BY IRWIN MATH, WA2NDM

MATH'S NOTES

WHAT'S NEW AND HOW TO USE IT

Some Pointers on Shielding

Almost every project that we as experimenters build gets mounted in some sort of housing or enclosure. Often it is desirable to shield these projects so that they do not pick up unwanted signals nor radiate unwanted RF. However, enclosures are not perfect. There is always a seam, crack, connector access hole, ventilation grille, or other similar opening that may allow RF to leak in or out. In addition, the materials available for the construction of such housings often range from aluminum to steel to copper. How do we deal with all of this? The purpose of this month's column is to try to shed some light on this subject.

When the frequency range to be blocked is low—such as audio, sensitive DC circuits, very low speed digital logic, and random magnetic fields—only iron- or ferrous-based materials will do the right job. This material has what is termed a high "permeability" to such fields and is used around most commercial microphones, low-level audio preamplifiers, and the like.

c/o CQ magazine

If you try to pick up a paper clip with a magnet through a piece of thin iron or steel, you quickly will see what I mean. The magnet easily will attract the paper clip through thin aluminum foil, but not through any iron-based material, no matter how thin. As the frequency rises, aluminum and copper become more and more effective, and in the true RF region both work quite well. The only problem here, as already mentioned, is that any enclosure has openings of one sort or another, especially around the edges if the enclosure is made of sheet metal or PC board material. The problem now becomes how to deal with such openings.

Fig. 1 is a simple table of frequency versus wavelength for some of the RF regions of interest to experimenters. It should be noted that if an opening is longer than a particular wavelength, it will function as a slot antenna and actually radiate (as well as receive) RF. If it is shorter, it will attenuate the RF to a degree that is a function of the ratio of the slot length to the wavelength. At one quarter the wavelength (1.5 meters for the 6 meter band) the slot will attenuate a signal passing through it by 6 dB. At one eighth the wavelength, as shown on the chart, the attenuation factor will drop to 20 dB, and at one sixteenth of the operating wavelength (also shown) it will be attenuated by 26 dB. This means, for example, that to build a good 6 meter enclosure, there should not be any openings longer than 150 mm, or 5.9 inches. While this may seem a large opening, remember that its attenuation factor is only 26 dB. A sensitive receiver may require 80 or 90 (or more) dB of attenuation, which means that the opening has to be practically nonexistent. When we consider normal construction practices, particularly the way in

Frequency	λ	–20 dB	–26 dB
28 MHz	10.7 m	536 mm	268 mm
50 MHz	6 m	300 mm	150 mm
150 MHz	2 m	100 mm	50 mm
220 MHz	1.36 m	68 mm	34 mm
450 MHz	0.66 m	33 mm	17 mm

Fig. 1– Chart of signal attenuation by various size slots.

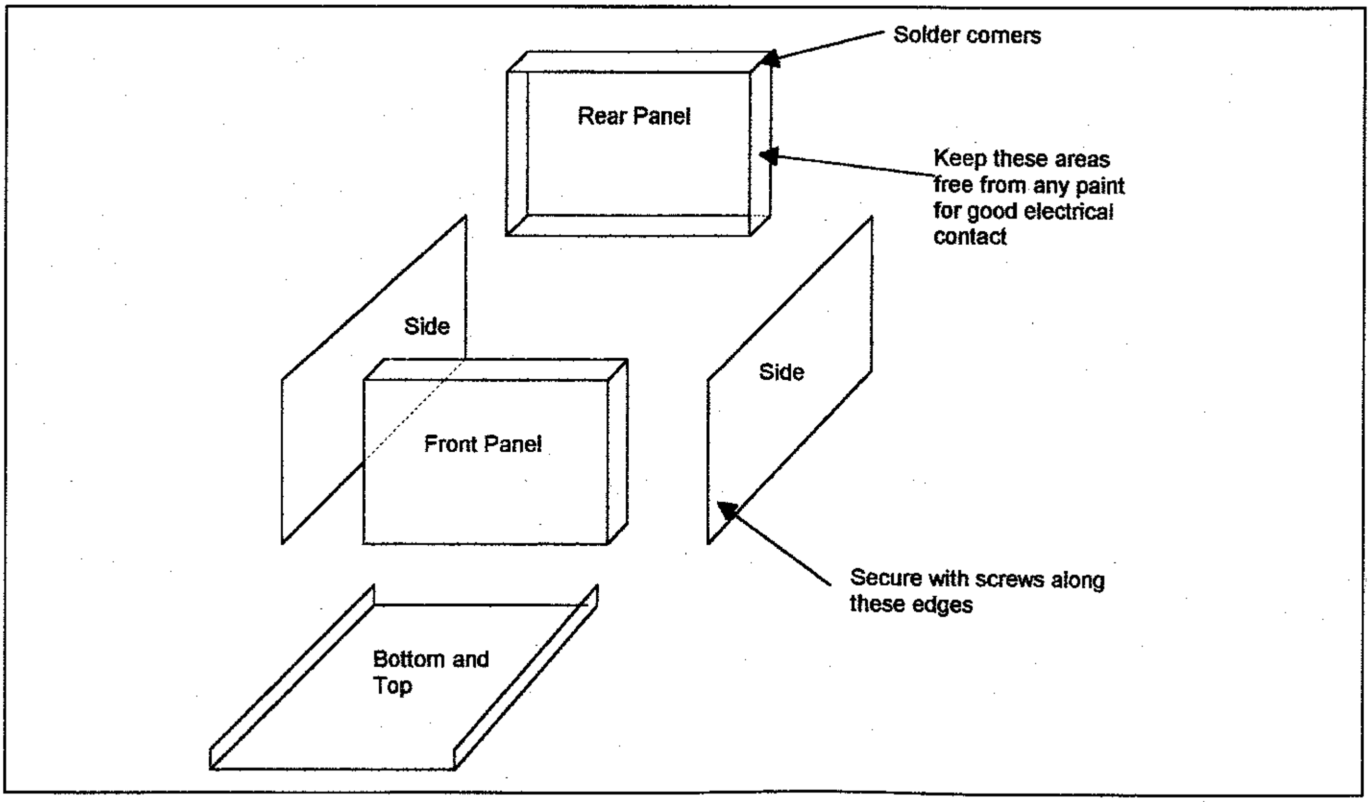

Fig. 2– Basic construction of aluminum or copper-clad housing.

which amateurs bend aluminum, the problem can seem insurmountable at first.

Fig. 2 is a sketch of a type of construction that the amateur should consider when building an enclosure from sheet metal where attenuation is important. As you can see, overlapping flaps are used, thereby minimizing gaps. Any paint is left off mating pieces, and the use of numerous screws for shielding as well as mechanical strength is greatly encouraged.

Building housings of PC board material is also permissible if the corners are soldered continuously. Simply tack-soldering at each corner can leave a gap that easily will pass a harmonic of what you want to shield against. The same holds true of a shield on a PC board. The board layout should be such that the shield is soldered to the ground plane at as many points a practical.

When rotating shafts have to pass through a panel, the gap needed for proper clearance of these shafts can be a problem. In "the old days" you could purchase so-called panel-bearing devices which you would then mount on your enclosure. These bearings allowed a 1/4 inch shaft to pass through while making decent enough contact along the portion of the shaft passing through them for fairly good shielding purposes. Today these are not so readily available, so you must improvise. A good substitute you might consider is to secure a small piece of steel wool or copper wool (look in the cleaning supplies section of your local supermarket) around the hole. Another material that might be of use is the conductive foam/plastic often used for protecting the pins of some integrated circuits. All of these could be attached with conductive epoxy or a simple mechanical clamp. Even ordinary solder might work with copper wool.

Wires passing into and out of a shielded enclosure also pose problems. After all, they are conductors and easily can carry unwanted signals in addition to the lines they are supposed to carry. The method here is to use feed-through capacitors and inductors for power supplies, as well as RF chokes made of some of the readily available ferrite cores now on the market for AC line cords.

When all is said and done, a simple method of RFI susceptibility testing is to place the whip antenna of an HT in close proximity to the shielded equipment. Keying the HT for a second or two quickly can show how well your shielding job actually is. To test for radiated emissions, a general-purpose shortwave communications receiver with a small loop of wire at the end of a piece of coaxial cable connected to the antenna terminals will do. In a pinch, even a sensitive field strength meter can be used.

73, Irwin, WA2NDM