

A Big Signal from a Small Lot

Good things often come in small packages. Consider N7RK's 60-foot vertical, a proven top-notch DX contest antenna.

By David S. Hollander,* N7RK, ex-WB6NRK/7

Regardless of what others throughout the rest of the country may think, not every radio amateur in Arizona has 10 acres of land or more on which to farm exotic antennas for DXing. On the contrary, indeed, many of us in the Grand Canyon state reside in apartments or homes with little or no space for outdoor antennas. Where there is space, most likely it is insufficient for installing an aerial designed for use on 75 or 80 meters, much less 160.

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Among these city dwellers living in the shadow of such limitations are many amateurs, like myself, who prefer operating on the low-frequency bands. Some, perhaps, have resigned themselves to the facts of their individual lives and settled for operation on 10, 15 or 20 meters or the uhf bands. Although I was faced with similar restrictions, dismay was not about to rule me out of my favorite bands. In the end I erected an antenna that rewarded me with a gratifying amount of DX and helped me earn a position in the top brackets of the 1976 DX contest on 160!

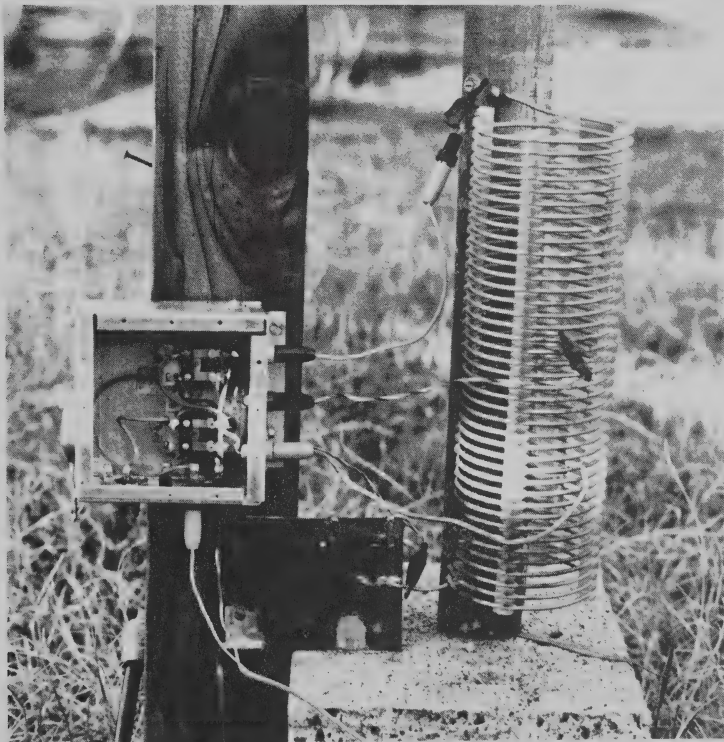
The long winter nights of 1975, during which I was living in an apartment in Tempe, AZ, gave me the opportunity to observe that DX-minded amateurs on 75, 80 and even 160 were communicating across the oceans with modest amounts of power and, seemingly, with little difficulty. As I scanned these frequencies night after night, my desire to be a part of this DX action became more fervent. I realize that some QST readers may reason that if DX happens to be my goal, I should simply switch to 10, 15 or 20 meters. My ready-made rebuttal, of course, is that DXing on these bands lacks the challenge to be found on 75, 80 and especially 160 meters.

From Horizontal to Vertical

Conditions at the apartment where I lived that winter were such that I could install a 150-foot horizontal antenna. This end-fed wire, however, left much to be desired as far as DX is concerned. After all it was only 20 feet above ground. As a result the angle of radiation was very high. The best compliment I can give this antenna is that it did more to keep my interests aglow than anything else.

An observation I made that winter coincided with antenna theory dating back to the early days of radio. The best DX on 75, 80 and 160 meters came from stations having vertical antennas. This seemed particularly true on 160. Of course, an exception might occur if an amateur station had a horizontal antenna suspended 120 feet above ground. In a practical sense, however, such a situation is quite unlikely for the amateur whose residence is on a small city lot.

In time, I moved from the apartment to a house. While this transition gave me more personal freedom to work with antennas, the lot size, just 60 × 25 feet (18.3 × 7.6 m), offered no advantage for stringing up a suitable wire antenna for my favorite bands. No longer could I have a 150-foot antenna. In fact the smallness of the yard precluded the erection of even a half-wave antenna for 40 meters. Nevertheless, I was not dismayed by the prospects of being unable to string out a skywire.



The N7RK antenna loading coil and relay box. Transmitting-type air-wound coils such as used in this photograph may be found in surplus military gear, dismantled broadcast transmitters or may be obtained from G. R. Whitehouse & Co., 11 Newbury Dr., Amherst, NH 03031

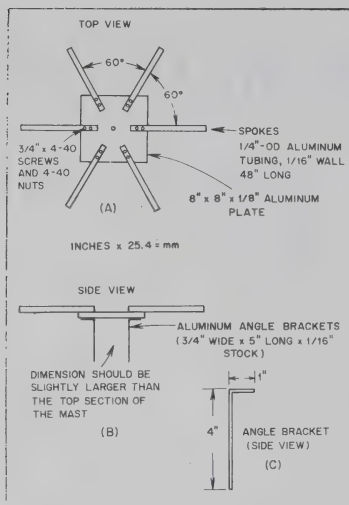


Fig. 1 — Construction of the N7RK vertical antenna capacitance hat. Each spoke is fastened to the aluminum plate by means of 3/4 × 4-40 machine screws and 4-40 nuts. The capacitance hat is fastened to the mast by means of plumbing or automotive hose clamps. To obtain good continuity between the hat and the mast, a length of wire mesh braid should be brazed to the mast and secured to the aluminum plate with the use of a solder lug and machine screw.

Long before leaving the apartment, I had firmly decided that my next antenna would be vertical. For that reason, the dimensions of the lot were of minor concern. Anxious to be ready for the next DX season, I experienced no difficulty in being motivated to erect a 60-foot radiator. Preparations began soon after getting settled at the new location.

That I decided upon a height of 60 feet was largely a matter of the material on hand. For some time I had saved some tubular TV masts, thinking that the day would come when they would be useful for my Amateur Radio activities.

Obviously there was little choice in where to locate the antenna. It could be erected in the middle of the yard or close to the house. My decision was to forgo any technical advantage of having the mast in the middle of the yard in order to leave that area free of any encumbrances. Instead it now stands against the carport. Placing the mast at this location enabled me to secure it to one of the 4 × 4 supports for the carport roof. Clamps placed at the 3- and 8-foot levels hold the mast firmly against the wooden upright.

About Construction

The material on hand consisted mainly of a 50-foot (15.2-m) telescoping TV mast. This turned out to provide a length of 44 feet when assembled. Consequently an additional 16-foot section was needed.

A capacitance hat, illustrated in Fig. 1,

furnishes additional electrical length. The hat has six 4-foot tubular aluminum spokes equally spaced atop an aluminum plate. Each spoke is fastened to the plate with machine screws.

The mast is guyed at the 35-foot level and a point 2 feet below the top. I used ordinary TV guy wire, such as one may obtain at most electronics stores. To prevent any unwanted resonances occurring along the guys, each wire is broken at random points with insulators installed between the segments. Turnbuckles provide means for tightening the wires. Anchor points are each 25 feet from the base (two on the house and one on a fence post).

Purists might cast a jaundiced eye at my method of supporting the bottom of the mast above ground. Lacking a suitable insulator, I simply placed it atop a cinder block. No appreciable loss seems to have resulted, however.

The Ground System

A ground rod alone is usually not considered to be an effective means of providing a ground for a vertical antenna. Explanations to this effect are found in *The ARRL Antenna Book* and other texts. The ideal ground system would have been 120 radials, at least 1/2-wavelength long, spaced equally around the base of the antenna every 3 degrees.¹ Inasmuch as the distance from the base of the antenna to the end of the yard was only 60 feet, such an installation was slightly out of the question. Instead, I used far less than that amount. Indeed, amateurs often obtain good results with far fewer radials. My situation is a case in point.

Because of the space limitations at my new home, my ground system had to be

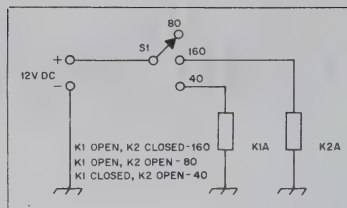


Fig. 3 — Band changing of the N7RK vertical antenna system is simplified by this relay control system. A two-conductor control cable to the remote outdoor tuning system is required. The ground return is by way of the coaxial feed-line braid. S1 is a single-pole, three-position rotary switch located on a control box in the station.

far short of the ideal. I compromised by laying out 20 radials of no. 12 copper wire, 60 feet in length and buried 3 inches in the ground.

After reading further on the subject of ground systems,^{2,3} I learned that if only a small number of radials are used, there is little point in extending them out 1/4 or 1/2 wavelength. I reasoned that 1/8 wavelength would have been adequate for my installation. According to the literature I read, a large number of radials, even though short, are preferable to a few long radials. Most of the ground losses seem to occur near the base of a vertical antenna. Therefore, within reason, the more metallic surface area a radial system has near the base, the lower will be the ground losses.

Antenna Matching

In order to obtain a good antenna match for each of the bands, I relied mainly on a dip oscillator, an SWR indicator and a bit of cut and try. Arbitrarily, I decided to adjust the antenna first for operation on 75 meters. With the oscillator coupled to the base of the mast, I noted a dip that occurred at 3 MHz. This also indicated that the antenna was approximately 1/4 wavelength long at that frequency. However, at 3.8 MHz it would appear to be longer than 1/4 wavelength, with inductive reactance being evident at the feed point. To cancel this reactance, I inserted a capacitance of 300 pF in series with the antenna, as shown in Fig. 2. I arrived at that value purely by experimentation. Four 1200-pF, 500-V dipped-mica capacitors wired in series provide the 300-pF capacitance.

A 60-foot vertical antenna will display capacitive reactance at the feed point when operated on 160 meters, because it is electrically shorter than 1/4 wavelength. To cancel this capacitive reactance, inductance must be introduced into the antenna circuit. Fig. 2 shows this inductance, L1, in series between the antenna and the ground. Taps on the coil enable it to be used for both 160 and 40 meters. Although the tap points I use for L1 are indicated in the caption for Fig. 1, they

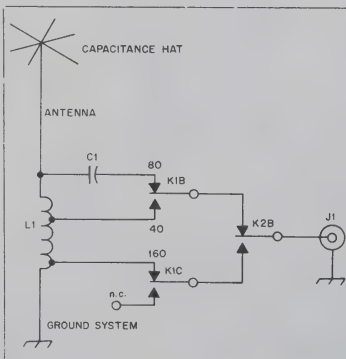


Fig. 2 — Antenna matching system for the N7RK vertical. The ground system consists of 20 radials of no. 12 copper wire, each 60 ft long (see text). L1 is a B & W no. 3035 coil tapped at 7 turns from the top and 4 turns from the bottom. Four 1200-pF fixed capacitors in series are used for C1. K1 and K2 are Potter and Brumfield KRP11DG dpdt 12-V dc relays with 10-A contacts. Only one set of contacts is used for K2. J1 is an SO-239 uhf connector.

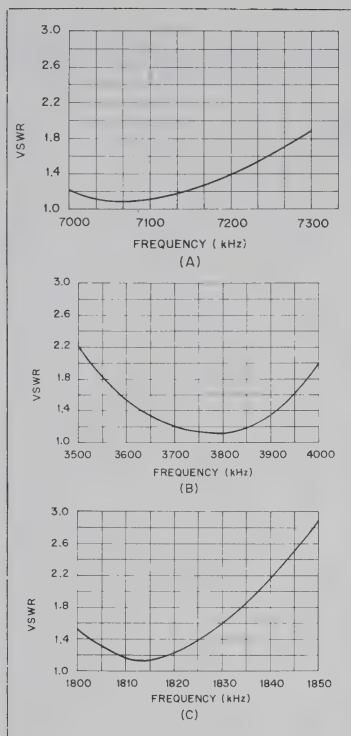


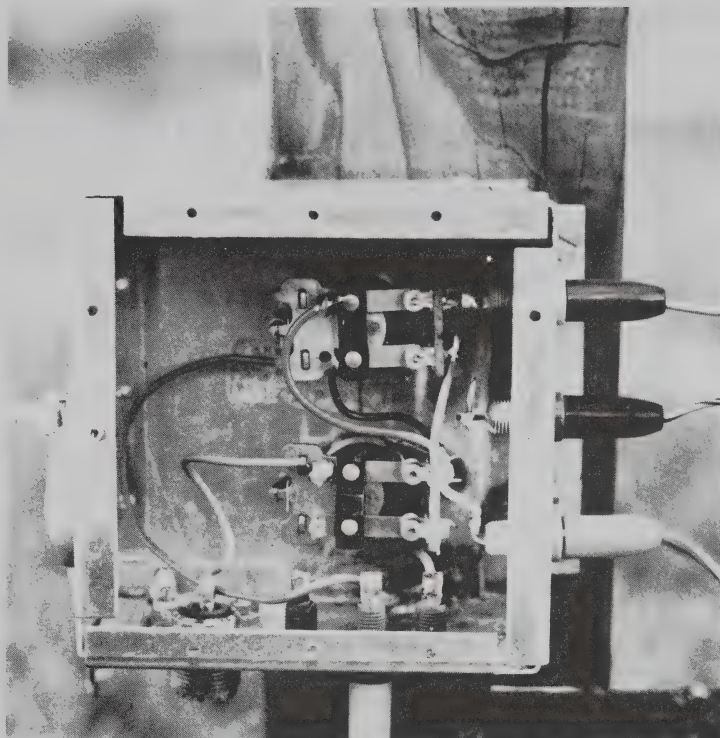
Fig. 4 — The three graphs compare the VSWR versus frequency for the N7RK vertical antenna for the 40- through 160-meter amateur bands.

may not be the same at other installations. Proper tap adjustment and minimum SWR are obtained rather easily by experimentation. Fig. 4 shows the results of SWR measurements at N7RK.

Control System

The simple control system illustrated in Figs. 2 and 3 eliminates trips to the antenna each time a switch from one band to another is made. L1 is a Barker and Williamson no. 3035 inductor. If one is not available, a suitable substitute would be an air-wound coil 2 inches in diameter (51 mm) having 40 turns. Such inductors are often found at flea markets or are offered for sale by surplus dealers. These same sources may also have a relay that is equivalent to the Potter and Brumfield 12-V unit no. KRP11DG that I use. A good idea is to check the coil voltage rating. For example, Potter and Brumfield makes this model with coils for 6, 12, 24, 48 and 110 V dc.

The relays should be protected from the weather by a suitable housing. I chose not to enclose the inductor perhaps because of the generally favorable weather conditions in my area. For regions subject to much moisture, enclosing both the coil and the



This close-up photograph shows how the antenna changeover relays are housed at the base of the N7RK vertical antenna. The relays, remotely controlled from the shack, provide quick band changing.

relays seems desirable. Plastic freezer boxes are relatively inexpensive yet quite satisfactory for this purpose.

Only a two-wire cable from the shack to the changeover relays is required for the control circuit. The coaxial-cable braid may be used for the ground return. My relays are operated by a homemade 12-volt unregulated supply. Relays of other voltage ratings may be used, of course, but in such cases the supply voltage and current must be compatible with the particular relay to be used.

Antenna Performance

As evidence of success with this vertical antenna, let me offer these results. In the 1976 ARRL 160-meter contest I logged 345 QSOs and had 73 multipliers and 48 states. That earned me the second-highest score in the West and made me the winner for the state of Arizona. Furthermore, I established ocean-hopping contacts with Japan and New Zealand. I've worked ZL2BT several times on phone and cw. I should also point out that all of these contacts were made with just 200 watts input.

The success I've experienced with this antenna didn't end there. Over a six-month period I worked 97 countries on

the 75-meter band. Many European stations were worked, even though that part of the world is generally difficult to contact from this section of the United States. An advantage I had on 75 meters, I will admit, is that I used a full kilowatt input.

Because the antenna also performs well on 40 meters, I've had rewarding experiences on that band, too. Not only do my 40-meter contacts include European stations but also stations deep in Asia. I have log entries for call signs such as VU2, 4S7, UJ8 and VQ9, all worked on the long path according to my friends with rotary antennas. They told me which direction the signals were from since I couldn't rotate my vertical!

If you have little room to install a typical wire antenna for the lower frequency amateur bands, consider the results I've obtained with this antenna. The world could be at your fingertips with the help of a simple 60-foot stick.

Notes

"Grounding Systems," *The ARRL Antenna Book*, 13th edition, 1974, p. 61.

²See note 1.

³Stanley, "Optimum Ground Systems for Vertical Antennas," *QST*, December 1976.