Design Guide

In the event that you wish to design your own magnetic shielding, you may find the following information useful. MμShield engineers will be available for consultation should you require assistance.

Definitions and Symbols

Gauss = measure of magnetic intensity equal to one line of magnetic force per square centimeter.

Flux = the rate of flow of magnetic field.

Saturation field = field generated within the magnetic shield causing the permeability to asymptotically approach unity.

B = flux density in the shield, in gauss.

d = shield diameter. (Note: in rectangular shields, use longest dimension.)

Ho = external field in gauss (oersted).

μ = permeability of material.

A = attenuation of field (ratio).

t = shield material thickness.

Engineering Formulas

Magnetic Field

To determine the approximate magnetic field in the shield:

$$B\ (\text{gauss}) = \frac{2.5d\ Ho}{2t}$$

Example: A shield 1.5″ in diameter made of material .06″ thick in a field of 80 gauss would have a flux density of 2,500.

$$B\ (\text{gauss}) = \frac{2.5 \times 1.5 \times 80}{2 \times .06} = 2{,}500 \text{ gauss}$$

Shield Thickness

For selection of shield thickness for magnetic fields of less than 2 gauss, this formula applies:

$$t = \frac{Ad}{\mu}\ (\text{inches})$$

Example: A shield 1.5″ in diameter, with a permeability of 80,000 and attenuation field of 1000 to 1 would need a shield .019″ thick.

$$t = \frac{1000 \times 1.5}{80{,}000} = .019 \text{ inches}$$

Cost Efficient Shielding

With material cost a factor, it is important the correct thickness of material be used. Basically, it is important that magnetic shielding material have an initial permeability of at least 80,000. If not, shield thicknesses will be compromised.

If a strong field is encountered, a thickness can be selected that will develop the maximum permeability in the material. Note that a flux density in the shield of 2,300–2,500 gauss will result in the maximum permeability of the material (see BH curve). To determine the required thickness of the shielding material use the following formula:

$$t = \frac{1.25\ d\ Ho}{B} = (\text{inches})$$

Example: A shield of 6″ long, 1½″ in diameter in an 80-gauss field would require a shield of .06″ thickness.

$$t = \frac{1.25 \times 1.5 \times 80}{2{,}500} = .06 \text{ inches}$$

Attenuation of Field

To determine the attenuation of field (ratio) use the following formula:

$$A = \frac{\mu t}{d}$$

Example: Using the same information available in the example above, attenuation of field can be found to be 14,000, assuming the shielding material has a permeability of 350,000.

$$A = \frac{3.5 \times 10^5 \times .06}{1.5} = 14{,}000$$

Flux Density

To determine the flux density within the shield in gauss, use this formula:

$$B = \frac{Ho}{A} \text{ gauss}$$

Example: Using the information from the preceding examples it is possible to determine that a flux density of .0057 gauss is present within the shield when a field of 80 gauss exists outside the shield and an attenuation of 14,000 has been achieved.

$$B = \frac{80}{14{,}000} = .0057 \text{ gauss}$$

Additional Design Points

· Begin the design process by analyzing the interfering field and calculate its strength and frequency. Next, determine the interference level that can be tolerated.

· Make multi-layer shields when shielding high field magnets, such as vac ion pumps. If possible, leave a ½″ space between the inner shield and the magnet.

· In shielding a vac ion pump, use low permeability material for the inside layer, medium permeability material for the intermediate shield, and high permeability material for the outer shield.

· Use a single layer shield to shield sensitive devices such as cathode ray tubes. You should use a total enclosure on CRTs up to 5″. But on larger models, it may be necessary only to shield the neck section or the yoke assemblies.

· For very low field chambers, use a 3-layer shield of high permeability materials with a copper shield on the outside of the inner shield. By passing a heavy A.C. current through the copper shield, you can degauss the inner shield. The copper will also shield electrostatic fields.

· For shield construction, use lap spot welding where material thickness permits. Laps should overlap by at least ⅜″. For diameter changes on corners, you may use Heliarc welding.

Tips on Using Magnetic Foil

If it is impractical to shield smaller components by fabricating rigid metal shields, foil makes an excellent alternative. When working with foil, the following information may be helpful.

· To minimize fringing of fields, don't create sharp corners. If holes are required, use round holes or slots with generous radii on either end.

· When covering a cylindrical object, overlap the foil by at least ¾″ in each layer. Make the first two seams 180° apart. Make the next layer at right angles, the next at 180°, and so on.

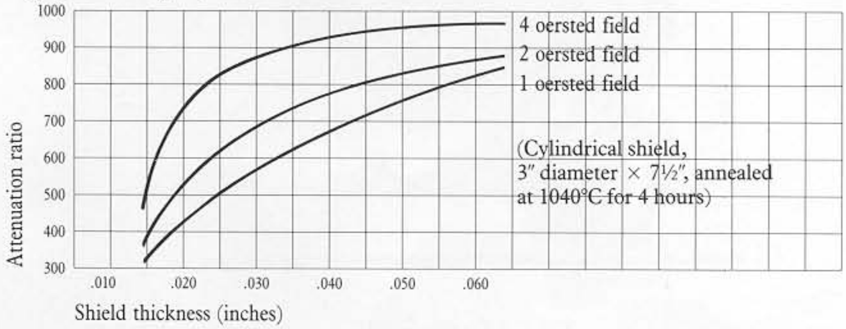
· To improve shielding, space the foil layers by three or four thicknesses of masking tape.

· Because foil has a high permeability, never wind it continuously in a spiral. If the material is spiraled, there is danger of creating a pole piece in the center of the shield.

· When drilling foil, be sure that the drill is ground for cutting sheet metal and not for normal steel cutting. A normal drill will pick up the foil with a corkscrew effect. This bending will reduce the foil's permeability.

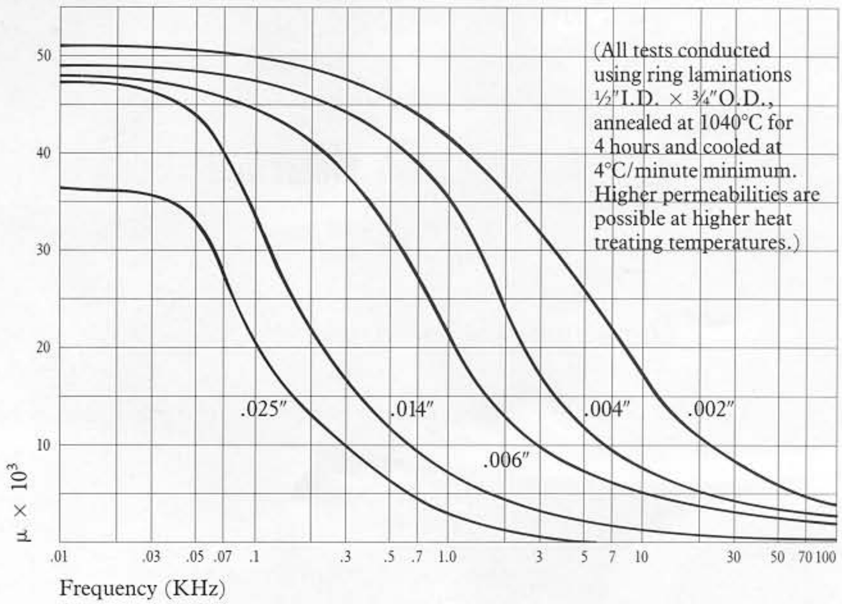
Shield Thickness vs. Attenuation Ratio at 60Hz

High-permeability MμShield Material



Typical Permeability vs. Frequency at B = 40 Gauss

High-permeability MμShield Material



B/H Graph

High-permeability MμShield Material