A Low-Cost Method for Constructing a Shielded Enclosure

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Publisher

With increasing "RF pollution" from wireless communications services, computer systems, and many other electronic devices, routine workbench measurements are getting difficult. These interference sources can get into our circuits and test equipment, creating unwanted signals or masking the ones we want to see.

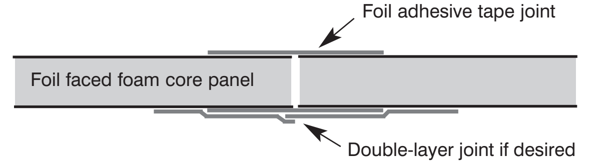
The standard method for dealing with this problem is a shielded "screen room." A commercial installation can cost tens of thousands of dollars. At this price, a company may only obtain one unit, to be shared by an entire engineering department. While the assured performance of a well-designed screen room can be justified for important measurements that must be thoroughly documented, sometimes all we want is a better bench measurement or a chance to see if an unusual behavior is externally induced.

The lumberyard solution

This article illustrates techniques that allow the use of commonly-available foil-faced foam insulation board as the shielding material. With a cost of only a few dollars per four-by-eight foot sheet, and with easy availability at a lumberyard or home center, these panels are attractive for use in a room-sized or smaller enclosure. I'm not going to show you step-by-step construction details, but I will point out the basic assembly methods that will achieve good shielding performance.

The properties of insulation board need a little explanation. First, the material selected must have metal foil as the facing material, not metallized plastic or fabric. Double-faced board can be used to make a double-shielded wall. Insulation board is available in several thicknesses. Your particular installation will dictate whether you can use the thinner walls of half-inch material, or if you need the extra stiffness of thicker board.

The foil used on insulation board is typically quite thin, and the foam interior has little strength. Mechanically, it is easy to tear, puncture or break unless well supported. Electrically, the thin metal has less shielding ability than thicker metal, especially at frequencies where the thickness is less than the RF skin effect depth. At these lower frequencies, currents flowing on the outside are also present on the inside, and are subject to less attenuation than high frequency energy. If you need to provide shielding for low-frequency RF interference (e.g. AM radio stations or aeronautical ADF beacons), double shielding is highly recommended.



■ **Figure 1. Joint technique for adjacent panels.**

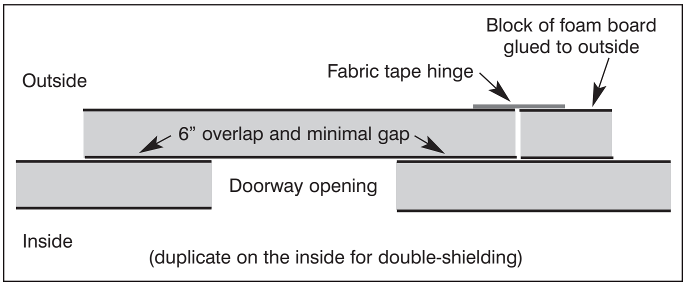
Problem areas to be addressed

If you have any experience with RF shielding, several areas will come immediately to mind for special consideration. The most important ones are joints between panels, a shielded doorway, power/signal cable entry and HVAC vents.

Panel joints — Another lumberyard or hardware store item is the key to simple joints and corners. Aluminum foil adhesive tape (the real "duct tape") can be found in 2-inch widths, and often in 3- or 4-inch widths. Get the widest tape you can find, although you can get by adequately with only 2-inch tape.

Figure 1 shows how joints are assembled. A taped joint may not have good DC conductivity, but it will work at RF because of its capacitive coupling. At microwave frequencies, the gap between tape and foil can also be considered as waveguide-beyond-cutoff. With two-inch tape seams (one inch on either side of the joint), the coupling may not be sufficient to provide an adequate RF seal. Wider tape is recommended, but you can also place two additional strips of 2-inch tape to obtain a wider coverage area and get better RF attenuation. Corners are made similarly, using care to apply the tape uniformly. Miter the corners to get the foil faces close together at the joint.

Access doors — The simplest solution for personnel access is — none. A benchtop shielded box may be all you need for your testing needs. Equipment is placed inside through an open end panel, which is replaced and taped to complete the shield. This type of mini-shielded enclosure can be a true benchtop solution for interference-free measurements. The small size, however, places limits on the quality and reliability of cable access ports.



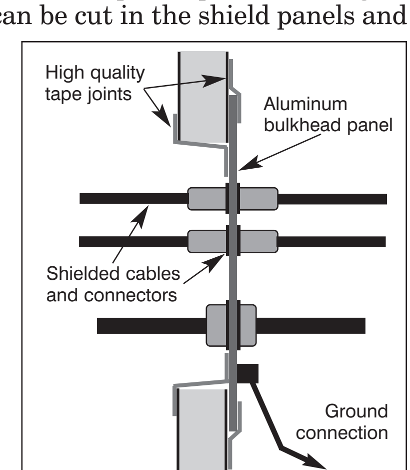
■ **Figure 2. Door construction detail.**

In a room-sized enclosure, we can take advantage of the light weight of insulation board. By making the door out of the same material as the walls, it can be much larger than the doorway opening and still be easily handled (Figure 2). With a large area of overlap (at least 6 inches is recommended), the coupling between the door and walls is sufficient to provide good shielding, as long as the gap is not too wide. Double-shielded rooms should have double doors, one outside and one inside.

Door construction can use a hinge, a lift-and-remove panel, or whatever else the builder might contrive! With this lightweight, easily worked material, almost any assembly can be made with tape, glue or both.

Power and signal entry points — The simplest way to get power and signal into and out of the enclosure is through a bulkhead panel. If all cables are shielded, connectors or clamp connections to the shields are made at the bulkhead (Figure 3). Currents flowing on the shields are thus diverted to the shielded room’s outer conducting surface. Because the magnitude of currents flowing in the cables will far exceed those induced by ambient RF fields, the bulkhead is an excellent place to make the master ground connection. Follow the cardinal rule of grounding for interference reduction — ground at a single point to avoiding circulating ground currents!

HVAC provisions — The simplest option is straightforward. First, a hole can be cut in the shield panels and window screen material taped over it with the foil tape. Again, use two pieces, inside and out, for double-shielding. An air inlet at the bottom and an outlet at the top are needed. The grid size of the screening needs to be small enough to act as an effective shield. Any window screen that keeps out insects has a grid that is fine enough to keep out RF!



■ **Figure 3. Cable entry bulkhead.**

Floor strength — If you are making a room-size enclosure, it must be strong enough to support your weight and the weight of a bench or table. You can install a plywood floor by installing spacers that offer support while protecting the foil from damage. Wood spacer blocks can be installed through small (e.g. 2 inch square) holes in the foil-faced board used for the floor. Or, furring strips can be used, and sections of foam board placed between them. Figure 4 is an attempt to show how this might work. Wide foil tape or aluminum flashing can bridge the gaps between panels. Some experimentation may be necessary, based on the type of floor under the enclosure and whether maximum performance is required.

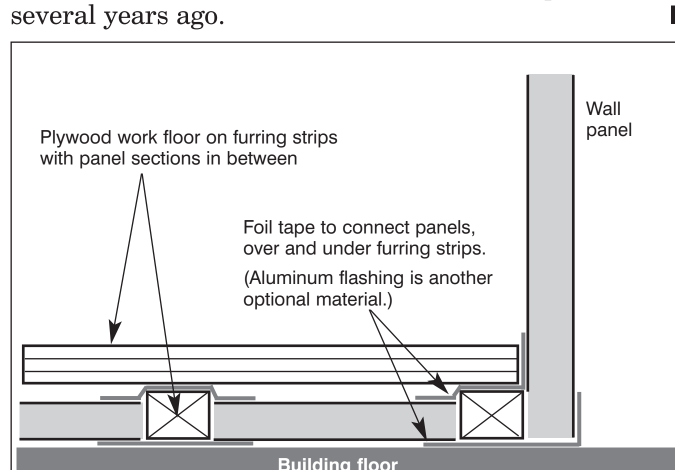
Testing shielding performance

After you have built the shielded room, a quantitative measurement of its performance will demonstrate that it is doing what it should, but a simpler qualitative test might be enough to convince you. Place a typical test setup in the enclosure, with all power and signal lines in place. An ordinary battery-powered portable AM-FM radio will quickly tell you how well the shielding is working! Outside the enclosure, tune to strong stations on both bands and get an idea of their signal-to-noise ratio. Take the radio into the enclosure and put the doors in place. The effect of the shielding should be immediately apparent as you try to hear the radio stations.

This is a good test of door and power entry integrity, too. Leave the radio running inside the enclosure as you try different configurations and attachments.

Summary

I hope that these notes on simple shielded room construction give you enough basic information to make your own enclosure. Then you can make better quality measurements. Credit for most of this information belongs to Ken Javor, an EMC consultant in Huntsville, AL, who described this construction technique in detail several years ago. ■



■ **Figure 4. One possible floor construction technique.**