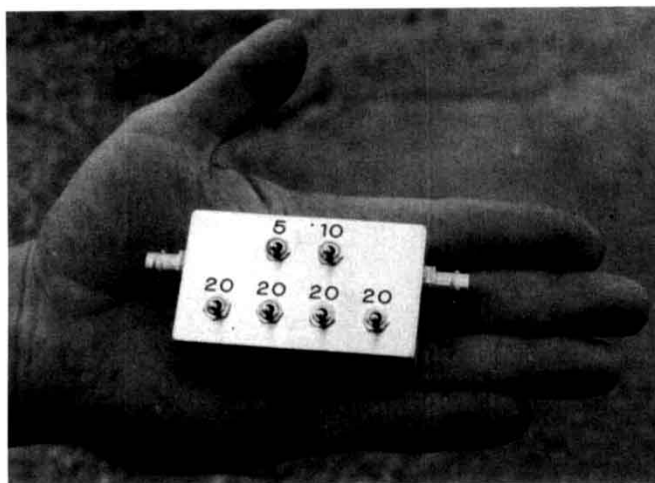


A Rugged, Compact Attenuator

This attenuator is worth your attention. Built like the proverbial brick outhouse, it's one you can easily duplicate!



PHOTOS BY MIKE MCCAULEY, WN9NDU

After becoming a ham in 1993, I soon realized the value of being able to locate a transmitter by radio-direction finding (RDF or "DFing"). One of the first purchases I made while awaiting my license was a 13 element, 2 meter Yagi antenna. I bought the antenna so I could work the more-distant repeaters, but it soon came in handy for DF work: The Elkhart County Radio Association's (ECRA) 2 meter repeater was suffering an enormous amount of malicious interference. Mike McCauley, WN9NDU, then the club president, appointed me Interference Committee chairman. I was one of the few members with a beam antenna—and everyone else had a life.

Background

Some H-T S meters have a scale of S9 + 40. From that, you might think that you have an S-meter range of 94 dB, but you'll

find that most H-T S meters likely have a range of from 6 to 15 dB. (The graduations apparently are window dressing put there by somebody in marketing.)

When you're DFing and head off to find the source of the signal, you'll likely take along a small "fox-hunting" Yagi with four or five elements. Eventually you'll get close enough to the transmitter so that you get a full-scale S-meter reading no matter which way you point your antenna. Are you dead in the water? Not if you have an RF attenuator! Simply insert the attenuator between your antenna and radio and select a value of attenuation that puts the S-meter needle into the active region, then continue

with the hunt. Increase the attenuation as you get closer to the fox so that you never quite get a full-scale reading as you rotate your antenna through 360°.

This Design

I've seen 65-dB attenuators sell for as much as \$400, but with some scrupulous switch shopping, you can put this attenuator together for \$50. It's an ideal first project. No power supply is needed, no coils to wind and there's no PC board to etch. In three hours, you can assemble the unit and de-test it with a voltmeter. Best of all, even though you built it yourself, it

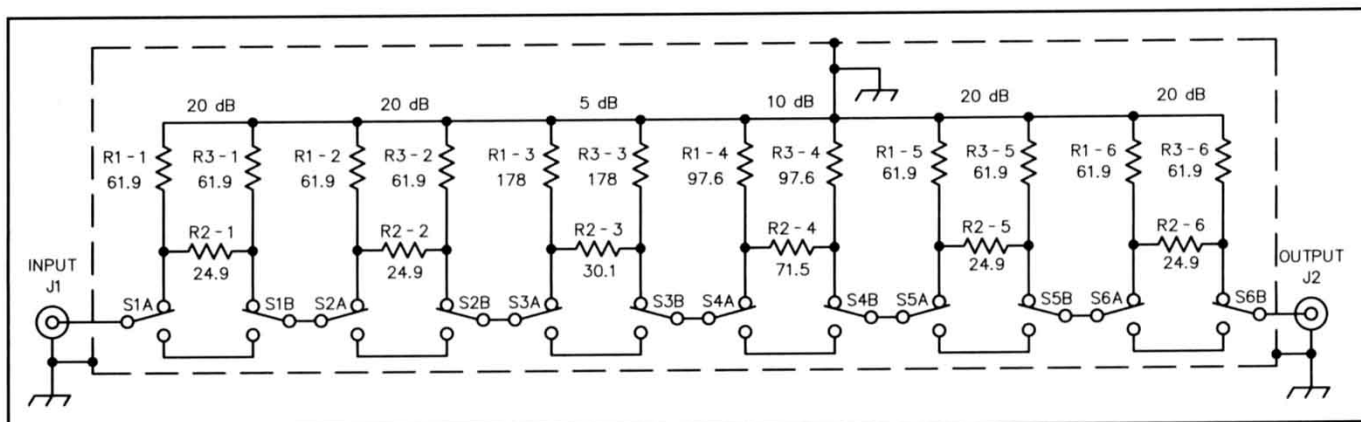


Figure 1—Schematic of the attenuator. Equivalent parts can be substituted. Unless otherwise specified, resistors are 1/4 W, 1% tolerance film or carbon-composition units.

J1, J2—BNC connector
S1-S6—DPDT toggle switch, 120 Vac, 5 A (see text); C&K 7201 MDZBE,

Alcoswitch MTF 206N and other suitable switches are available from Newark Electronics, 4801 N Ravenswood Ave,

Chicago, IL 06040-4496; tel 800-463-9275; 312-784-5100; fax: 312-907-5217, <http://www.newark.com>.

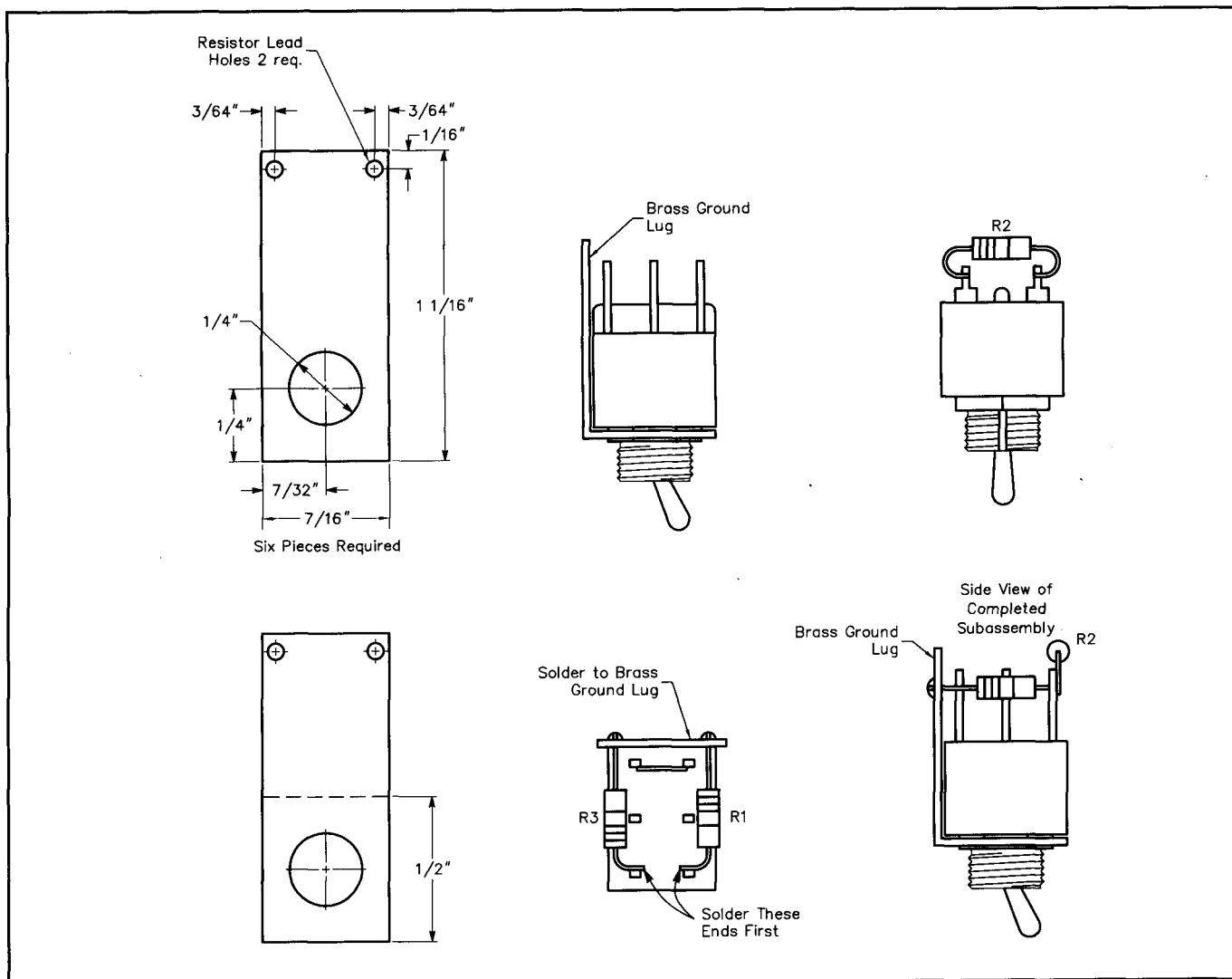


Figure 2—Preparation of the brass grounding strip and assembly of the individual attenuator sections.

won't look like you did!

I chose a 95 dB limit for my attenuator. Why? Because going much beyond that (an attenuation of 95 dB is a power ratio of 3,162,277,660 to 1) is like trying to keep your soda cold while visiting friends on the Sun! For this attenuator, I chose steps of 5, 10, 20, 20, 20 and 20 dB. By limiting the attenuation steps to no more than 20 dB, the unit works well up to 450 MHz.¹

To allow an attenuator to work with any radio that you want to use for fox-hunting, the smallest attenuation step should be 5 dB. With the increments I've chosen, you can select attenuations from 0 to 95 dB in 5 dB steps. The physical switch arrangement allows you to use the attenuator in total darkness. This is an important consideration because most H-Ts are backlit, attenuators are not.

The 1997 ARRL Handbook's resistive attenuator table (page 30-30) provided the resistor values needed to obtain the desired attenuation steps while maintaining a 50 Ω

impedance. For ease of construction, I chose to use pi networks (see Figure 1).

Although we were told not to use miniature toggle switches, we found they work well. We were told to use carbon-composition resistors (good luck finding them nowadays!), but the RN55 1/4 W, 1% tolerance metal-film resistors available from Digi-Key work well and offer a great selection of resistor values.

A Pilgrim's Progress

My first attenuator attempt was a dismal failure. One sentence in the *Handbook* that reads "Good shielding between each attenuator section is essential," went right over my head. My second attempt was a dismal success. It worked, but it was too time-consuming to build because of all the sheet-metal bending, fitting and mounting required. My third attempt involved machining a solid block of 6061-T6 aluminum to provide chambers in which to mount the switches and resistors. This, too, is labor-intensive, but the end result looked so good that I didn't care! (I know—some of you

are muttering that you don't have a vertical milling machine, but don't worry; I don't expect you to make your own toggle switches either! I'll get to that later.)

The next question was "Does it work?" I turned to Dave Evans, AA9DG, the trustee of the ECRA 2-meter repeater. Dave has a masters degree in electrical engineering. He is as logical as Mr Spock, but has a sense of humor. More importantly, he is employed by a manufacturer of audio equipment and broadcast transmitters. That explains why I turned to Dave in the first place: He could evaluate the attenuator and I wouldn't have to buy \$10,000 worth of test equipment! During tests, we found that the two resistors that connect to ground in each pi network should be located on opposite sides of a chamber, touching—or almost touching—the aluminum partitions to minimize crosstalk and attenuation roll-off at higher frequencies.

A Solid Enclosure

About that machined enclosure I mentioned earlier:² I had aluminum bar stock

¹Notes appear on page 43.

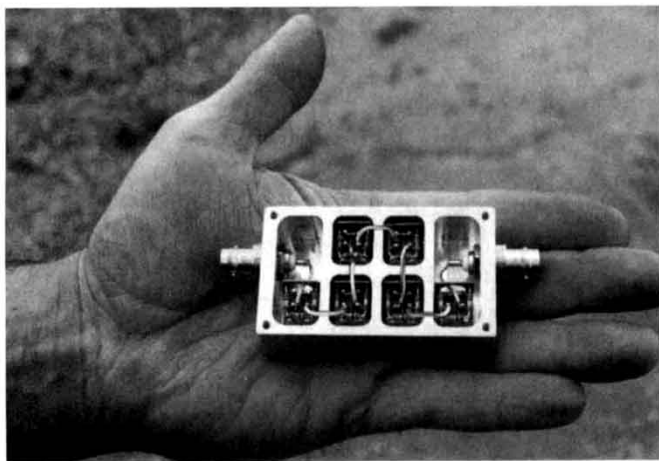


Figure 3—An inside view of an assembled attenuator.

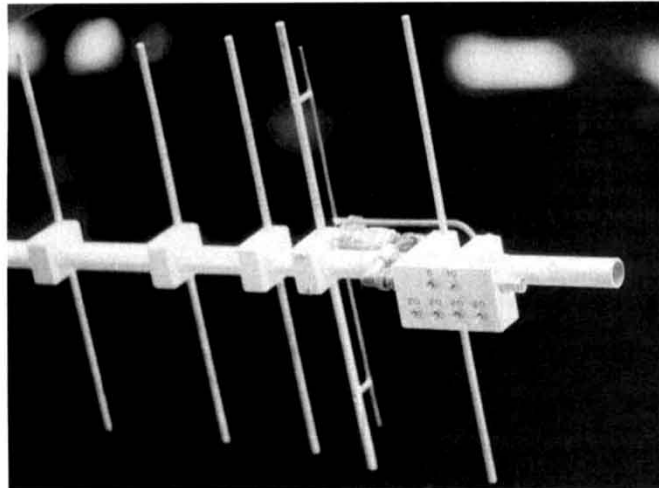


Figure 4—Here, the attenuator is shown attached to a portable fox-hunting antenna.

for the attenuator enclosure, but I needed to cut it to size and then send it off for CNC machining. Marty, KB9OYL, who got her license in 1996, said that she'd like to try building Amateur Radio equipment. Having no military background, she never learned Rule Number 1: Never Volunteer, so I put her to work machining the aluminum blanks to size. I told her that one finished unit would be hers, so she made no mistakes. When Marty finished, we went to see a friend, Bud Kramer, who specializes in CNC machining, and got a CNC education. Afterward, we visited Jerry Wood, who has a CNC engraving machine. I spoke those words that nobody wants to hear, "Remember when I helped you . . . ?" Jerry did a splendid job of engraving the attenuation value at each switch position. I filled in the numbers with black paint to make them stand out better. (See the title photo.)

As you can probably guess, this project made me a firm believer in the old saying, "It's not *what* you know, it's *who* you know!"

Construction

I used miniature toggle switches with a 1/4-inch-diameter bushing and a 0.4 VA maximum rating. My first attenuator was built with generic toggle switches and is still working fine after two years. The unit shown here uses C&K switches. Denny, KA9WNR, had some C&K 7201s at a good price (\$1 each!). These switches have gold-plated contacts for reliable dry switching. Their terminals are arranged for right-angle PC board mounting, but a few minutes with pliers and side cutters yields switches well-suited for the job. The switch has a short (1/4 inch) bat handle that makes it less apt to get snagged and switched accidentally. It looks better, too, because the attenuator is quite small. The C&K 7201 is not my first choice because of the terminal arrangement (and the new price is about 10 times what I paid for them), but the switches' specifications will put you in the ballpark when you

go shopping for switches.

I don't care if you have a thermonuclear soldering iron, don't even think about soldering the resistors to the aluminum enclosure!—it's small (7/8×1 3/4×3 inches), but it's quite stout. I put a bare enclosure (backed up by a 2×4 piece of lumber so as not to mar the case finish) in my hydraulic press. By the time the pressure got to 14,000 pounds, the enclosure was buried in wood fragments—without damage. (Don't try this at home.)

Refer to Figure 2. To ease assembly, cut six strips of 0.01 to 0.02-inch-thick brass shim stock to 7/16 × 1 1/16 inch. Punch a 1/4-inch-diameter hole in each strip at one end, and two holes in the corners at the opposite end. The corner holes are just big enough to allow the resistor leads to pass. Scribe a line 1/2 inch from one end of each strip and bend the strip 90°. Mount each strip on a switch using a single bushing nut. Using some component-lead scraps or bare wire, connect together one pair of terminals at an end of each of the switches. (These are the bypass connections.) Next, solder in place the two resistors (R1 and R3) of each network that connect to ground passing the ground lead of each resistor through the corner holes in the brass strip. Form each section's third resistor (R2) and solder it in place. Now, you can drop each resistor/switch assembly into place and secure them with a second bushing nut, which also grounds the brass clip. Once all the subassemblies are mounted, interconnect them with insulated #24 stranded hook-up wire. This construction approach allows easy disassembly of each section in the event you loaned the attenuator to an ex-friend who used it to reduce the power of his 50 W radio to 5 W.

For the input and output connectors, J1 and J2 (which can be used interchangeably), I use BNC connectors with a threaded (3/8-32) bushing and nut. You can locate the connectors on the enclosure ends, as shown in Figure 3 and other photos, or on the top, front, or any combination of

these. Other connector types can be used for other applications, but BNC connectors are quite common on H-Ts, and H-Ts are well-suited to fox-hunting. The attenuator is small enough to be secured to the boom of a fox-hunting antenna (see Figure 4).

Summary

Now our interference committee has a bunch of compact and rugged attenuators—and you'll eventually have at least one. I hope you'll enjoy building this project and have many successful fox-hunts. If you've already spent the money for an H-T and you're tired of interference to your repeater, you can now "Hang 'em High" for "A Few Dollars More."

Peter ("Pete") Ostapchuk, N9SFX, has always had a fascination with electrical, electronic and mechanical gadgets. In high school, his physics teacher was Stan Rohrer, W9FQN. After high school, following an offer he couldn't refuse, Pete spent three years in Germany as a guest of the US Army working as a radar and computer operator. While still in the Army in 1968, he bought his first ARRL Handbook. From that Handbook, Pete built his first QRP transmitter in 1970, but wasn't licensed until 1993 because of the Morse code requirement. Once he applied himself, he went from 0 to 20 WPM copy in six months, and within a year, went from no license to Extra Class. Pete's wife, Linda, is KB9RUC. His daughter, Sarah, N9ZZT, is a junior at Purdue University and hopes to become an astronaut. You can contact Pete at 59425 Apple Rd, Osceola, IN 46561; e-mail devans@skynet.net.

Notes

¹Verified in the ARRL Lab.

²Enclosures are available from me for \$21 each, plus \$5 each for shipping and handling. Contact me by telephone at 1-219-679-4627 from 8:00 AM to 11:00 PM. You'll have a better chance of reaching me in the morning or during the evening. Or, send a self-addressed stamped envelope to Pete Ostapchuk, N9SFX, 59425 Apple Rd, Osceola, Indiana 46561. I would like to hear your comments about the attenuator.

QST