MAGNETIC SHIELD CORPORATION FAQs

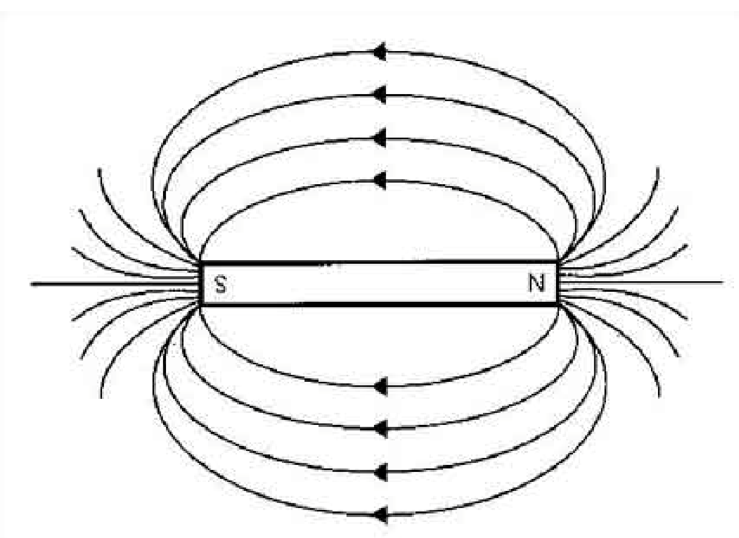
Official MAGNETIC SHIELD CORPORATION Document

Magnetic Fields & Shields Overview

What is a magnetic field?

Typically, most people have been exposed to the phenomena created when you lay a bar magnet on a table, place a piece of glass over it and sprinkle iron filings on the glass. What turns up is a pattern of lines formed by the iron filings going from one end of the magnet to the other. Although a magnetic field isn't truly comprised of lines, the iron filings give a good visual representation of the bar magnet's magnetic field.

You may have also noticed that further away from the magnet there weren't as many lines and close to the magnet they were quite concentrated. This is a good demonstration of one of the best magnetic shielding methods available. Move the source of the magnetic field away from the item to be shielded or move the item away from the field. Even if it isn't practical to remove the item from the field any increased separation will lower the strength of the field to be shielded.



Looking again at the bar magnet, imagine placing an item (something you wish to shield) into the magnetic field (lines of iron filings). There will be a certain number of lines penetrating the item depending on where you placed it. Now if you were to leave the item at the same location but increased its size the number of lines penetrating the object also increases. What this means is that even if the strength of the magnetic field stays constant the amount (perhaps you can think of it as volume) of the field an item is exposed to will influence shield design.

A magnetic field cannot be seen, heard, or felt. All magnetic fields result from a source of magnetic flux, which might be the Earth, a motor, transformer or electric power line, or even a bar magnet. Usually magnetic fields are created electrically. Electro magnetic shielding is necessary to isolate sensitive apparatus from these electro magnetic fields.

We can sense magnetic fields with measuring instruments, called Gaussmeters, or something simpler, like a compass (for DC fields) or a pickup coil (for AC fields). The first step to developing an effective magnetic shield is to measure the intensity of the field surrounding the area to be shielded.

Will a magnetic shield block the field's effects?

There is no known material that blocks magnetic fields without itself being attracted to the magnetic force. Magnetic fields can only be redirected, not created or removed. To do this, high-permeability shielding alloys are used. The magnetic field lines are strongly attracted into the shielding material. There are many types of shielding materials, Their alloy composition is a highly guarded secret, based on years of extensive research and application. CO-NETIC-AA®, NETIC S3-6® and MuMETAL® are three unique shielding materials provided by Magnetic Shield Corp.

Should the source of interference or the sensitive device be shielded?

The answer to this question depends on several factors. Shielding the source may involve stronger fields, and therefore thicker materials. One must be sure that all interference sources are shielded, or the sensitive device will still be affected. The usual approach is to shield the sensitive device. This prevents interference from both present and future sources. Many electro magnetic shielding solutions begin with our Magnetic Shielding Lab Kit. This kit enables a "hands-on" approach to solving a shielding problem.

How can I shield one magnet so it doesn't interact with another that is close by?

All commercially available magnetic shielding materials are ferromagnetic. This means they are attracted by a magnet just like iron or steel. Ferromagnetic materials are necessary because shields work by pulling the magnetic field towards them and away from what needs to be shielded. The magnetic field will actually become concentrated within the shield itself, but the field will still exist.

If two magnets are close enough together to attract each other and a ferromagnetic material is placed between them both magnets are now attracted to the shield. The net effect is that both magnets are still being attracted in the same direction prior to the shield being put in place.

Now turn one of the magnets around so they are repelling each other and then place ferromagnetic material between them. Again the magnets are attracted to the shield and will stick to it. With a thick enough piece of material the poles may actually be directed facing each other. With a thinner piece the magnets will be offset from each other, but will still stick to the shield.

What is the difference between RF and Magnetic shielding?

Radio frequency (or RF) shielding is required when it is necessary to block high frequency - 100 kilohertz and above - interference fields. These shields typically use copper, aluminum, galvanized steel, or conductive rubber, plastic or paints. These materials work at high frequencies by means of their high conductivity, and little or no magnetic permeability. Magnetic shields use their high permeability to attract magnetic fields and divert the magnetic energy through themselves. With proper construction, magnetic shielding alloys have the ability to function as broadband shields, shielding both rf and magnetic interference fields.

What is the difference between DC and AC fields?

DC fields are non-varying, or perhaps slowly changing. A DC field might be from the Earth, a permanent magnet, or a coil carrying direct current. AC magnetic fields oscillate in direction at a frequency. The most common AC magnetic fields are 60 Hertz fields emitted by electric power equipment. These are typically referred to as EMI or electro-magnetic interference.

What are the frequency ranges of electromagnetic interference?

EMI (electro magnetic interference) can be roughly classified by the frequency of the interfering signal. Although some users may consider differing break points, approximate ranges are:

Microwave (MW)	300 MHz - 300 Ghz
Radiofrequency (RF)	300 Hz - 300 MHz
Extremely Low Frequency (ELF)	30 Hz - 300 Hz

The ELF range includes the 60 Hertz power line frequency commonly used in the United States and many countries. In other countries and regions, the power line frequency is 50 Hertz.

The radio frequency range is quite broad, and includes some lower frequencies that can be effectively shielded by magnetic shielding alloys and constructions. At the highest frequencies, shield techniques include much greater need for tight seams and space-filling conductive gaskets at joints.

To clarify, look at the definitions of terms sometime encountered in EMI (electromagnetic interference) control, in the following table:

Term	Definition
ELF	Extremely Low Frequency. Typically used to describe magnetic fields in the power line frequency range - 50 or 60 Hertz
EMF	Electromotive Force or Electromagnetic Field. Describes the presence of magnetic field energy and its intensity and distribution.
EMF Protection	Providing shielding to prevent exposure to magnetic flux fields and reduce their effects

How are magnetic fields measured?

The traditional CGS units for measuring magnetic fields are Gauss and Oersted. Magnetic flux density is measured in Gauss, while magnetic field intensity is measured in Oersted. The ratio of B, magnetic flux, in Gauss, to H, magnetic field, in Oersted, is defined as permeability, "µ" (pronounced "mew"). The B/H ratio, or "µ", is a measure of the material's properties. It is high for ferromagnetic materials. In air, however, Gauss and Oersted are identical numerically. The modern S/I or Metric system prefers the Tesla and Ampere-turns/meter units for magnetic flux density and magnetic field intensity, respectively. Conversions are shown in the table below.

Property	CGS unit	S/I Unit	Conversion
Magnetic Flux	Line (or Maxwell)	Weber	1 Weber = 10^8 Lines
Flux Density (B)	Gauss	Tesla	1 Tesla = 10^4 Gauss
Magnetomotive force	Gilbert	Ampere-turn	1 Gilbert = 0.796 ampere-turn
Magnetizing Force Field (H)	Oersted	Ampere-turn/ meter	1 Oersted = 79.577 ampere-turn/meter
Permeability	Gauss/ Oersted	Weber/ m-ampere-turns	

Often prefixes are used to make the quantities more manageable. For instance, we may speak of magnetic fields in milliGauss, where 1000 milliGauss (mG) are equal to one Gauss. Because a Tesla is a large amount of magnetic flux, fields are often described in mT (milliTesla) or µT (microTesla). 10 milliGauss are equal to one micro-Tesla.®

You may notice that the magnetic fields are sometimes described in technical literature as fields and sometimes as magnetic flux. In air, the magnitudes of magnetic field (in Oersted) and magnetic flux (in Gauss) are numerically equal, so the terms are sometimes used imprecisely, leading to such confusion. In air, relative permeability, μ_r, is equal to one, so the numerical magnitudes are the same.