ARRL Handbook CD

Template File

Title:	Step Attenuator
Chapter:	22
Topic:	Pi-Network Resistive Attenuators (50 Ω)

Template contains:

Detailed instructions for low-power step attenuators.

LOW-POWER STEP ATTENUATORS

A step attenuator is a useful and important tool for receiver testing. It can be used to check gain and loss between circuits, measure input and output level differences and to keep one circuit from affecting another. Low-value attenuators are often used commercially to make sure that a 50-Ω output from one stage sees a 50-Ω input to another. Step attenuators that can be used into the VHF frequencies are often made in boxes with standard DPDT switches. Lead lengths are kept very short or nonexistent.

Described here is a simple low-power step attenuator suitable for receiver front-end protection and as a calibrated attenuator for receiver performance evaluation. This attenuator uses double-pole, double-throw slide switches to select different amounts of attenuation. Coaxial fittings are used at each end of the attenuator.

Description

Fig 26.52 is the schematic diagram of the attenuator. Eight pi-network resistive sections are used; the attenuation is variable in 1-dB steps. They add up to 81 dB with all the sections switched in. The maximum attenuation of any single section is limited to 20 dB because isolation between sections is limited. If the attenuation is spread out though several sections, the leakage between sections doesn't effect the readings of the whole attenuator.

This is a low-power attenuator; it is not designed for use at power levels exceeding 1/4 W. If for some reason the attenuator will be connected to a transceiver, it must be bypassed during transmissions. This is the most common reason for attenuator failure.

Parts

All the switches are standard-size DPDT slide units, such as Digi-Key SW 105. Other switches may work as well. Don't use subminiature switches.

Carbon-composition or metal-film 1/4-W 5% tolerance resistors were used. Ideally, the resistors should be selected using a reliable ohmmeter to ensure accuracy.

Double-sided PC board is used for the

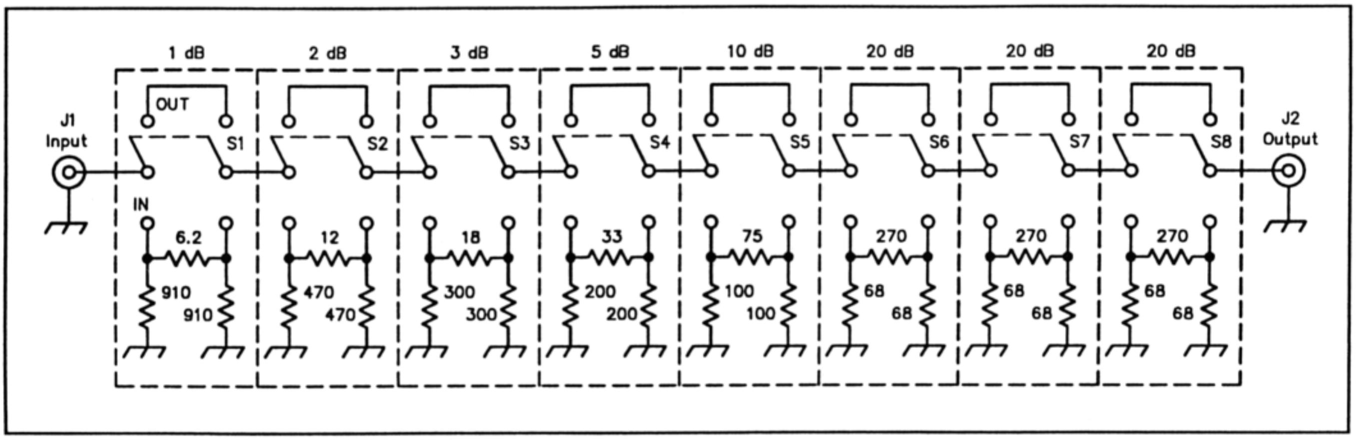

Fig 26.52 — A ladder configuration step attenuator. All resistors are 1/4-W 5%-tolerance, carbon-composition or film types. Values are given in ohms.

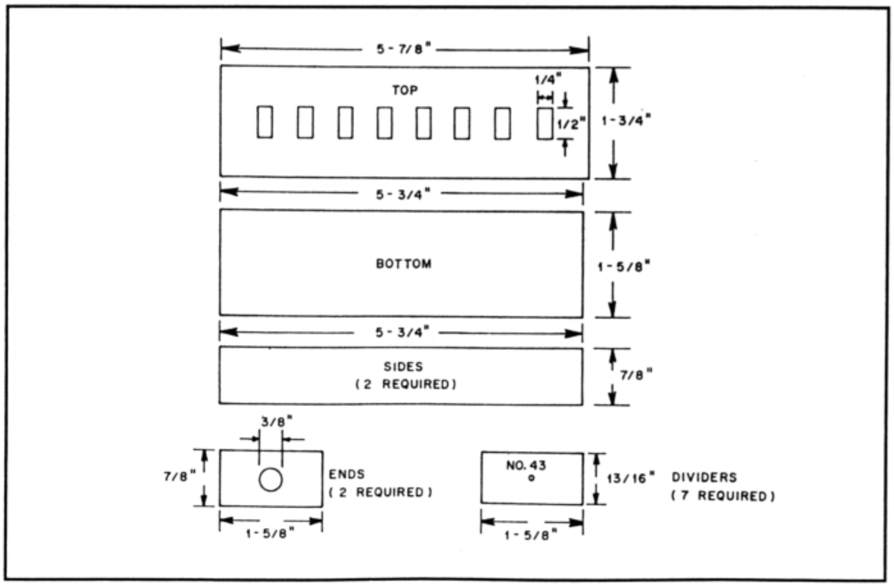

Fig 26.53 — Attenuator enclosure dimensions. See the text for precautions on soldering.

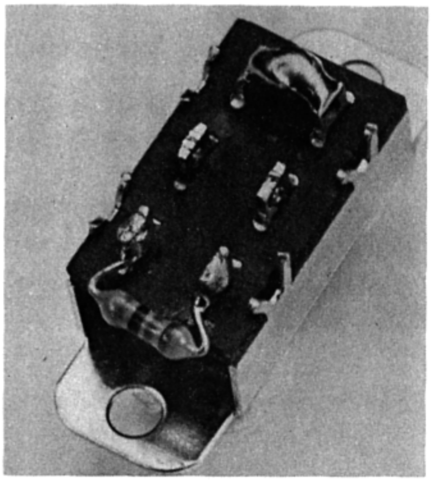

Fig 26.54 — Switch detail close-up.

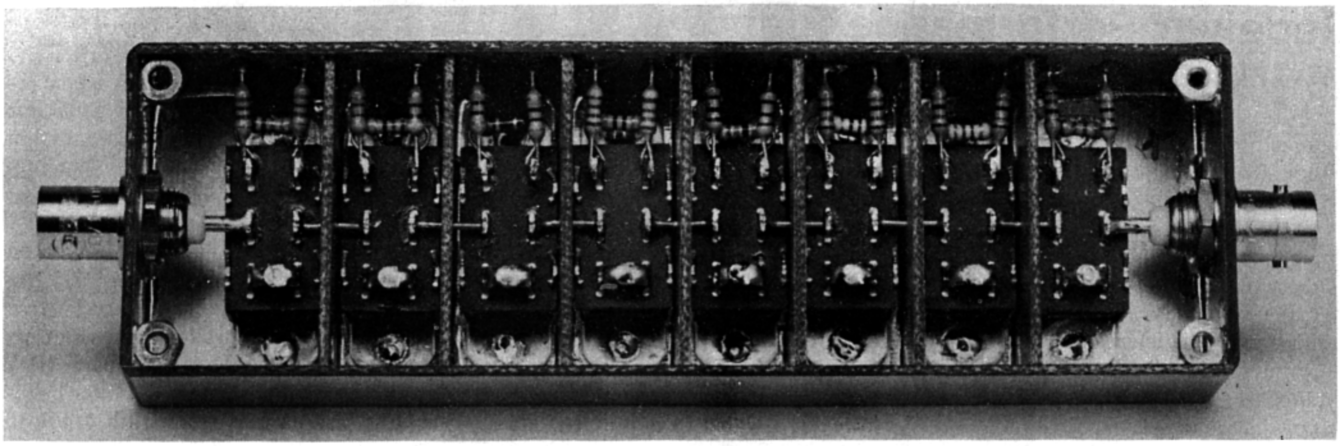

Fig 26.55 — Interior view of the completed attenuator. Use short, direct leads. Brass nuts soldered at each of the four corners are for machine screws that secure the bottom cover. File one corner of each nut to permit a flat, two-sided fit within the enclosure.

enclosure. Dimensions for the model described here are given in **Fig 26.53**. The attenuator has identification lettering etched into the top surface (or front panel) of the unit. This adds a nice touch and is a permanent means of labeling.

Female BNC single-hole, chassis-mount connectors were used at each end of the enclosure. These connectors are small and easy to mount, have excellent RF qualities and are easy to operate.

Construction

After all the box parts are cut to size and the necessary holes are made, scribe light lines to locate the inner partitions. Carefully tack solder all partitions in position. Change any PC-board parts that do not fit squarely. Once everything is in the position, run a solder bead all the way around the joints. *Caution:* Do not use a lot of solder, as the switches must later fit flat against the panel. The top, sides, ends and partitions can be completed. Label and mark the outside of the box to suit your taste. Buff the copper with steel wool, add lettering and finish off the work with a coat of clear lacquer or polyurethane varnish.

Using a little lacquer thinner or acetone (and a lot of caution), soak the switches to remove the grease that was added during manufacture. When dry, spray the inside of the switches lightly with a TV-tuner cleaner/lubricant. Using a sharp drill bit (about 3/16 inch will do), countersink the mounting holes on the actuator side of the switch mounting plate. This ensures that the switches will fit flush against the top plate. At one end of each switch, bend the two lugs over and solder them together. Cut off the upper halves of the remaining switch lugs. (A look at **Fig 26.54** will help clarify these steps.)

Solder the horizontal components of the pi sections between their switch lugs. Keep the lead lengths as short as possible and do not overheat the resistors. Next solder the switches in place to the top section of the enclosure by flowing solder through the mounting holes and onto the circuit-board material. Be certain to place the switches in their proper positions; and match the resistor values with the amount of attenuation. Otherwise, you may wind up with the 1-dB step at the wrong end of the box.

Once the switches are installed, thread a piece of #18 bare-copper wire through the center lugs of all the switches, passing it through the holes in the partitions. Solder the wire at each switch terminal. Cut the wire between the poles of each individual switch, leaving the wire connecting one switch pole to the neighboring one on the other side of the partition, as shown in **Fig 26.55**.

At each of the two end switch terminals, leave a wire length of approximately 1/8 inch. Install the BNC connectors and solder the wire pieces to the connector center conductors.

Now install the resistors that comprise the grounded legs of each pi section. Use short lead lengths and remember not to use too much heat when soldering.

Solder a #4-40 brass nut at each inside corner of the enclosure. Recess the nuts approximately 1/16 inch from the bottom edge of the box to allow enough room for the bottom panel to fit flush. Attach the bottom panel with four #4-40, 1/4-inch machine screws and you're done!

This circuit was described by Shriner and Pagel in September 1982 *QST*. Resistance values for pi- and T-network resistive attenuators are given in the **References** chapter. Values are for use in 50-Ω unbalanced systems. These values can be scaled for use in other systems by dividing the resistance values by 50 and then multiplying by the system resistance. The resistances shown in Fig 26.52 are the nearest standard values to those appearing in the tables, taking 5% tolerances into account. Although some of the values are a few ohms off, they give good results.