COMMUNICATIONS CORNER

When a shield isn't a shield

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WHETHER WE'RE DEALING WITH DIGITAL or analog circuits, shielding often seems to resemble a kind of magical force that works in its own mysterious way. Quite possibly, had electronics existed back in the days of the Salem witchcraft trials, Cotton Mather would have condemned a piece of metal to be dunked in the river until drowned.

My first introduction to the mysteries of shielding came about with the introduction of the aluminum chassis and cabinet. Prior to aluminum, all audio circuits were assembled on and/or in an iron or steel chassis or enclosure because iron was a magnetic shield. It kept the 60-Hz hum radiated by adjacent powerlines from entering the unshielded wires that interconnected the high-impedance vacuum-tube audio circuits. Quite often, it was necessary to place an iron shield between a power transformer and audio-circuit wiring in order to "shield" the wiring from the transformer's radiated hum field.

I have no idea how many Greenlee punches I wore out punching socket holes in No. 16- and 18-gauge steel chassis and cabinets, but I do remember much of my allowance being spent on Greenlee punches.

I think it was out of pure desperation—meaning I had run out of funds for Greenlee punches—that I built a tubed dynamic noise suppressor on an aluminum chassis and used an aluminum cabinet (I think it was a Budd *Minibox*). Wonders of wonders: the Sun did not stand still, rivers did not stop flowing, and the multi-tubed project (it seemed more as if it were mega-tubed) worked without any hum. I don't think I ever built another project on, or in, iron or steel again, although I have used iron as transformer shields, just as I have used aluminum for transformer shields. But regardless what I used for the chassis, the one thing I did know was that the entire circuit had to be shielded. If I left off a chassis bottom plate, and the project wasn't *totally* shielded, I was just asking for hum or RF-radiation problems.

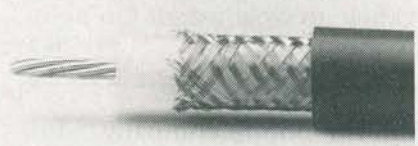

FIG. 1

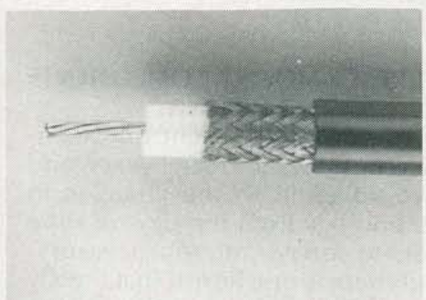

FIG. 2

Percentage shielding

On the other hand, I have had more than my share of troubles with "total" transmission-line shields that weren't. When I first started out in electronics, the metal braid of any kind of shielded wire—audio, RF, powerline, whatever—was wound so tightly around the center conductor that I remember having to pick away at the shielding braid for what seemed like hours in order to make a "shield pigtail" for circuit or socket connections. The magic number that sticks in my mind was 95%. In other words, as I understand it (and I'm certain someone will write in with a college-level thesis on why I am wrong), the shield could reduce radiation into or out of the center conductor by 95%. (As I recall, the surplus military cables used by my first employers were rated at almost 100% shielding; 95% was the minimum acceptable value for non-military industrial shielded cable.)

When I got into both SWL and amateur radio I discovered that some of my antenna systems were fantastic, while others of the exact same design suffered from local noise pickup on reception, or radiated RF from what was supposed to be a "flat" (non-radiating) transmission line.

In virtually every instance the problem was traced to a manufacturer's greed. In order to undersell their competition, some manufacturers were reducing the number of strands in the shield wrap, or stretching the wrap, actually creating "holes" in the shield through which energy could radiate into or out of the center conductor. An example of "stretched" shielding is shown in Fig. 1. Use that stuff for a high-impedance audio signal running adjacent to, or through a powerful 60-Hz field, and I will guarantee the signal will pick up hum. Similarly, if used as an antenna's transmission line, and you run the cable through a strong RFI or EMI field, I'll give you an odds-on bet that you'll hear interference you never expected.

Keep it tight

In many instances, it doesn't matter what kind of metal the braid is made of as long as it is tightly wound. For example, Fig. 2 shows the new Radio Shack coaxial cable, which is rated for at least 95% shielding. Notice that you cannot see the insulation under the braid, which is probably the best visual test you can make on any kind of shielded cable. Comparing Fig. 2 with Fig. 1 gives you a good idea of what to look for as far as the shield itself is concerned. (In fact, much professional shielded audio cable no longer uses braid at all. Instead, the shield is actually a wrapped foil with a drain wire running its entire length.)

A tight braid is particularly important when handling digital signals. You've probably experienced the RF interference on a radio or telephone that is in close proximity to a personal computer. Those of you who have a shortwave receiver may have experienced RFI from a computer in the next house. Often, the interference is caused by RFI leaking through "shielded" cables.

The RFI is created because digital signals are squarewaves, and squarewaves generate at least five harmonics if they're to retain their square shape. Let's assume that you have an early computer having a slow clock of approximately 2 MHz. Since the clock signal is a square wave, you really are generating strong harmonics up to at least 10 MHz. If any of it radiates into a shielded wire that leads from the computer to a peripheral, and the shield isn't too efficient or if the braid is stretched, the RF is going to radiate right through the shield just as if it were broadcast by an antenna. **R-E**