display clarity and overall performance. Depending on the surface resistance of the film, the cost of shielding utilizing this approach is slightly below the blackened mesh method.

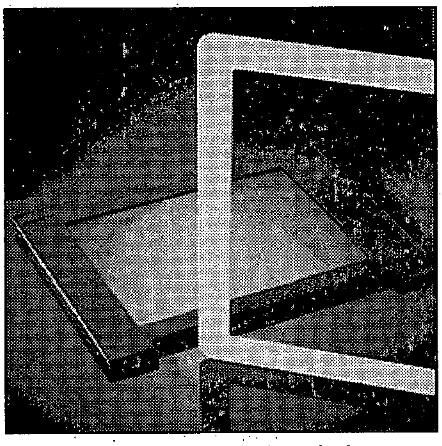

Figure 1. *Stainless Steel Mesh that is Silver-plated and Blackened Allows for Excellent Light Transmission and Attenuation Levels.*

Figure 2. *Shielded Filters Can Be Designed with Graphic Borders, Logos or Other Artwork.*

WIRE MESH VS. CONDUCTIVE FILMS

In general, the stainless steel based shielding materials (stainless steel, stainless steel silver-plated and blackened or stainless steel copper-plated and blackened) provide the most effective EMI/RFI shielding over the widest ranges of frequencies. Lower mesh counts (the number of openings per square inch) and thicker wire diameters give better EMI attenuation. Wire diameter is typically available in 0.0012" and 0.0022" gauges. Openings per square inch of 50, 80 and 100 are generally specified.

Wire mesh, by virtue of its geometric pattern, can partially obstruct pixels and for that reason, the mesh must be oriented with respect to the normal x-y direction of alpha-numeric character segments. Typically, 45° orientation is effective with most displays. However, other orientation angles have been specified.

There are applications that may be restricted because of the display type used. Many LCDs and high resolution CRTs do not lend themselves to incorporate a conductive mesh in the display filter. In these cases, laminating or combining a conductive film with the display filter may be a suitable shielding option. Typically, these are plastic films with a thin, transparent conductive coating. These coatings combine high visible light transmission, uniform electrical conductivity and excellent environmental stability. Naturally, however, these films do not offer the same attenuation performance as the mesh shielded products. This material, generally 5 to 7 mils thick, is available from 5 ohms to 300 ohms per square.

DESIGNING A FILTER WITH SHIELDING

When designing a filter that will incorporate shielding, the most effective approach is to first select the base filter material. When doing so, consideration should be given to weight, flammability requirements, end use environment, safety, and design versatility. Filter color, desired surface finish, and graphic requirements should also be reviewed (Figure 2).

Specifications regarding the glare, light transmission, haze, chemical/scratch resistance, and temperature/humidity performance should be evaluated to match the filter materials with the end application. The distance between the back of the filter and front of the display should be taken into consideration when selecting filter materials and surface finishes.

Generally, LCD displays will require a filter that is clear or has a "light smoke" appearance. Electronic illuminated displays can incorporate a broad range of "contrast enhancement" transparent colors, depending on the display type. As noted earlier, these materials can be used to hide the reflectance of stainless steel wire mesh, possibly eliminating the need for plating and blackening.

DISPLAY TERMINATION

The termination or grounding of the shielded display filter is critical. The overall shielding effectiveness of the filter is dependent on the termination method and the ground itself. Several options are available, including: extending the wire mesh beyond the filter; conductive tapes/fabrics; conductive adhesives; conductive gaskets; or mechanical fasteners. Special fabrication or machining of the filter's perimeter can improve the efficiency of the termination.

Actual shielding effectiveness is dependent on several variables, such as the final installation, test method, and the environment in which the product was tested. Final EMC testing should be conducted with the shielded filter installed on the instrument.

CONCLUSION

If the display filter needs to provide EMI, RFI or ESD shielding, there are several options available. When designed properly, the filter not only can provide excellent attenuation, but can also protect and complement the display to which it is mounted.

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