Simple J-Type 10m Vertical

For more versatile DXing.

by John C. Reed W6IOJ

The main advantage the vertical HF antenna has over its horizontal counterparts is its low-angle radiation pattern. This is important on 10 meters, where success often requires low-angle radiation propagation. Another advantage of the vertical antenna is its unobtrusive profile. You can use it in locations, such as on a city lot, where many other antennas would not fit, or would be considered an eyesore by the neighbors.

The main negative feature of verticals is that ground path radiation is dominantly vertically polarized, making this type of antenna sensitive to interference from such sources as automotive ignition noise. If, however, your environment is fairly noise-free, as is mine, then the vertical may just be for you!

Entry-Level Construction

This is a simple antenna project any do-it-yourselfer can put together. All the parts are available from Radio Shack and your local hardware store. The assembly includes an easy-build balun-matching transformer. Also described is a simple SWR directional coupler so that you can accurately match the antenna to a 50-ohm feedline.

10m "J" Overview

The diagram in Figure 1 shows the configuration and lists the materials. The 1/2-wave radiator is a 1/4-wave whip antenna connected to a 1/4-wave wire inside a plastic PVC pipe. The wire end of this 1/2-wave assembly is matched to a 50-ohm transmission line with an open wire 1/4-wave stub with a balanced to unbalanced balun. In the normal J-type antenna the 1/4-wave stub is part of the vertical structure. My antenna worked well with the stub close to perpendicular to the ground; you may want to experiment with this angle for best results.

As indicated in Figure 1, the stub wires are spaced 1 1/2" with plastic spacers at 1-foot intervals. Although I used glass epoxy for the spacers (etched PCB), Plexiglas (TM) works just as well. Drill the spacers with wire clearance holes at each end, temporarily hold them in position with small pieces of masking tape, and then fasten them with a spot of all-purpose adhesive.

Figure 2 depicts the simple method of mounting the whip antenna in the plastic pipe. Although I used glass epoxy for the indicated plastic washers, you can use any hard plastic.

The balun transformer detailed in Figure 3 converts the single-ended, 50-ohm transmission line to a balanced 200-ohm output for interfacing with the 1/4-wave antenna stub. The transformer consists of

A) 8ft 6in whip antenna (RS 21-903).
B) End coupling (see Figure 2 for details).
C) 8-ft.3/4 in plastic pipe (PVC 1120 PR200-200 PSI).
D) 6-ft. 1-in x 2-in wooden dowel, which supports for plastic pipe).
E) 2" wide duct tape, which fastens pipe to wood support.
F) 2" x 2" wooden dowel.
G) Stub and interface. 1 3/4" x 1/2" x 1/16" glass epoxy with copper stripped from PCB (RS 276-1591). Center tied to the 3/4" plastic pipe.
H) 9-ft. open wire 1/4-wave stub, #18 wire (solid hookup wire, insulation stripped off (RS 278-1291)). Wires spaced 1 1/2" with glass-epoxy spacers every 12."
I) Stub/cable balun. (See Figure 3 for details.) Connected to stub about 7 ft. 9" from open stub end (adjustable).
J) Shorting bar, about 8 ft. 8in from open stub end (adjustable).
K) Glass epoxy stub tie down.
L) 50-ohm feedline (RG-58U, RS 278-1326).
M) Highest house roof elevation.

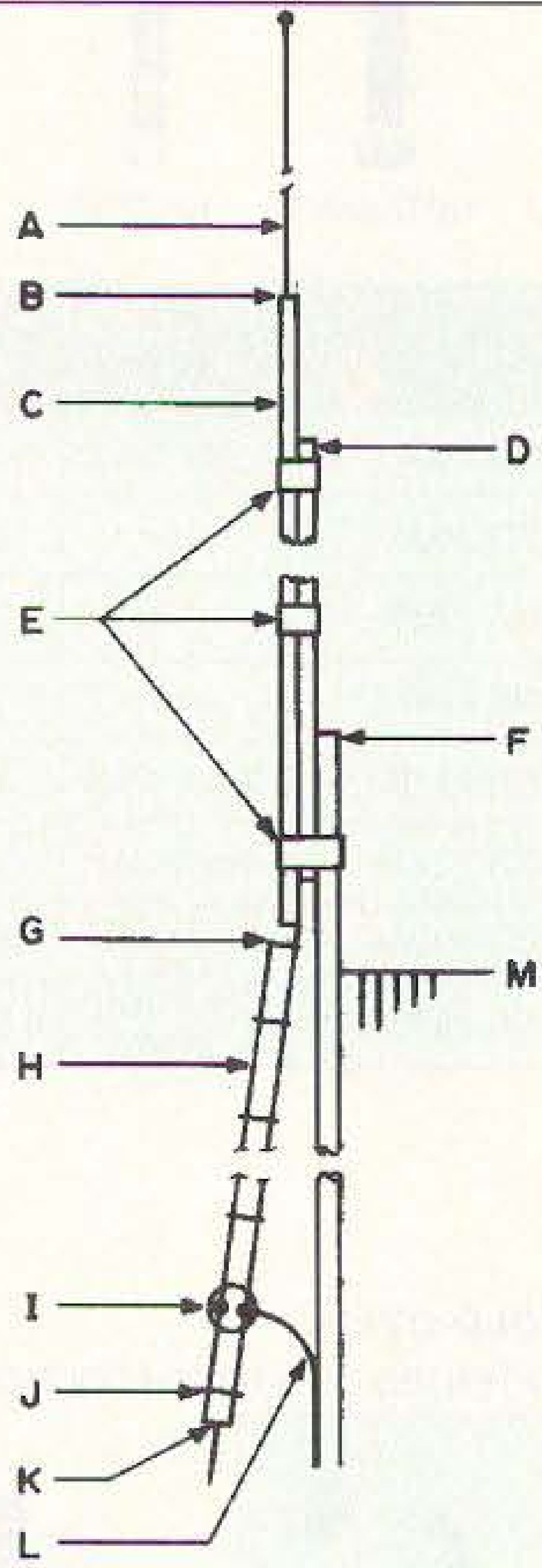


Figure 1. Antenna Schematic.

A) Whip antenna.
B) Whip antenna clamp made from sheet aluminum.
C) 1 1/8" x 1/16" plastic washer,center clearance hole for the whip (foil stripped PBC).
D) 1/4" thick spacer, several layers of plastic tape.
E) 7/8" x 1/16" plastic washer, clearance hole for whip.
F) Plastic tape to prevent the washer from sliding down.
G) 3/4" PVC pipe.
H) 7/8" x 1/16" plastic washer, clearance hole for the whip antenna mounting screw.
I) Washer/soldering lug.
J) Whip antenna hold-down nut.
K) ##18 wire solid hookup (RS 278-1291).

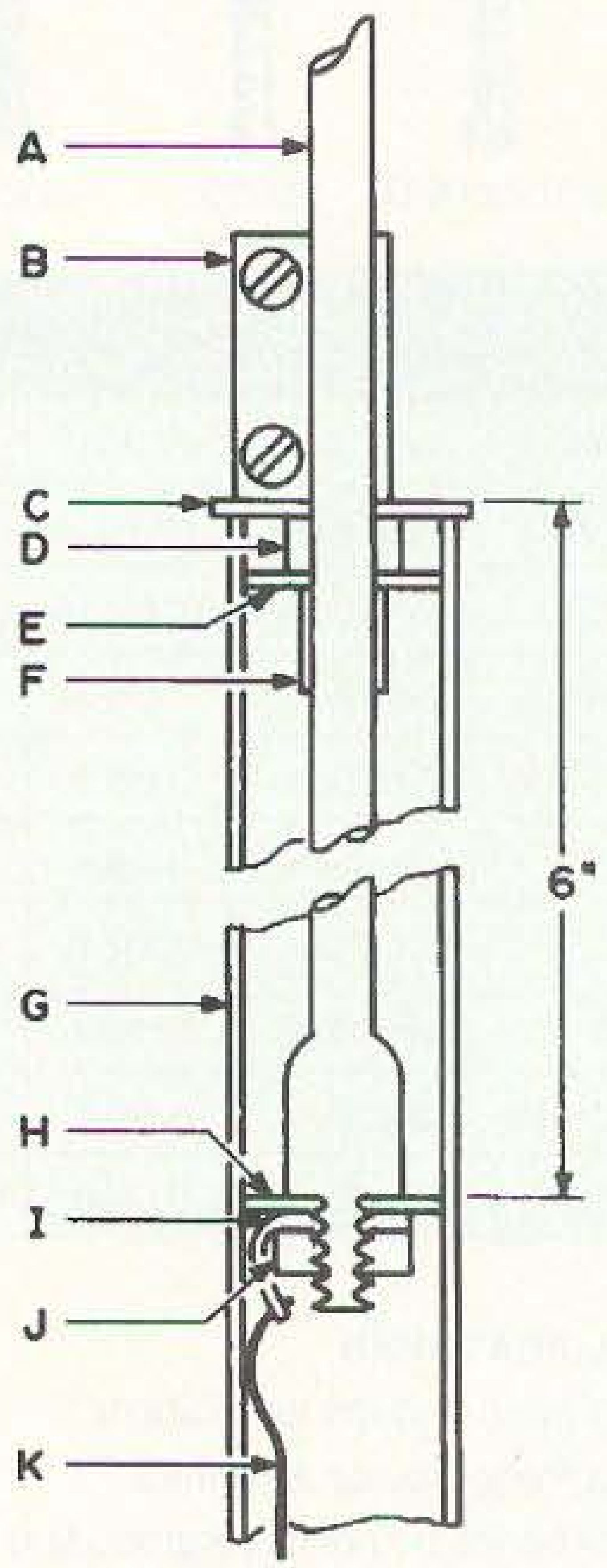


Figure 2. Whip antenna-PVC pipe interface detail.

a bi-filar six-turn coil wound on a 1-1/16" diameter form (3/4" PVC). The wire used is #18 solid hook-up wire (RS 278-1291).

The J Measures Up

Line type performance results from the distributed capacitance between the two wires, making a relatively wide bandpass transformer. Performance was measured using a 50-ohm source together with a 200-ohm resistive load. Although the results indicated the response is less than -0.5 dB at 14 MHz, it falls off much faster at the high frequencies. At 146 MHz, it's about -20 dB (an advantage when working RS-11).

To measure insertion loss, I connected two transformers in series (50-200-200-50-ohm), and measured the response with and without the transformers. The difference was about 0.1 dB. This is trivial when considering radiation loss, but there is still significant thermal (heating) losses while running high power. In the final antenna configuration, with 100 watts into the antenna, element heating is just barely apparent to the touch.

You can double the wattage capability by simply paralleling two transformers.

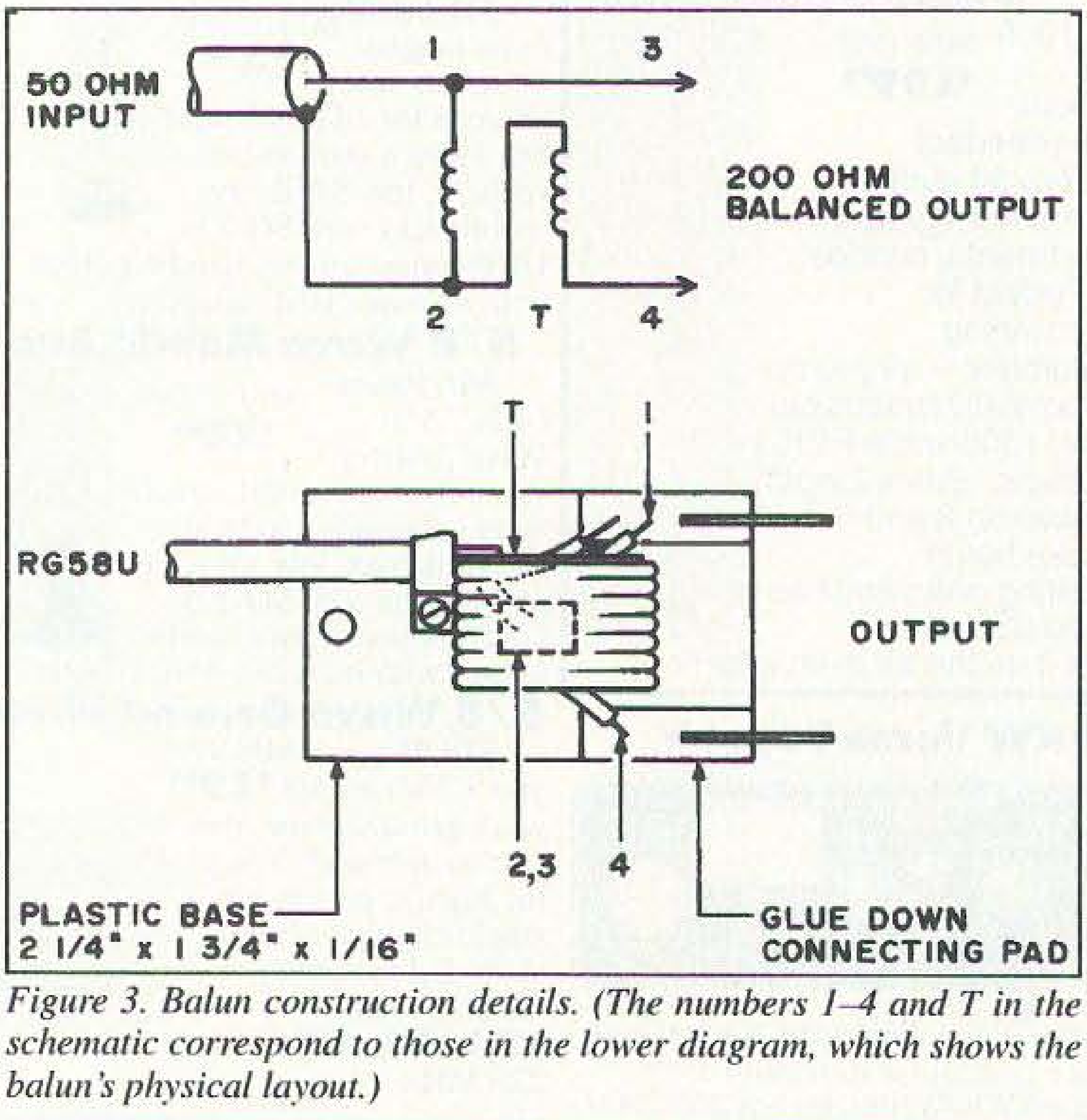


Figure 3. Balun construction details. (The numbers 1–4 and T in the schematic correspond to those in the lower diagram, which shows the balun's physical layout.)

Correction Factors for Selected Diodes

Vp In	Vp Out	Factor
5.0	4.88	1.02
4.0	3.90	1.03
3.0	2.87	1.04
2.0	1.89	1.06
1.0	0.92	1.09
0.8	0.72	1.11
0.6	0.52	1.15
0.5	0.43	1.16
0.4	0.33	1.21
0.3	0.24	1.25
0.2	0.15	1.33
0.1	0.06	1.67
0.05	0.02	2.5

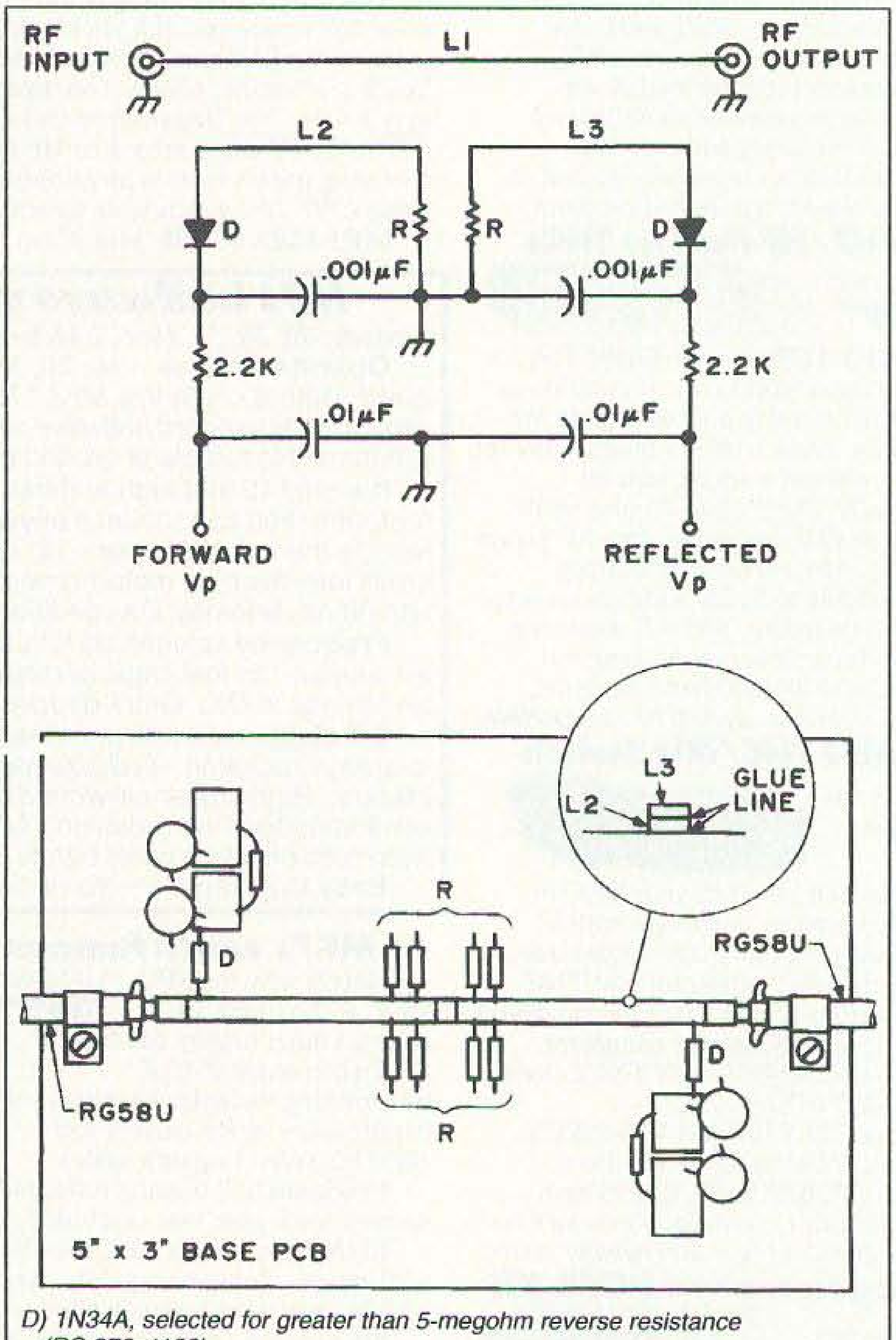
My tests of this configuration show near identical results at 28 MHz, but the frequency response becomes sharper—about -1 dB—at 14 MHz. When fabricating the transformer, you must hold the wires close together to achieve the desired distributed capacitance between wires. Do this by making the form length the same as the bi-filar coil width, and strapping the two together.

For the strapping I used two pieces of masking tape about 1/4" wide. I wrapped them through the form center and around the wire, then coated the masking tape with an all-purpose adhesive (RS 642307). In forming the coil, first wind the wire on a mandrel smaller than the actual form to make certain the wire has a snug fit when placed on the final form.

Directional Coupler

This antenna, which is essentially an end-fed wire dipole, has a significant Q (about 13). Since the 10m band is so wide (28–29.7 MHz), a high-Q antenna there will give high SWR values at the band edges, so it's important to accurately trim the 1/4-wave stub length (shorting bar position), and adjust the balun connecting position for minimum SWR. You can do this easily by using a simple home-made directional coupler.

The directional coupler detailed in Figure 4 uses glue-down 1/8" wide PCB



D) 1N34A, selected for greater than 5-megohm reverse resistance (RS 276-1123).
L1) 3 1/2" x 1/8" x 1/16" glass epoxy PCB, either single- or double-sided copper (RS 276-1591). Glue to base PCB with adhesive (RS 64-2307).
L2) 1-1/4" x 1/8" x 1/16" glass epoxy PCB, either single- or double-sided copper. Glue to top of L1.
L3) Same as L2; leave about 1/32" spacing between ends of L2 and L3.
R) Select for minimum reflected power. About 36 ohms (100-100-150-1k in parallel).

Figure 4. Directional coupler.

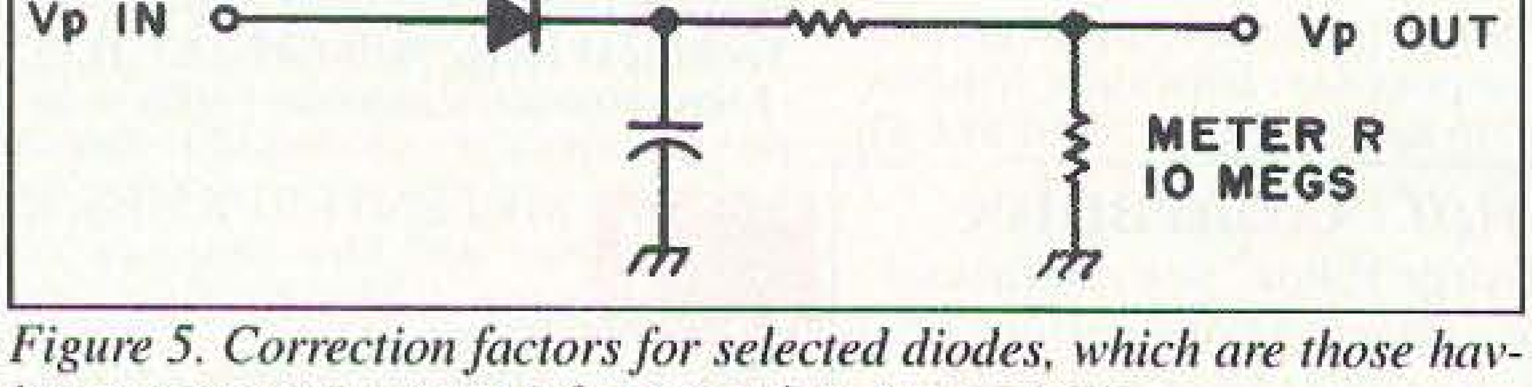


Figure 5. Correction factors for selected diodes, which are those having a reverse resistance of greater than 5 megohms.

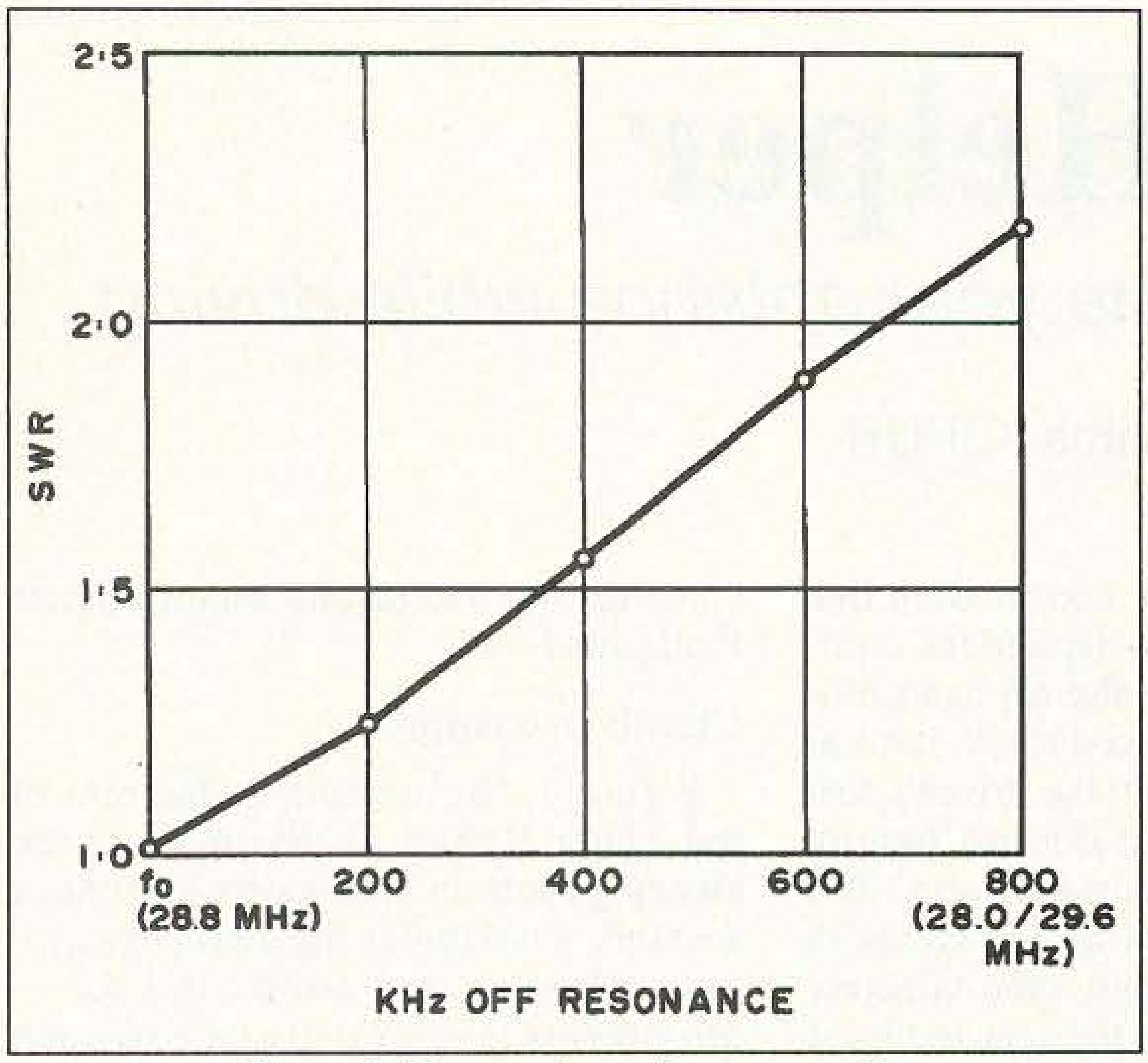


Figure 6. Measured standing wave ratio.

strips. Directional current is detected with short strips glued to the top of a transmission stripline. Resistor terminations on these coupled strips cancel the effective coupled output in one direction. These terminations are trimmed for minimum SWR indication with 20-watt or more input into the directional coupler and loaded with a 50-ohm dummy load. My dummy is 20 1k 1/2-watt resistors in parallel, immersed in a pint of cooking oil.

The termination resistor is actually four 1/4-watt resistors in parallel, which lets you select various resistor values to establish minimum reflection indication. My assembly uses 100-100-150-1k-ohm resistors. This value will be different for different assemblies, depending upon the PC thickness and dielectric constant. When aligned, and with 20-watt input, the coupler output should read about 2 Vp in the forward direction and less than 0.1 Vp in the reflected direction (SWR = V(fwd) + V(ref)/V(fwd) - V(ref)). 1N34A diodes with a reverse resistance of 5 megohm or greater give reliable Vp readings up to less than 0.1. Correction factors for the low voltage readings are indicated in Figure 5. (Since sensitivity is directly proportional to frequency, this directional coupler works well in the VHF/UHF frequency range.)

Alignment is simple when using the directional coupler. Simply slide the shorting bar and the balun connecting position for minimum reflected Vp. The adjustments are rather critical, but it is not too hard to obtain an SWR of less than 1:1. The final measurement results are shown in Figure 6.

Cover More Angles

I compared the vertical antenna performance with that of my horizontal antenna using a coax relay to switch quickly between the two. My horizontal antenna is a center-fed long wire with dominant nodes in specific directions (66 feet long).

The antennas complemented each other very well. As mentioned above, the vertical tended to perform better on low-angle skip; the horizontal on high-angle skip. It was also handy to be able to switch between the two to find a better S/N ratio, depending on whether vertically or horizontally polarized ambient noise dominated.

For little money and a few hours of home-brewing, I improved my DXing considerably! 73