MuShield®

Magnetic Shielding

catalog and design guide

If you need the best magnetic shielding, you need MμShield materials.

MμShield products have been proven in a wide range of demanding applications.

Cathode ray tubes and yokes

Photomultiplier tubes

Storage tubes

PET and CAT scan machines

Power supplies

Electro-optical devices

Camera housings

Computers

Disk drives

Printed circuits

PC terminals

Nuclear Magnetic Resonance Imaging

Electron microscopes

X-ray spectrography

Wide area shielding in laboratories and other sensitive areas

Magnetic interference can drive sensitive electronic circuits crazy. Sometimes with disastrous results.

That's why companies with highly demanding applications specify magnetic shielding made of MμShield materials.

A pilot flying a jet fighter at Mach III can't afford any surprises from the instrument panel. That's why McDonnell-Douglas shields the instruments of its F-18 with MμShield materials.

When NASA planned to send the Voyager Space Probe on a three year trip to Uranus, the engineers specified MμShield materials to protect the atomic clock that timed its arrival to within 12 seconds.

And when the Smithsonian Astrophysical Observatory scientists set up an experiment to test Einstein's Theory of Relativity, they specified MμShield to protect the atomic clock used to explore the structure of space and time.

Specifications don't get more demanding than that. Do you need magnetic shielding this good? Custom shielding with optimum attenuation or totally uniform permeability? Then you need MμShield magnetic shields and shielding material.

Who needs magnetic shielding?

Magnetic shielding protects electronic circuitry from magnetic interference. Usually, the sources of this interference are permanent magnets, transformers, motors, solenoids, and cables.

In operation, a magnetic shield deflects magnetic flux by providing a path around the sensitive area. In addition, shielding may be used to contain magnetic flux around a component generating magnetic flux.

The ability to conduct magnetic lines of force is called *permeability.* In a magnetic shield, the degree of permeability is expressed numerically; the standard is free space with a rating of one. MμShield materials range in permeability from 200 to 350,000.

You can count on our experience.

The MμShield Company has extensive experience in the aerospace, nuclear, and electronics industries. As a result, we're used to meeting the tightest shielding specifications for photomultiplier, cathode ray, and storage tubes.

In addition to meeting shielding specs, we can also form metal into nearly any configuration. MμShield offers many capabilities, including spinning, hydroforming, drawing, stamping, and welding. Whatever it takes to produce the most intricate shapes for the most demanding applications.

We can design the complete shield, or assist your own design engineers. Prototypes and production lots can be furnished as you require. For custom shapes, we can often minimize set-up costs by adapting tooling from similar shields we have manufactured. Or we can provide you with coils, sheets, and tubing from our large inventory.

Heat treatment is standard.

To ensure maximum permeability with low shock sensitivity, MμShield heat treats all materials during manufacturing. Should your permeability requirements ever change, you can return any MμShield product for special heat treating.

Precision testing for highest quality.

To ensure optimum performance, MμShield sophisticated test equipment precisely measures field reductions. Our principal QC instrumentation includes a one-meter Helmholtz Coil, a Rawson-Lush Gauss Meter (rotating coil type), and an F.W. Bell Gauss Meter (Hall Effect type). These instruments provide a guaranteed accuracy of readings to ±0.1%, traceable to the National Bureau of Standards. Overall quality control, including mechanical inspection, is in conformance with Mil-I 45208-A standards.

Finally, the MμShield Company guarantees the permeability and uniformity of all MμShield material. So you can install our shielding with complete confidence.

Shielding for all conditions.

MμShield products can handle two categories of shielding applications. One is to keep strong fields from radiating from sources such as transformers, magnets, or motors.

The second application is to shield instruments and devices from magnetic fields present in the environment or emanating from other sources.

MμShield maintains a substantial inventory of tested annealed raw materials for these two categories of shielding. There are three general types: high permeability, medium permeability, and high saturation.

· High Permeability MμShield Material. Minimum permeability is 80,000 at B-40. Maximum permeabilty is 350,000 with a saturation point of approximately 7,500 gauss after MμShield heat treating.

· Medium Permeability MμShield Material. Normally used in conjunction with high permeability material. It has a permeability of 12,500 to 150,000 with a saturation point of approximately 15,500 gauss.

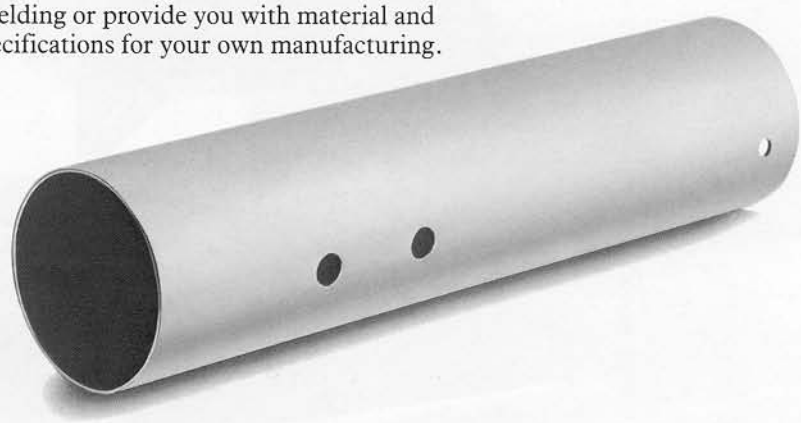
· High Saturation MμShield Material. Permeability ranges from 200 to 50,000 with a saturation point between 18,000 and 21,000 gauss.

Consultation services

What if you've got a shielding problem so big that you can't bring it to us? The answer is simple: we'll come to you.

MμShield engineers have solved some highly unusual shielding problems in hospitals, factories, process mills, and offices.

If you need on-site consultation, we can analyze your problems and issue a report for corrective action. And we can implement any or all of our recommendations if you desire. As you wish, we can design and manufacture custom shielding or provide you with material and specifications for your own manufacturing.



MμShield is the only supplier of seamless, magnetic shield tubing. The unique manufacturing process eliminates the non-uniformity of permeability inherent in welded tubing.

Design • Prototype • Production
MµShield is Magnetic Shielding

MµShield has a tradition of producing high quality magnetic shields which are both affordable and effective. Our business is magnetic shielding; we will work closely with our customers in the initial stage of shield design, through protoype, and into production. Because product turn-around and affordability are critical to our customers, we have invested in both the engineering expertise and the machinery to produce high quality products as needed.

MμShield Material Available from Stock

MμShield Sheet and Coiled Stock

If you plan to manufacture your own shields, we can supply you with MμShield stock in sheets and coils.

To assist you with fabricating, all stock comes in a temper suitable for drawing, punching, spinning and welding.

Sheets Minimum order 30″ × 36″

Thickness (±.002 in.)	Approx. weight (lbs.) per square foot	Approx. weight (lbs.) per sheet 30″ × 36″	30″ × 120″
High permeability			
.015	.654	5.02	16.73
.020	.872	6.60	22.0
.025	1.1	8.36	27.88
.030	1.3	10.03	33.43
.040	1.74	13.37	44.58
.050	2.2	16.4	54.50
.061	2.7	20.0	66.5
Medium permeability			
.025	1.107	8.3	
Low permeability, high saturation			
.030	1.3	9.75	26

Foil All foil stock is available in coils 15″ wide. All stock is high permeability.

Thickness (in.)	Weight (lbs.) per linear foot
.004	.22
.006	.32
.010	.54

MμShield Seamless Tubing for Totally Uniform Permeability

MμShield is the only manufacturer of seamless tubular shielding material. Through advanced technology and extensive manufacturing capabilities, we produce tubular shielding material with totally uniform permeability. This uniformity is impossible to achieve in tubing with welded seams.

All MμShield tubing has high permeability and is heat treated for low shock sensitivity. Sizes range from 0.10″ to 2.00″ I.D., wall thickness from .010″ to .120″, and lengths to 20′.

Heat Treating

With every magnetic shield MµShield manufactures, the Company's goal is to attain the maximum shielding capacity or permeability for that part while maintaining its dimensional and structural integrity. MµShield meets these objectives by heat treating parts and material on-site.

Why is heat treatment necessary?

Typical manufacturing methods for magnetic shielding involve bending, forming, welding, hammering, and sanding. Bending and forming are mechanical operations which can workharden and/or stress high permeability materials. Welding introduces oxygen to the material, and sanding and hammering can introduce carbon. Each of these factors contribute to the degradation of the shielding performance of high permeability materials.

What is "Permeability?"

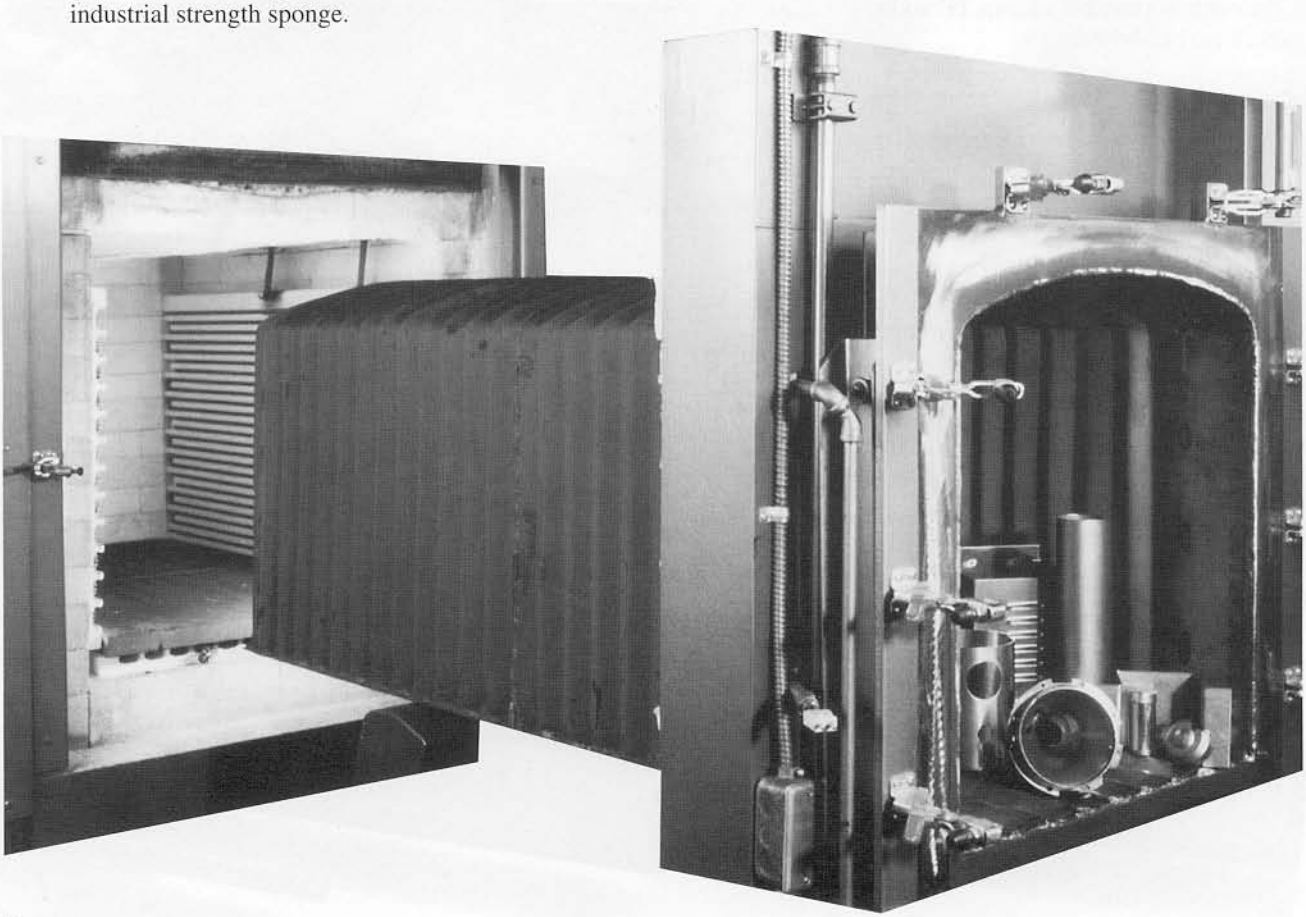
Imagine a sponge. Some sponges have big holes, some are more tightly structured, each absorbs liquid to a point of saturation. Magnetic shielding material is similar. It absorbs magnetic interference to its point of saturation. The absorption is based on its permeability. Highly permeable shielding material is similar to an industrial strength sponge.

How does heat treatment increase the permeability of shielding materials?

When the shielding materials that MµShield uses are exposed to extremely high levels of heat (2100°F for 1-2 hours), the grain of the material grows, increasing the materials ability to absorb magnetic flux. In addition, the hydrogen atmosphere in the heat chamber produces a chemical reaction with the shielding material, removing impurities such as carbon and oxygen, thereby enhancing the permeability. Finally, rapid and controlled cooling of the parts freezes the desired large grain of the shield yielding maximum permeability. MµShield engineers regulate the temperature and time the parts are in the heat chamber with care as it is critical that the parts maintain their structural and dimensional integrity.

Does MµShield provide heat treatment services for parts other than its own?

Absolutely. MµShield has a large heat treating capacity and is committed to investing in additional equipment to keep up with demand for these services. Fast turn around of heat treated parts is critical to MµShield customers.



Consulting

Frequently, MµShield is called to a customer site to solve an electromagnetic interference (EMI) problem. Typically the customer knows the source of his problem, but does not have the expertise necessary to carry out a plan to eliminate the interference. Each consulting job is unique. MµShield is prepared to work in partnership with the client to provide a feasible, efficient, and cost effective solution.
As part of MµShield's plan to provide appropriate magnetic shielding, our Engineers are trained to consult regarding the design and manufacturability of magnetic shields. Some of this can be accomplished over the telephone. When and Engineer is called on-site, or if the design services are extensive, our formal consulting services come into play.

In Part, The MµShield Contract for Services Reads:

"The MµShield Co. agrees to provide the client with advice, expertise, and guidance towards solving their magnetic interference problem. This can include a site survey, magnetic field measurements, material specifications, and shield construction techniques. MµShield will prepare a written report recommending remedial actions and provide a quotation where applicable."

Some examples of recent shield consultation jobs include:

A RECORDING STUDIO

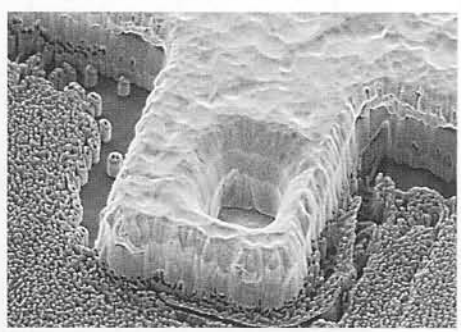
Today's recording studios are jam-packed with highly sensitive electronic equipment designed to recreate the big sound of live music on compact disc or magnetic tape. MµShield has worked with several studios with a variety of EMI related problems. One source of EMI is the recording equipment itself. When an electric guitar is close to the equipment, it will often pick up EMI "noise" from the wiring. MµShield was asked to interpret the problem, and to shield the source of interference.

A UNIVERSITY COMPUTER LAB

A common source of interference from EMI is power supplies and/or conditioners. When many computers are packed into a small space near a power related product, the computer monitors can be adversely affected by radiated EMI from the power unit. While one solution may be to shield each computer, it is often cheaper and easier to shield the source of the interference, in this case the power conditioner.

AN ELECTRON MICROSCOPE MANUFACTURER

In an electron microscope, an electron beam is used to scan a specimen to create an image up to 15,000 times its actual size. (The image at right is that of a reactive ion etched integrated circuit magnified 12,000 times.) Ambient EMI can render the image useless unless there is adequate shielding. For many years, MµShield has provided magnetic shielding consultation and design services to this highly competitive industry. Major advances in this industry are made on a consistent basis, therefore getting new products to market means rapid response and expertise.



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.

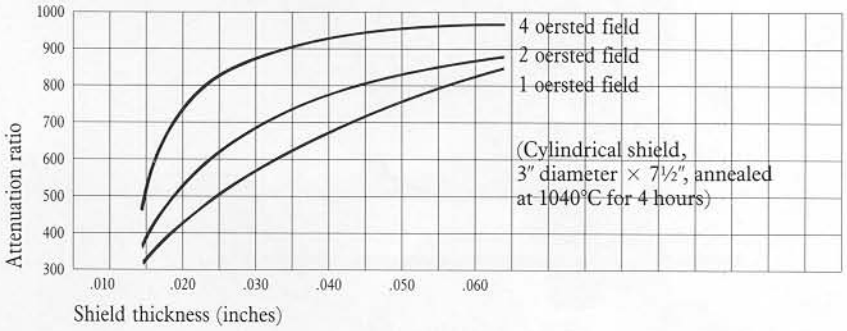
· When covering a cylindrical object, overlap the foil by at least ¾″ in each layer. Make the first two seams 180° apart. Make the next layer at right angles, the next at 180°, and so on.

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

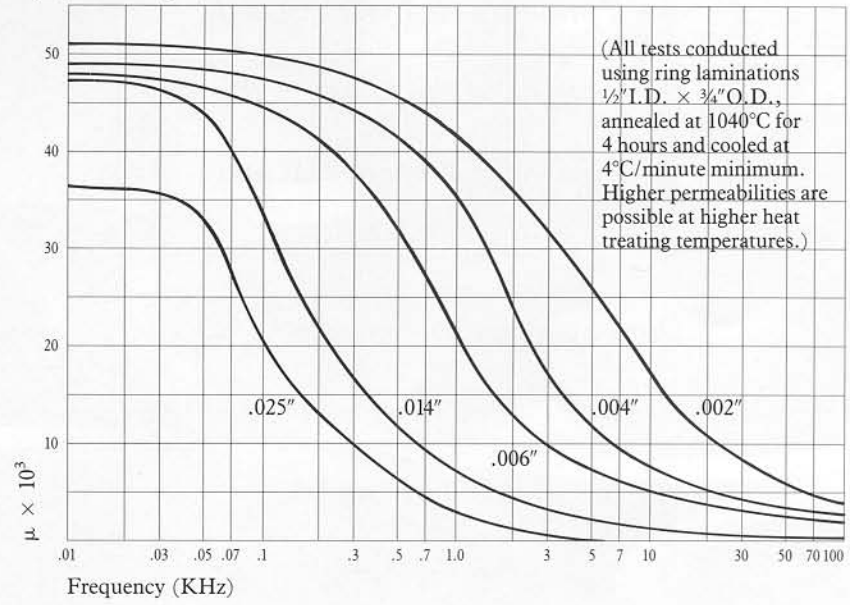
· Because foil has a high permeability, never wind it continuously in a spiral. If the material is spiraled, there is danger of creating a pole piece in the center of the shield.

· 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.

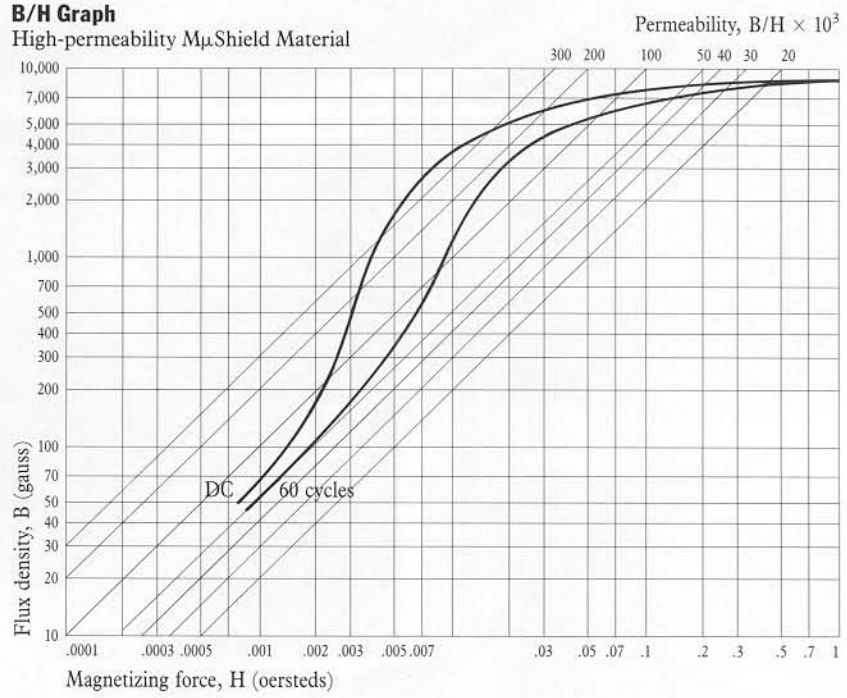
Shield Thickness vs. Attenuation Ratio at 60Hz
High-permeability MμShield Material



Typical Permeability vs. Frequency at B = 40 Gauss
High-permeability MμShield Material



B/H Graph
High-permeability MμShield Material



The MμShield Company provides custom designed magnetic shielding for the medical, commercial and military industries. Our engineers will assist you in designing your own magnetic shield or can provide off-the-shelf products to satisfy your needs.

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