the half-square antenna

Practical information on feeding and operating this popular radiator

The half-bobtail or half-square antenna has begun to receive a substantial amount of attention in recent Amateur publications. This versatile antenna has yet to make the impression it deserves in actual field use, however. This is due, in my opinion, to a lack of practical information regarding methods of feeding it.

The purpose of this article is twofold. First, it is to discuss examples of feed systems for the half-square antenna that are currently in use at several stations in widely varying environments. Second, it explores the virtues of this antenna as a multiband performer.

The theory of operation of this antenna has been discussed by Ben Vester, K3BC.[1] Interested readers may refer to the bibliography for additional background.

feed system

The basic layout of the antenna is shown in **fig. 1**. Of primary interest to most Amateurs (beyond performance) is how to connect the coax and get the antenna fired up.

Several feed methods have been examined in terms of available parts, weathering, and ease of adjustment. By far the simplest is the parallel-tuned tank circuit (**fig. 2**).

Network *L1C1* should resonate at the desired operating frequency. The values of *L1* and *C1* are calculated by:

$$LC = \frac{25{,}350}{f^2} \qquad (1)$$

where L = inductance (mH)
C = capacitance (pF)
f = frequency (MHz)

A large value of L for a given frequency is desirable, because it decreases the Q of the LC network, thus increasing the bandwidth of the feedpoint. A value of 13 μH was chosen for L; therefore, for C at 7.15 MHz:

$$C = \frac{25{,}350/7.15^2}{13} = 38.1\,pF \qquad (2)$$

In practice, a few additional turns for *L1* are needed. So two or three turns are added (3 μH) to the calculated value for *L1*. In my case, L is made of 15 turns of B&W No. 3033 3-inch (7.6-cm) diameter coil stock, but any 15-μH coil of No. 14 (1.6 mm) or larger wire will handle a kilowatt output.

Coils are easy to procure or wind, but capacitors are expensive, difficult to find, or both. Also, should a variable capacitor be desired for *C1*, weatherproofing becomes a problem. Because of these constraints, I chose a homemade capacitor that could be made from inexpensive RG-8/U coax and easily weather-proofed with silicone sealant.

The capacitor value is calculated using **eq. 2**, and the appropriate length of RG-8/U cable is determined by the distributed capacitance listed in the literature for the properties of common transmission lines. For RG-8/U the value is approximately 30 pF/foot (98.4

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pF/meter). Therefore, if 38 pF is required, the desired length is found by dividing the capacitance per unit length for RG-8/U into the desired number of picofarads. That is, *30 pF/12 inches = 2.5 pF/inch (0.98 pF/cm)*, so that *38 pF/2.5 pF/inch = 15.2 inches or 38.6 cm*. A 15.2-inch (38.6 cm) length of RG-8/U will provide a 5-kV capacitor at inconsequential cost. Weather-proofing is important.

It is important to note, however, that until the sealant has cured, it is not an insulator and will short out the capacitor at the treated ends. The capacitor need not slow the project down; rather, it can be assembled and weather-proofed first and set aside to cure while the rest of the project is carried out.

Refer to **fig. 3** for capacitor details. The capacitor is formed by the center conductor on one end and the shield on the opposite end. Treat both ends (except for the wire at the connection point) liberally with silicone sealant. This produces a reliable capacitor that will stand high power levels.

The feed system is completed by the input tap setting. A good initial setting is to tap up from the ground side two to three turns for 50 ohms. By using an SWR bridge at the antenna, the tap may be set exactly for a 1:1 SWR at any part of the band you desire. The following is an adjustment procedure that has proven effective (refer to **fig. 4**):

1. Set input (low-side) tap at 2½ turns up from ground.

2. Set high-side tap at one turn greater than predicted in calculations.

3. Measure SWR across band and note the low point; this is primarily influenced by the high-side tap. If the low point is not in the area of the band you desire, move the tap higher for a decrease in frequency or move the tap lower for an increase in frequency.

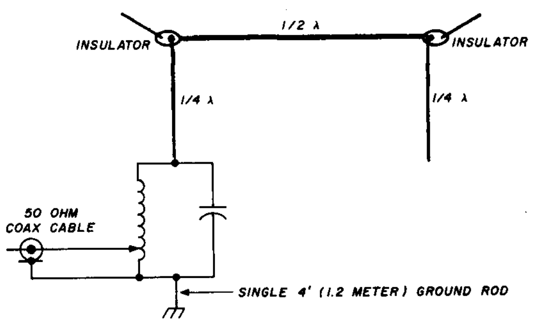

fig. 1. General arrangement of the half-square antenna, which originally appeared in *QST* and later in reference 1. It was described in these publications by Ben Vester, K3BC.

4. Once the low point of SWR has been set at the desired portion of the band (no matter what its value), proceed to adjust the low-side tap ¼ to ½ turn at a time to get a match of 1.2:1 or better at the desired operating frequency.

I've used this approach in three different environments. It has resulted in a match of 1.1:1 in no more than twenty minutes.

multiband operation

As may be seen from the wavelength relationships of **fig. 1**, this antenna, when constructed for 40 meters, is resonant on several other bands. By merely changing the feed system slightly, the antenna will perform very well on harmonically related bands. For example, the 40-meter array may be operated on 20 meters as a pair of half-wave verticals spaced one wavelength apart. While the phasing is not ideal, the performance of this antenna is very impressive, given the investment of time and money it requires. **Table 1** shows the manner in which the antenna can be operated on harmonically related bands and what feed point changes are needed.

performance

At the time of this writing, this antenna has been evaluated in two ways. First, it has been compared

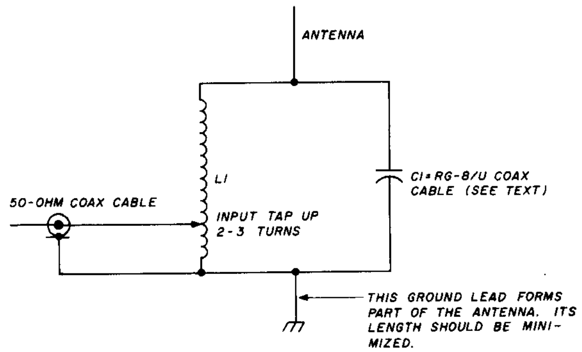

fig. 2. Antenna tuning network consists of a parallel-tuned circuit, which features simplicity and ease of adjustment.

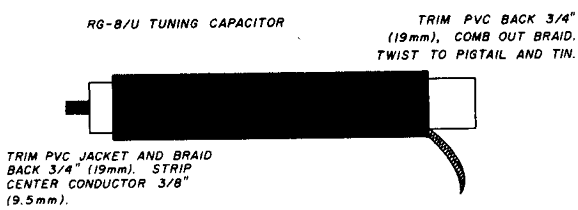

fig. 3. Construction details for the network capacitor.

(by instant switching) with on-site antennas. In comparison with a full-wave loop vertically polarized and mounted 8 feet (2.4 meters) off the ground, the half-square array consistently outperformed the loop by two to three S-units. There were virtually no instances where the loop was superior to the half-square, regardless of time of day, bearing, or distance. The period of these observations was approximately one month of daily use.

This same comparison, that is, loop to half-square, was made in terms of communication effectiveness during the recent ARRL phone SS contest. For a similar 15-minute period (in the same half hour) the half-square array produced over double the number of contacts that were achieved with the loop.

table 1. Characteristics of the half-square antenna as an harmonic radiator. Band design: 40 meters.

Amateur band	antenna operates as	feed
160 meters	¼λ Marconi	bypass tuning network and feed against ground
80 meters	½λ end fed	add ≈ 100 pF across existing coil cap. Input tap need not be readjusted.
40 meters	half-square array	as designed
20 meters	pair ½λ verticals spaced 1λ	tap coil for fewer turns (total). Retap input. Change tuning cap.
10 meters	pair 1λ verticals spaced 2λ	tap coil for fewer turns (total). Retap input. Change tuning cap.

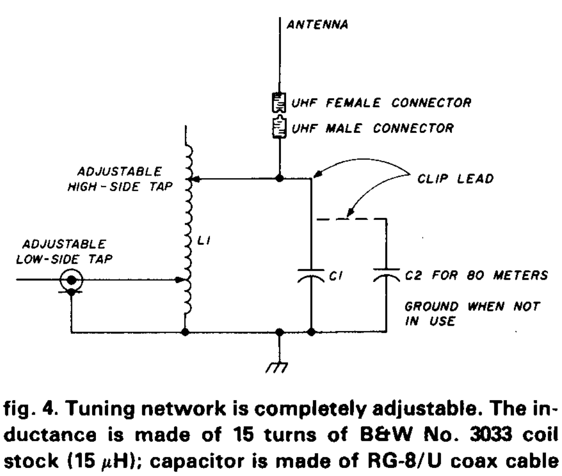

fig. 4. Tuning network is completely adjustable. The inductance is made of 15 turns of B&W No. 3033 coil stock (15 μH); capacitor is made of RG-8/U coax cable as described in the text. In this arrangement C1 is 38.1 pF. System resonates at 7.15 MHz.

In a second comparison, the half-square array was compared with a roof-mounted trap vertical with eight radials. Again, in virtually every case, the half-square array was superior. The half-square's superiority was 3 to 5 S-units.

In my own application, the half-square was compared with a center fed 130-foot (40-meter) dipole, at 35 feet (10.7 meters), using balanced wire feed and a tuner. During the day, the systems were nearly equal, with a slight edge given to the dipole. As soon as the sun set, however, the half-square array emerged as a truly superior, if not an amazing performer. My half-square pattern is broadside east-west. I frequently operate between 1130 and 1300Z from fall through spring. Each morning, I work approximately five to ten JAs with a mean signal report of 589 using a kW. In addition, I have worked VKs, ZLs, H44, and YB9 as well as other scattered Pacific and Asian countries. In the recent CQ WW phone contest, I was able to compete in the pileups with the "big guns" for the very first time. It was rare for me to make more than four attempts to raise anyone. Countries in Africa and Europe were worked during the test as well as in Asia and the Pacific.

closing remarks

It seems we may have hit upon a complete antenna for a variety of Amateurs. It has proven to give high performance for DX as well as being more than adequate for normal use. It is efficient and easily fed. The half-square array is economical both in terms of initial investment and multiband applicability. The next time you get the bug to experiment with an antenna, try the half-square array. It may end your experimental urges (because of its high performance), or it may further stimulate you to try the extended approaches of parallel arrays recommended by the original author, Ben Vester. See you on 40, 160, 80, 20 and 10.

acknowledgment

I wish to thank KØCQ for advice as well as AIØZ and WDØERH for their hours of comparisons and willingness to try something new with something old.

reference

1. *The ARRL Antenna Anthology*, American Radio Relay League, 1978 edition, pages 81-83.

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