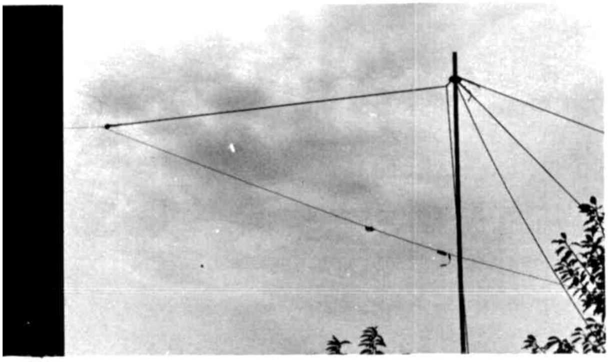

a multiband long-wire antenna

Design details for a low-cost efficient radiator

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Would you like a multiband antenna that favors the direction of hard-to-get states or countries, yet has good omnidirectional coverage? One answer is the long wire, a much neglected antenna that deserves more recognition.

The long wire is mentioned often in the literature. Information on feed methods is meager, however, which may be why it's seldom used. If you have about 300 feet of reasonably clear space, you can erect the long wire described here and enjoy excellent performance on 40 through 10 meters. Depending on the feed method, the antenna gives either unidirectional or bidirectional coverage, with substantial gain in the direction of the wire. Power gain over a dipole is from 1.2 to 7, corresponding to lengths from 1 to 12 wavelengths. (Numbers are ratios, not dB.) Minor lobes, concentrated near the center of the wire, provide omnidirectional response.

The single long wire is probably the simplest antenna you can build that will provide maximum gain for lowest cost and effort. Only two masts are required; however, one will do (at the far end) if you use your eaves to support the near end. The tilt thus provided increases radiation at the low vertical angles for DX, as discussed below.

principles

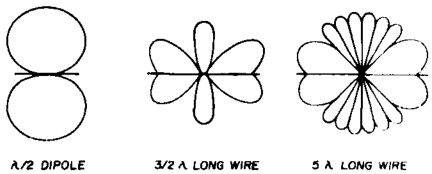
The dipole, which is one-half electrical wavelength long, is the simplest resonant antenna. Two major lobes occur at right angles to the antenna **(fig. 1).** If the wire length is increased in multiples of one-half wavelength, the antenna will also be resonant at these points. Additional lobes appear as the wire length is increased. The major lobes move in the direction of the wire, so that maximum radiation is concentrated off the end.

The longer the wire, in multiples of one-half wavelength, the greater will be its gain in the direction of the major lobes as compared to a dipole. The secondary lobes, **fig. 1,** give good omnidirectional coverage.

feed point

Resonant long-wire antennas can be center- or end-fed **(fig. 2).** A low-impedance point is made available at the center by making each leg an odd multiple of a quarter-wave-length long. Contrary to a rather wide belief that the precise length of a long-wire antenna is unimportant, the leg lengths must be accurately cut to obtain a low-impedance feed point.

fig. 1. Horizontal radiation pattern of long wire as a function of length.



A low-impedance feed point for end feed is found a quarter wavelength in from the transmitter end of the long wire. End feeding is a preferred method for two reasons. The antenna is more unidirectional with a higher gain in the direction of the long leg. The longer the long leg, the higher the gain and the more directive the pattern becomes off its end.

It is apparent from the above that a long-wire antenna can be erected to favor a given area. If a group of states give you trouble, point the antenna in their direction.

If you prefer a bidirectional pattern, use a center feed. If you live along the East Coast, the long leg can be pointed west. Conversely, for a western station, the long leg can be directed east. In the Central States you may prefer a bidirectional center-fed type, or perhaps you might want the end-fed unidirectional characteristic if you are having difficulties with certain states.

antenna length

Each leg must be an odd multiple of a quarter-wavelength for center feed.

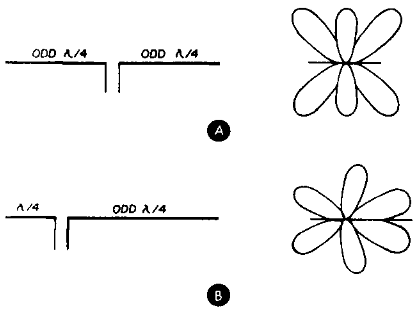


fig. 2. Center feeding the long wire, A, and end feed, B, with respective patterns.

$$\text{leg length} = \frac{246\ (N)}{f\ \text{MHz}}$$

Where N is the number of quarter wavelengths.

End effect is important on these long wires, and you must trim the legs evenly to reach a given resonant frequency. Start with the formula given above, and prune until resonance is obtained. Usually, the antenna must be shortened from two to six percent as a function of antenna height, tilt, and nearby conducting surfaces.

Antenna resistance is low and varies slowly with length, **fig. 3.**[1] **Fig. 4** shows two end-feed methods for different antenna lengths. Using the coax cable impedance shown, you can obtain a match with an swr of about 1.5:1 without a tuner.

The length of the short leg of the end-fed type can be calculated using the regular dipole equation. The long leg must be made some multiple of a quarter wavelength.

$$\text{long leg} = \frac{246\ (N)}{f\ MHz}\ (N)\ \text{feet}$$

$$\text{short leg} = \frac{234}{f\ MHz}\ \text{feet}$$

Again, the antenna legs must be trimmed carefully to find resonance and establish a feed-point impedance that can match the transmission line. Short sections should be trimmed off the quarter-wave segment to obtain resonance just as you trim an ordinary dipole. Because the long leg is so very long, you can trim off larger pieces of the antenna wire in moving toward the desired resonant point.

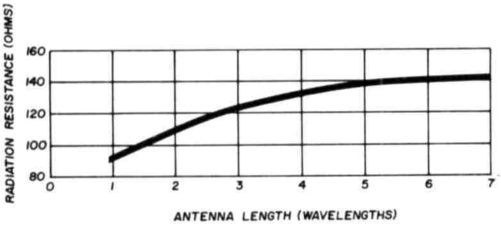


fig. 3. Change of radiation resistance with length of longwire antenna.

For the end-fed long-wire, it is helpful to first set the quarter-wave dipole leg to resonance. Then the longer leg is trimmed for a minimum swr. Two useful instruments for trimming this antenna are an swr meter and an antenna noise bridge. Always connect an swr meter in the line at some point that is a whole multiple of an electrical half wavelength away from the antenna feed point.

In fact, it is advisable to use a transmission line that is a multiple of a half wavelength between antenna and transmitter. In so doing, the low resistive impedance of the antenna is reflected to the transmitter, and the transmitter need not cope with reactive components that can be introduced by the line, however small its standing wave ratio.

multiband operation

For optimum results the long-wire antenna should be resonated on each band. There are three ways to do this. A tuner can be mounted at the feed point, but this presents a weather-proofing problem.

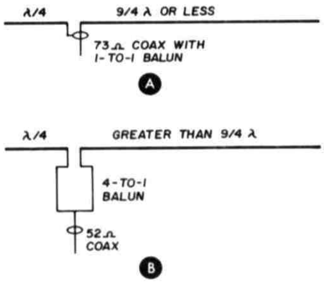
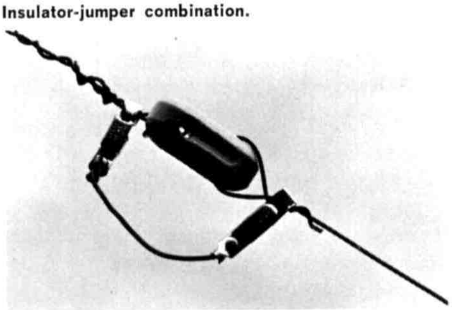


fig. 4. Two methods of feeding a long wire at the end. A swr of about 1.5:1 can be obtained using three systems.

Insulator-jumper combination.



Furthermore, the tuner must be retuned when changing bands or when shifting operation from one part of the band to another.

Reasonable results can be obtained by using a tuner at the transmitter. However, this technique makes the transmission line a part of the antenna, and the antenna pattern can be affected adversely. Furthermore, a high swr can develop on the line. Recall that a tuner at the transmitter actually works for the transmitter and does very little for the antenna system.

The third possibility is to preset the long-wire antenna for each band. This can be done by bringing the antenna ends down near the ground level **(fig. 5A).** This causes no serious pattern change. The antenna can be trimmed carefully for each band to obtain optimum operation without the use of any tuner.

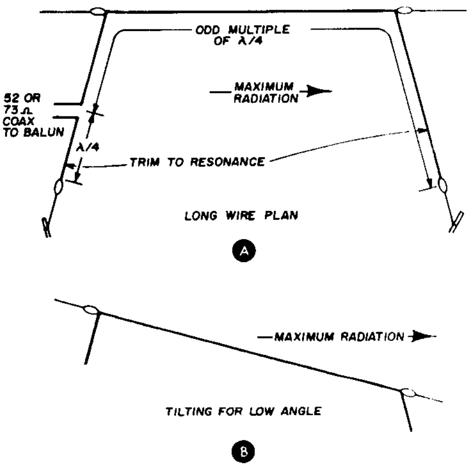
For DXing the long-wire can be tilted slightly in the direction of the long leg **(fig.**

5B) to improve the low-angle radiation in the favored direction. The angle increases in the opposite direction.

W3FQJ end-fed long wire

The arrangement and dimensions of a practical antenna are given in **fig. 6.** The quarter-wave dipole segments are easy to set up and permit 10- through 40-meter operation. A band change is made quickly by proper arrangement of the jumpers at each end of the antenna. For 20-meter operation the first jumper is left open. For 15-meter operation the first jumper is closed, and the second jumper is opened. On 20 meters the first two jumpers are closed, and the third jumper is opened. All jumpers are connected for 40-meter operation.

fig. 5. To avoid use of tuner, long wire ends are brought near ground and carefully trimmed for resonance, A. Antenna bandwidth will be quite narrow. At B, tilting the wire improves low-angle radiation slightly in direction of tilt.



The long leg of the antenna is 9 quarter-wavelengths long on 40, 17/4 on 20, 25/4 on 15, and 33/4 on 10. Formula values are

$$(40)\ \text{leg length} = \frac{2214}{7.2} = 307 \text{ feet}$$

$$(20)\ \text{leg length} = \frac{4182}{14.2} = 294 \text{ feet}$$

$$(15)\ \text{leg length} = \frac{6150}{21.3} = 288 \text{ feet}$$

$$(10)\ \text{leg length} = \frac{8118}{28.6} = 283 \text{ feet}$$

After trimming, the practical lengths reduce to 297 feet 7 inches, 271 feet, and 272 feet 10 inches respectively. Note that the same leg length can be used for both 10 and 15 meter operation. Thus in changing operation between these bands, only the near-end jumpers need be shifted.

results

Results have been gratifying on all four bands. The bearing of the long leg, as erected here in Eastern Pennsylvania, is set at 255°. On 10 meters, where the directivity is sharpest, this places a strong-signal area diagonally across the Continental United States. At the same time, good reports are obtained in the Southern States and in North Central States, thanks to the secondary lobes. Of course, on the lower bands the number of electrical wavelengths on the legs is not as great, and the horizontal radiation pattern is less sharp, encompassing a larger area of major-lobe coverage.

references

1. "Antennas and Radio Propagation," Dept. of the Army Technical Manual TM 11-666, February, 1953.

ham radio

fig. 6. The multiband, segmented long wire at W3FQJ. Coax cable should be at a right angle to feed point if possible.