TECHNICAL CONSIDERATIONS FOR VDT OPTICAL FILTERS

VDT optical filters offer an effective, versatile means to achieve shielding effectiveness.

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VDT OPTICAL FILTERS

Optical display filters can be used on all types of visual display terminals (VDT's). VDT's are predominately based on a cathode ray tube (CRT), although other engineering technologies are being introduced at a growing rate each year. These include electroluminescent displays (ELs), liquid crystal displays (LCDs), and gas plasma displays (PDs). Display filters are specified primarily for the following reasons:

- Radio frequency attenuation
- Security
- Viewability; contrast enhancement and user comfort; health and safety concerns

The terminal emits radio frequencies (RF) which are characterized by magnetic and electric fields. The main sources of RF are the flyback transformers and the horizontal deflection coils, which are parts of the circuitry responsible for moving the electronic beam horizontally on the screen. This movement usually occurs at a frequency around 18 kHz, and due to the complex waveform of the scan signal, harmonics of the fundamental frequency develop through 220 kHz. Other digital frequencies ranging from 3 to 300 MHz are also present, and the electric field strength is around 0.2 V/m at the VDT surface. At the operator's position, this is correspondingly less, since field strength is a function of distance from the source.

Figure 1. Typical VDT RF Filter in a Laminated Mesh Configuration.

RF containment is necessary for three primary reasons:

- Electronic interference
- Securing the information in the system
- Health and safety concerns for the VDT operator

A frequently referenced study issued by the Northern California Kaiser Permanente Medical Care Program explains the medical concerns. In addition, static control is assured by way of the integral grounding system which is a necessary part of any filter.

SHIELDING EFFECTIVENESS

Any device used to block the RF signal between its source of emission and a receiver is an electromagnetic interference (EMI) shield. (See Figure 1) Such a shield will react differently depending on its design variations, which include material

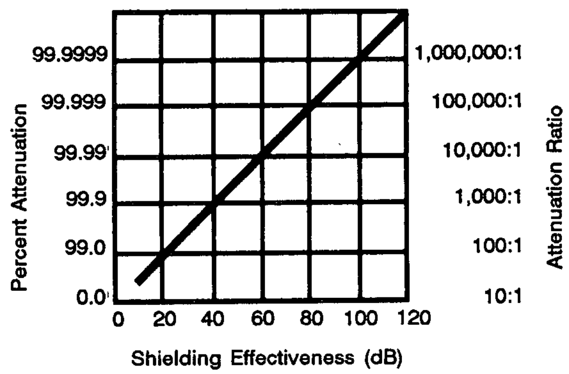
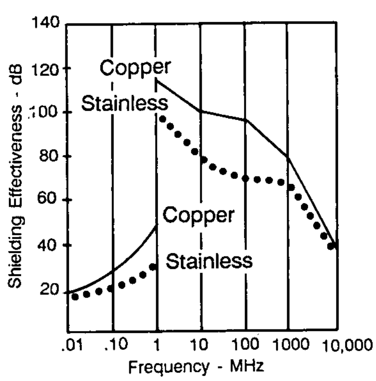


Figure 2. Shielding Effectiveness vs. Attenuation Ratio.

	TYPICAL PERFORMANCE		
SHIELDING MATERIALS	MAGNETIC 1 MHz	ELECTRIC 10 MHz	PLANE WAVE 1 GHz
Knitted wire mesh - 30 o.p.i.	30-40 dB	60-70 dB	20-25 dB
Conductive coating	40-50 dB	70-80 dB	30-40 dB
Woven copper mesh - 100 o.p.i.	54 dB	111 dB	72 dB

3a. Comparison of Different Manufacturing Methods



3b. Shielding Effectiveness of 100 o.p.i. Meshes: Copper and Stainless Steel.

Figure 3. Shielding Effectiveness of Typical VDT Filter Types.

composition and dimensions. The ability to attenuate RF is shielding effectiveness (SE), which is expressed in decibels (dBs), the ratio of field strength on one side of the shield to the other side. Figure 2 shows the relationship between shielding effectiveness (in dB), the amount of attenuation, and attenuation percentage.

SHIELDING PERFORMANCE

There are three common types of display shields: knitted mesh, conductive coating, and woven mesh. Manufacturing methods, respectively, are lamination with an optical substrate (knitted), surface deposition of metallic substances (coated), and either lamination or molding within an optical substrate (woven). Knitted meshes are usually limited to 30 openings per inch (o.p.i), and therefore contain enough properly spaced shield material to be effective only in circumstances where a small amount of attenuation is required. In addition, they produce an undesirable pattern (moiré) when viewed at different angles. Conductive coatings are somewhat effective; however, since SE is related to the thickness of the EMI barrier, only a thin coating of metallic material can be applied before viewing is impaired. While offering reasonable amounts of SE, any effort to increase attenuation quickly results in a trade-off in optical performance.

Woven mesh in a laminated or molded optical assembly has none of the problems of the other methods, and affords a greater selection of mesh density up to 230 o.p.i. The most common mesh preference is either copper or stainless steel at 100 o.p.i. These configurations offer about 62 percent light transmission, while creating an optimum amount of contrast (actually improving viewability) at high levels of attenuation. Figure 3 compares the shielding effectiveness of knitted mesh, con-

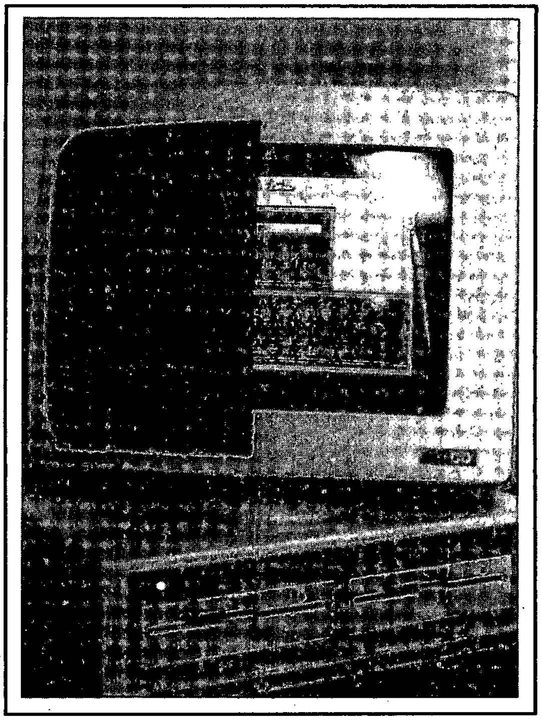


Figure 4. Demonstration of Contrast Enhancement and Anti-Glare Effectiveness.

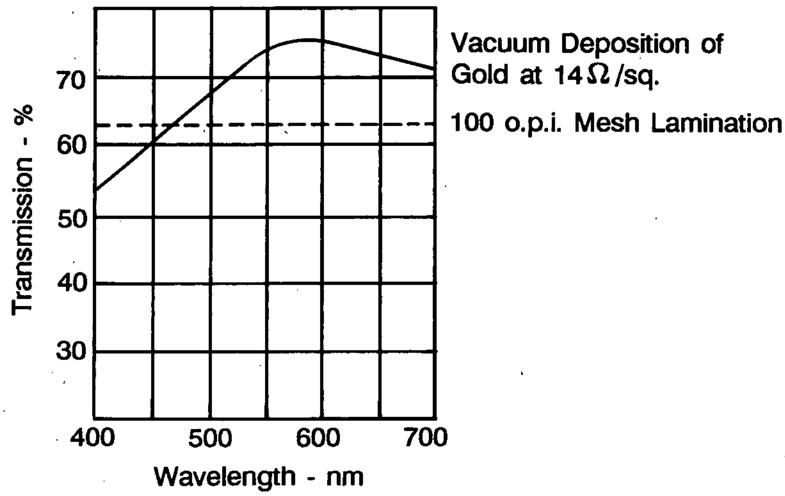


Figure 5. Light Transmission at Wavelengths in the Visible Spectrum. Gold-coated Version vs. Copper Mesh Lamination.

ductive coating, and woven mesh types.

OPTICAL PERFORMANCE

The installation of an RF shield on a VDT can be considered an opportunity to upgrade the optical performance of the display, due to the inherent contrast enhancement offered by the blackened mesh wires, anti-glare treatments, and substrate tinting variations. The effects are so striking in many cases that the brightness must actually be reduced, thus limiting the amount that the unit must be driven, and prolonging phosphor burn-life and the life of the unit overall.

Viewability is enhanced by the greater contrast, and by the reduction of external and internal reflections on the screen itself, both of which normally introduce glare. User comfort is generally increased as glare and reflections are dissipated (Figure 4). A standard 100 o.p.i. mesh permits 62 percent transmission of light (or 62 percent open area). The combination of the front surface hardening and anti-glare treatments, the mesh screening, and anti-Newton ring coating on the rear surface affects the light transmission of the filter assembly within the visible spectrum for a clear substrate as shown in Figure 5. A common reference point is 450 to 500 nanometers. The tinted versions permit as much as 22 percent to 35 percent transmission of light, and this combination, even under color CRT applications, affords the optimum in optical/RF performance.

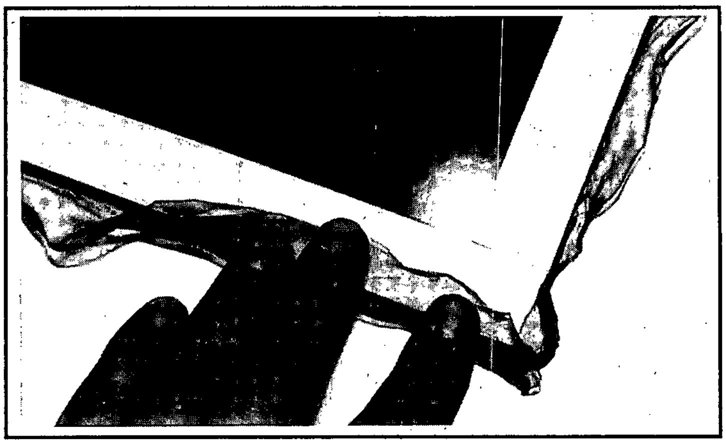


Figure 6. Closed-cell Polyethylene Foam Gasket Installation.

INSTALLATION

Recent manufacturing technologies have allowed important design advancements to be made since overall

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cost-effective manner, provisions to hold and protect the gasket material must be designed into the mold or die. These provisions consist of: (1) o-ring grooves and pinch bosses or retaining holes when using the convoluted spring gasket material; or (2) providing space between the various case sections to be EM bonded together when using the EMI strip gasket material. ■

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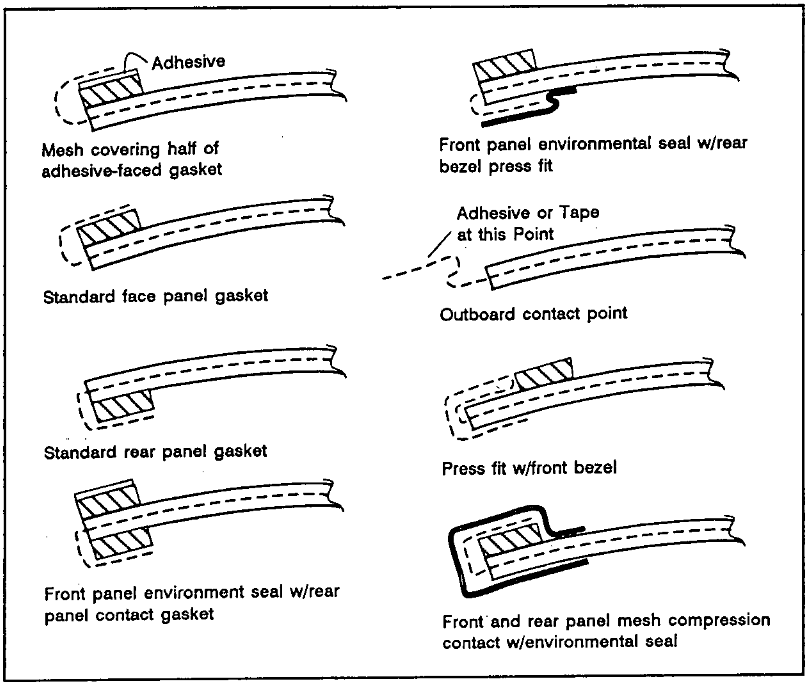

Figure 7. Cost-effective Gasket Configurations.

Note: In all figures a slack is left in the mesh to facilitate expansion/contraction and fitting up. Also, as a rule of thumb, a 12" x 12" filter requires a 0.030-inch tolerance around the perimeter as the gap between its bezel or frame. Larger or smaller sizes follow the same ratio.

thicknesses of these laminated assemblies have been reduced to 0.040-inch nominally. Effectively, this moves the face of the filter, which contains the anti-glare treatment, closer to the face of the display. This greatly improves optics because of the elimination of chromatic and spherical aberration. These thin design profiles are simple to install into every type of terminal bezel or display frame, an important factor when engineering a retrofit. In most cases, space for a 0.040 inch thickness can usually be provided without special rework of a standard commercial monitor or display. No costly conductive gaskets are ever required and up to three or four inches of excess mesh around the perimeter allows flexibility to reach the grounding surfaces. When a gasket is desired, as in the case of an environmental seal, the shield can be manufactured with a closed-cell polyethylene foam (Figure 6) in a thickness range from 0.031-inch to 0.125-inch, in various widths from 0.375-inch to 1.00-inch, and with pressure sensitive adhesive on one side or both sides. The gasket is installed around the perimeter of the shield, either on the face panel or rear panel. Some typical installation configurations are shown in Figure 7.

Cost-effectiveness is the overall by-product of these advanced designs. High-tech plastics offer versatile manufacturing treatments. When coupled with the simplicity of installation and the elimination of the necessity for conductive interface gasketing, a reasonable cost can be expected. ■