an efficient all-band tuned-dipole

Getting maximum efficiency from an outstanding multiband antenna

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The most popular antenna for 80 and 40 meters is the dipole. For the higher frequencies, the rotary beam is the favorite. However, there is much to be said for the all-band antenna, and the one described here will outperform a three-band Yagi in the dipole's favored direction and will only be about 6 dB down from the Yagi off the dipole's ends.

The average three-element three-band beam is actually very inefficient in transferring power from the transmitter into the ionosphere; it merely transmits its radiated power in a focused beam. Losses due to standing waves, mismatch and imbalances all reduce the efficiency so that the gain over an efficient reference dipole is not as great as it seems.

A well-balanced, highly-efficient tuned dipole, properly matched to the transmitter, radiates more power than does the untuned, unbalanced, coax fed dipole of a three-band beam. However, it wastes a lot of energy in unwanted directions while the less-efficient tribander makes the best use of whatever power it does radiate. Overall, the tribander does the better job.

The purpose of this article is to describe an all-band dipole which gives normal performance on 80 and 40, but competes favorably with a three-element beam on the higher frequencies. Apart from its ability to lay down a good signal, the antenna has attributes not possessed by a tribander.

basic design

The basic design is simple and well known. Take two pieces of 14 gauge wire 132 feet long, and use anything from 54 to 65 feet of each to form half of a center-fed dipole between 108- and 130-feet long. Use all of the remaining wire to build an open-wire transmission line with six-inch spacing. How to dispose of the feedline is a problem for the individual to solve. The result is an open-wire-fed dipole which is, effectively, a half wave on 80 meters with quarter-wave feeders. If your masts are less than 108 feet apart, arrange matters so that 8 or 10 feet at each end of the dipole drops vertically, but stop these dangling ends from swinging in the wind.

The feedline at ZS6BT is 78-feet long, and the antenna is 40-feet high. There is a six-foot length of feeder in the shack, and 30 feet goes vertically to the dipole. The remaining 42 feet runs horizontally at a height of 10 feet and is strung between the shack and a pole 10 feet high. It is held taut by a pair of turnbuckles, and there are no spreaders on the horizontal feedline.

The antenna is tuned by a balanced-to-unbalanced Z-match tuner connected through six feet of 50-ohm coax to the transmitter. Because of the quarter-wave feedline on 80, parallel tuning is used on all bands. There is no need to describe the tuner as many good designs have already appeared in the various amateur magazines and in the *ARRL Handbook*. The Johnson *Matchbox* does the job well and the tuneup information in this article is based on the *Matchbox.*

It is essential to use an swr bridge in the coax between the transmitter and the tuner. A twin-meter frequency-independant instrument is ideal, but any bridge will do. The idea is to tune the antenna to frequency anywhere in any band and to reduce the standing wave on the coax to zero. This produces a very efficient antenna.

There is no need for diagrams at this stage. A beginner could put up the antenna from the written description, and he would have an excellent all-band antenna. There are probably many such already in use. Radiator length is not important, as can be seen, and we need not be particular to 6 inches with the 132 feet of wire. The secret does lie in having quarter-wave feeders.

What we have done, to date, is describe a normal antenna which is an excellent performer on 80 and 40, and a reasonably good performer on all bands 80 thru 10. By strapping the feeders together and working against a good ground, it does an excellent job on 160 as a T. At ZS6BT, I copy North Americans on 160 and have been heard on that band at 2,000 miles with 10 W input.

improvements

Now, to that wasteful radiation from a dipole. There is nothing we can do about 80 and 40, but much we can do about the other bands. If we stack two dipoles, one above the other, and drive them in phase, we pull down a lot of that wasted upwards power and force it broadside to good effect. Stacked, driven dipoles and all-band performance do not go together very well.

If we sling a parasitic reflector, a half wavelength long and a half wavelength below a dipole, we have the proper phase for broadside performance, even though we do not have the efficiency of the driven array. Moreover, this reflector interferes with the ground effect and tends to alter the angle of radiation beneficially. Once we consider that we can sling two such reflectors in-line for 20, three in-line for 15 and five in-line for 10; we see a chance for considerable improvement.

Neither reflector length nor spacing is all that critical. In fact, if we narrow the spacing we may correct the phase by lengthening the reflector. If we have not sufficient head-room on 20, we may lift the reflectors another 5 feet and lengthen them by about 5 feet without ill effect.

Fig. 1 shows the arrangement and normal dimensions. The idea can be tried out on existing dipoles too.

tuneup

The initial tuneup of the antenna should be done with the aid of a dummy load, in order to calibrate the antenna tuner, and thereafter band changing will be a simple matter.

On each band, tune and load the transmitter into a dummy load until the swr bridge shows maximum forward current; of course, there should be no sign of reflected current.

Do not touch the transmitter tuning and loading controls, but couple up the antenna and tuner and vary the tuner controls until you obtain (a) the same forward current that was seen with dummy load and (b) no sign of reflected current. You see why a twin-meter bridge is best; you can read both directions simultaneously. Make a note of the tuner dial settings for future use.

In normal use, set the tuner controls appropriately and load up. Then tune out the last vestiges of reflected current and leave the bridge measuring reflected power. As you move around in the band, see that you maintain a zero on the bridge meter.

Now, about the bonuses which the tuned dipole can offer. It will attenuate harmonics because it is not tuned to them. If you use a TVI filter the extra tuned circuit between transmitter and antenna will improve the filter performance.

On reception, be sure to tune the antenna to the right band or you may get poor results; you have an extra tuned circuit between antenna and the receiver input. For some, this may be an extra *bonus.*

Modern receivers do not suffer greatly from images, but there is a possible exception. With shortwave broadcasts running to megawatts, they can break through even though the first i-f is 4 MHz or so. They will do this more easily if the antenna will respond to the broadcast station's frequency. Even a three-band beam is not very frequency conscious on reception, in part due to pickup on the coax outer shield, but a tuned dipole tends to attenuate signals to which it is not actually tuned.

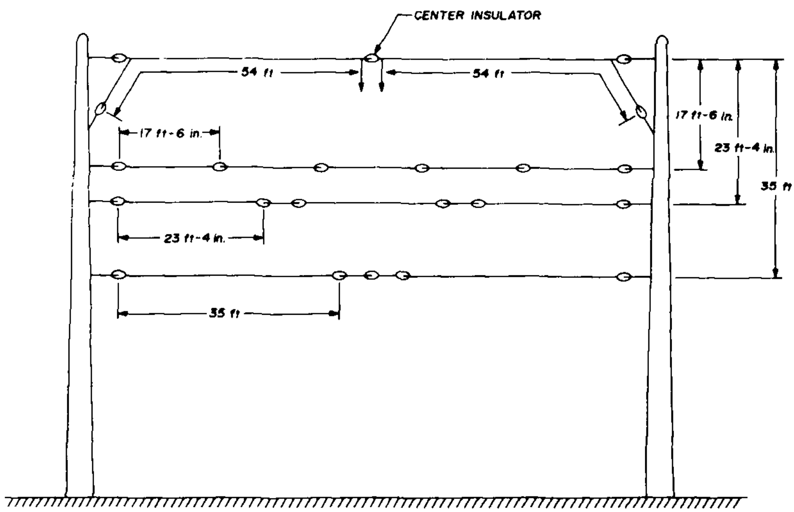

fig. 1. General arrangement and nominal dimensions for ZS6BT's all-band dipole.

There is no need to use particularly heavy guage wire for the reflectors as they are under no strain. The 20 meter, and perhaps the 15 meter reflector may be tied to the masts. The 10 meter ones may require halyards. To prevent unnecessary absorption, it is better to use nylon cord for guy wires and halyards.

160 meter operation

The first essential for 160 is a really good ground connection. Basically, the

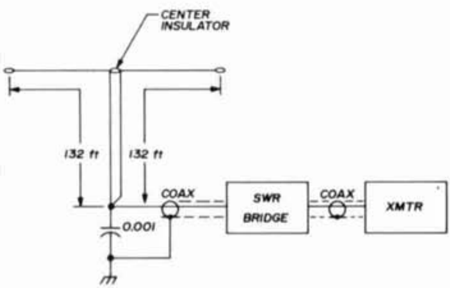

fig. 2. Arrangement for using the all-band dipole on 160 meters.

matching to the coax is done by an L-network. However, with a T antenna of the dimensions given, the L inductance appears to be unnecessary and only the capacitor is used at ZS6BT. Aim for maximum forward current and no reverse current on the bridge. My system is shown in **fig. 2.** The capacitor is an Aerovox Series 1650, 1200 V, 0.001 mF. The matching unit, therefore consists of a coax socket and the mica capacitor. Individual installations would call for some experimentation regarding matching.

During the past 45 years, most of the usual, and some unusual, antennas have been tried; most were up less than a year and not one gave six-band results which were acceptable. The present antenna has been in use for over eight years and there is no intention of trying any other. At last I am satisfied.

ham radio