HAM RADIO TECHNIQUES

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a nifty bi-square beam for 10 or 12 meters

The miserable DX conditions at the bottom of the sunspot cycle are but a bad memory. True, the higher frequency bands tend to fizzle during the summer, but they'll be back again with a bang as soon as the cooler fall months roll around.

If you're interested in DX operation on either 10 or 12 meters, you'll eventually need a beam antenna. You can work a lot of "easy" DX with a dipole, but sooner or later you'll wish you had a beam for the more exotic DX stations. An easy solution is to buy a Yagi beam kit, but it's less expensive to build your own wire beam from scratch. Here's an inexpensive beam for your consideration.

The Bi-square beam (**fig. 1A**) is a derivation of the so-called "Lazy-H" array, a favorite of point-to-point stations in the maritime and fixed services. The Lazy-H consists of two half-wave dipoles in phase over a similar pair of dipoles. Spacing between the top and bottom dipole pairs is a half wavelength. Proper phasing of the pairs is achieved with a transposed open-wire transmission line fed at the center of the lower pair of dipoles with a quarter-wave, open-wire stub. The feedpoint impedance at the bottom of the stub is about 220 ohms.

A more practical version of the Lazy-H antenna is the Bi-square beam, shown in **fig. 1B**. This arrangement requires only a single center pole support. The Lazy-H dipole pairs are connected together at the outer tips, resulting in a diamond-shaped wire arrangement. You can eliminate the transposed line connecting the center of the pairs. The quarter-wave stub is retained.

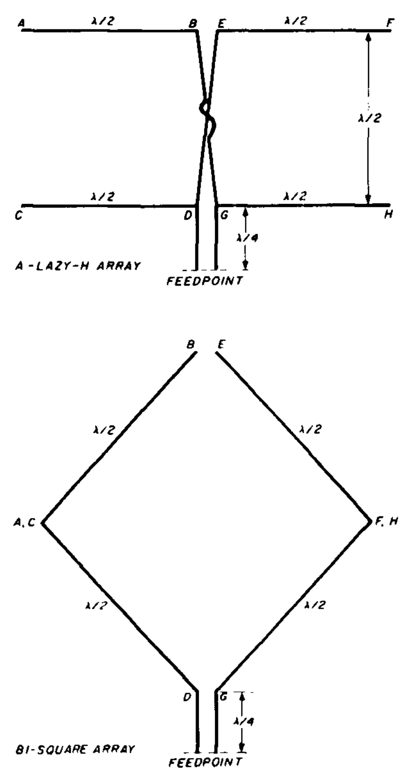


fig. 1 Simple bidirectional wire gain antennas: (A) lazy-H array and (B) bi-square array.

The feedpoint impedance at the bottom of the stub is close to 150 ohms. There is a reduction in feedpoint impedance because the top and bottom radiating elements of the Bi-square configuration are closer to each other than they are in the Lazy-H antenna.

The Bi-square radiation pattern is a figure eight (bidirectional) at right angles to the plane of the array. The power gain over a dipole located at the center height of the array is about 5 dB.

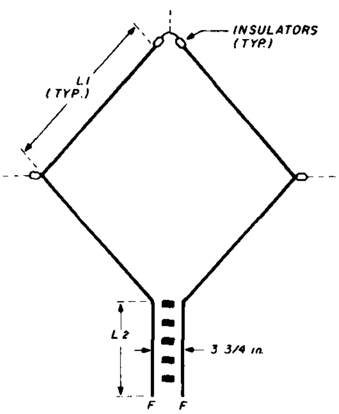
building the bi-square beam

The Bi-square is an easy, inexpensive beam to build. You'll need about 100 feet of No. 16 enamel or Formvar™ coated wire and four insulators. The quarter-wave stub needs five spreaders cut from 1/2-inch diameter phenolic (or plastic) rod. One of the spreaders serves as the bottom insulator for the antenna wires. The diamond-shaped antenna is open at the top (two insulators required). Overall height is a little less than 30 feet. I hung mine from a yard arm at the 45-foot level of my crank-up tower. The proximity of the metal tower to the plane of the loop didn't seem to cause any harm.

Dimensions for the 10- and 12-meter versions of the antenna are given in **fig. 2**. The sides are pulled out by ropes and tied off to convenient points on nearby trees. The bottom of the quarter-wave stub is about 7 feet above the ground.

The yard arm holds the loop about 3 feet away from the tower. The loop isn't quite in the vertical plane because I pulled the bottom of it 6 feet away from the tower in order to reach the bottom of the stub easily from the garage roof.

The Bi-square antenna's bandwidth is very broad; the antenna may be cut to the dimensions given without further ado. Purists may wish to trim the antenna to a specific frequency in the 10-meter band. Design frequencies for the antenna shown are 28.5 and 24.95 MHz. The 10-meter antenna covers the whole band with an SWR of less than 1.5:1 – quite an achievement!



FREQ. (MHz)	L1	L2
28.5	16 ft. 9 in.	8 ft. 4 in.
24.95	19 ft. 2 in.	9 ft. 5 in.

fig. 2. Bi-square antenna dimensions for 10- and 12-meter bands feedpoint impedance is about 150 ohms.

adjusting the antenna to frequency

It's easy to set the resonant frequency of the antenna "on the nose." The bottom of the stub (F-F) is shorted by a jumper that has a one-turn loop in the center. The loop is just big enough to fit over the coil of a dip oscillator. My shorting bar is made of two interconnected copper alligator clips so I can move it up and down the stub for adjustment. The dip oscillator is monitored in a nearby receiver. Move the shorting bar up and down the stub, an inch or so at a time, until the resonant frequency falls where you want it. Finally, cut the stub to the determined length.

matching antenna to feedline

As I stated earlier, the feedpoint impedance of the antenna is about 150 ohms. The antenna is symmetrical with respect to ground, and the feedpoint is balanced to ground. Two transformations are required to match the antenna to a 50-ohm unbalanced (coaxial) line. The 50-ohm point is first transformed from unbalanced to balanced by a 1:1 balun. The 50-ohm balanced condition is then transformed to 150 ohms. The first transformation is easy; I use a "Bencher ZA-1A" air-core balun which provides an excellent balance in the 10-meter region.

The transformation from 50 ohms to 150 ohms can be done in a number of ways. One is to use a ferrite toroid transformer (**fig. 3**). Take a core 2.4 inches in outer diameter and 0.5 inch high (Amidon FT-240-67, or equivalent) with a permeability of 40. Sand it to remove rough edges, and then wrap it with a layer of electrical vinyl tape. Wind 18 turns of No. 14 enamel wire around the core, tapped four turns from each end. Space the winding around the entire core. Fasten the completed transformer to a phenolic mounting plate with epoxy cement, and mount the assembly in a waterproof box for protection from the weather.

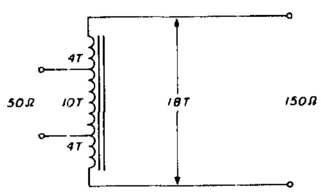


fig. 3. A 1:3 balanced transformer wound on ferrite toroid (Amidon FT-240-67).

a linear matching transformer

The second matching scheme uses a linear transformer, (**fig. 4**). The design is based on a balanced L-network. The circuit (**fig. 4A**) was built using a receiving-type variable capacitor for initial tests. The dimensions shown allow adjustment of the capacitor which quickly drops the SWR on the transmission line to unity at the design frequency of the antenna. The last step is to replace the variable capacitor with a fixed one and substitute a section of transmission line for the network inductors (**fig. 4B**). This works like a charm. A 50-μF, 5-kV ceramic capacitor (Centralab 850S-50Z, or equivalent) is substituted for the variable unit. Place it in a plastic refrigerator jar to keep moisture away. The short line section is made up in the same manner as the quarter-wave stub.

results

For a few days the dipole was left in position as a comparison with the Bi-square. In all tests, the Bi-square outperformed the dipole (usually between one and two S-units on transmit). On receive, signals that were almost in the noise were perfectly readable on the Bi-square antenna. No doubt about it, the Bi-square delivers the goods!

a 15-meter version?

The Bi-square should work well on 15 meters if you have the space. Multiply all 10-meter linear dimensions by 1.34 to get antenna size for this band.

W5LDA 160-meter antenna

Jim, W5LDA, has an interesting 160-meter antenna that incorporates a simplified feed system (**fig. 5**). He uses

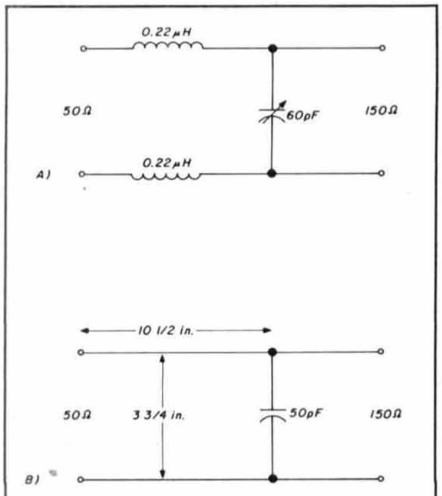


fig. 4. Linear matching transformers. (A) L-network uses lumped L and variable C (five turns, 1/2-inch I.D., No. 14 wire, eight turns per inch). (B) Linear network transformer made of No. 16 wire. Ends of wire are bent in 1 inch to connect to balun.

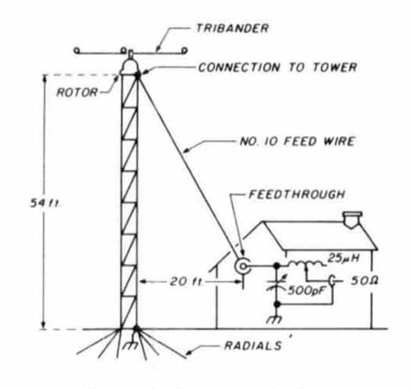


fig. 5. 160-meter folded unipole antenna at W5LDA. Rotor cable and coax for beam is strapped to tower leg.

his 54-foot tower (with a triband Yagi atop it) as a vertical, top-loaded radiator. Rather than fooling around with a gamma match on the tower (which can prove to be very tricky), Jim made his tower into a voltage-fed unipole antenna. He fastened a wire to the top, brought it off at an angle, and voltage fed the bottom end. The natural resonance of the top-loaded tower is such that only a simple matching network is required.

The base of the tower, as well as the shield of the coax running to the beam, are grounded at the tower base. Each lead of the rotor cable (not shown) is bypassed to ground at the tower base with a 0.01-μF, 1.6-kV disc capacitor. The leads are also bypassed to the tower at the rotor. (Jim learned the hard way that bypassing is important, after he burned out the rotor potentiometer atop the tower running 1500 watts on 160 meters!)

The coax and rotor cables are buried in a hose and run to the shack. Twenty radials, each 65 feet long, are fanned out on the surface of the ground beneath the tower.

The end of the wire is at a high voltage point and is brought into the station via a ceramic feedthrough insulator. A simple L-network matches the antenna to 50-ohm coax running to the operating position.

The antenna is very high-Q (narrow bandwidth); the network must be readjusted for a frequency change. It is possible to achieve 80-meter operation of the antenna by retuning the network.

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