Collinear 5/8-Wave Omni Antenna for 2 Meters

Commercial antenna performance at a home-brew price!

by John Conklin WDØO

Ready to try your hand at building an omnidirectional gain antenna? This may be just the project for you! Using ordinary hand tools, you can construct this antenna in one evening from common hardware store materials.

dB or Not dB?

What does all this gain stuff mean . . . really? An electronic amplifier has an absolute limit to the amount of power it can produce, regardless of the input level. Accordingly, amplifiers are often rated in watts—an absolute term. Antennas on the other hand, have no maximum theoretical output power—what you get out of them depends on what you put into them. Therefore, antenna performance is rated in relative, rather than absolute, terms. Enter the decibel (dB). A decibel is one tenth of a bel, named for Alexander Graham Bell (hence the little d and capital B). Originally established to express changes in sound levels, the decibel is a term of relative power. A change of 1 dB in power level is just barely detectable by the human ear.

The correlation between the dB and power ratio is:

dB = 10 log (output power/input power)

A gain of 3 dB corresponds to a doubling of power. Thus, an antenna with a gain of 3 dB will have the same effect on your signal strength as if you had doubled output power. As an added bonus, the gain of an antenna applies to received signals as well.

Where does all this extra power come from? According to the first law of thermodynamics (conservation of energy), you can't get something for nothing. To create gain in any given direction, the power must be taken from some other direction. In the case of a beam, most of the RF is concentrated toward the front of the array and sacrificed at the sides and rear. An omnidirectional antenna, on the other hand, obtains its gain by reducing the amount of RF that is radiated upwards. Look at it this way: An omni antenna has a radiation pattern shaped like a doughnut. In order to increase its gain, the doughnut merely needs to be flattened, thus putting more signal out instead of up.

Gain must be expressed in relation to some standard for it to have any meaning. In antenna work, these values are usually ren-

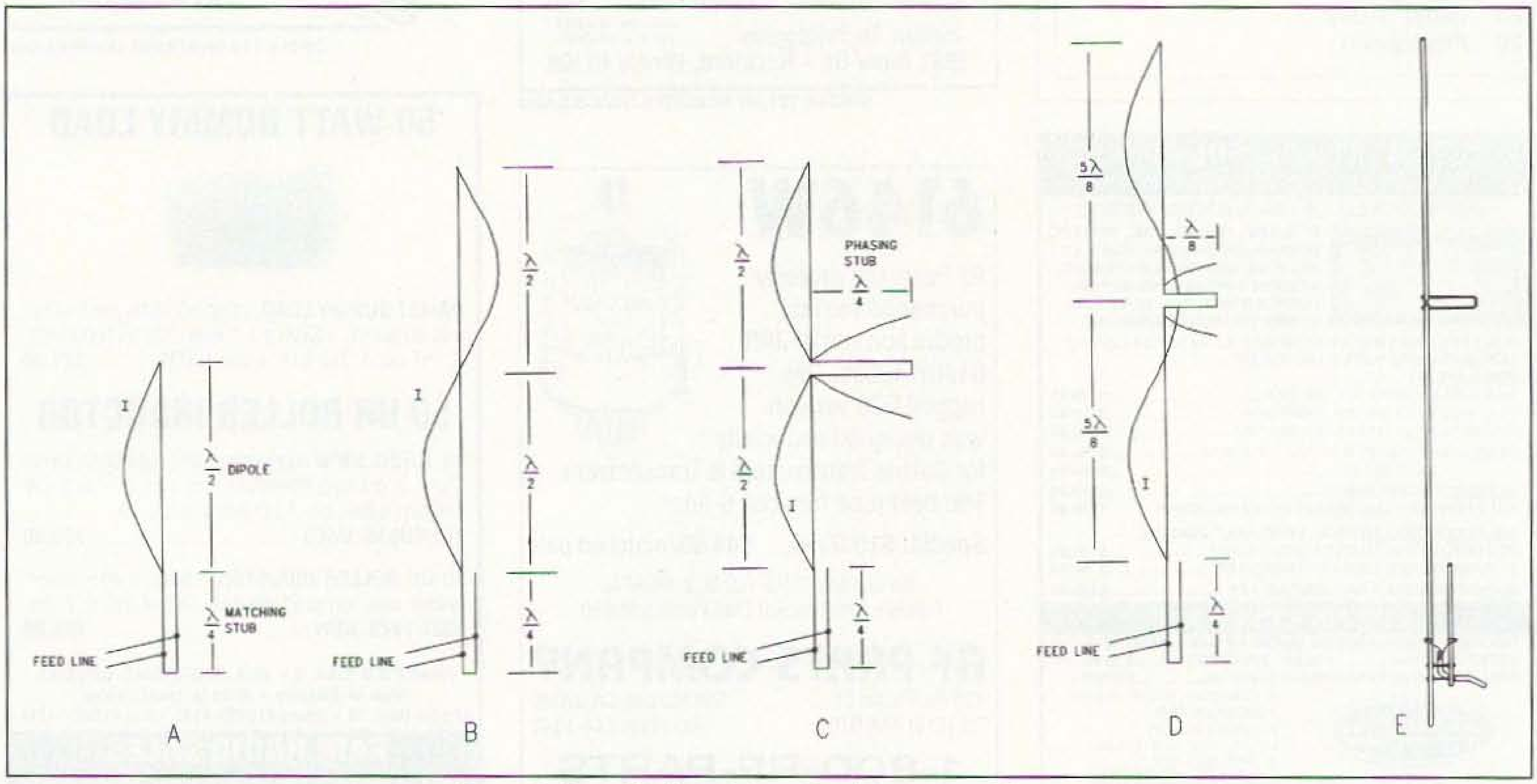

Figure 1. From dipole to deluxe. See this section of the text.

dered in terms of dBd (gain over a dipole), or less commonly, dBi (gain over isotropic). Since an isotropic radiator is a purely theoretical antenna, all measurements in this article are expressed in dBd. Incidentally, many manufacturers neglect to include any standard reference point in their advertising. There is no way of telling whether the purported gain is over a dipole, a ground plane, a dummy load or isotropic—even the venerable dipole has 2.1 dB gain over isotropic! It's wise to take advertised claims with a grain of salt.

From Dipole to Deluxe

An assortment of aluminium and hardware can double your effective radiated power. Here's how.

As you probably know, a half-wave dipole is customarily fed at the center. This is where the current is highest and the voltage is lowest, thus providing a nice, low impedance point for connecting 52-ohm coax. At the ends of the half-wave antenna just the opposite situation exists—the current is lowest, and the voltage is highest, constituting a very high impedance feed point.

Some sort of matching device must be used in order to overcome the impedance mismatch if an antenna is to be end-fed. The quarter-wave closed stub, a continuously variable impedance matching device, performs this function rather nicely. Think of it as a dipole folded in half. The impedance is very low at the closed end of the matching stub (center of the dipole), and very high at the open end of the stub (ends of the dipole). Connect the antenna to the open end and the feedline near the closed end (Figure 1A). The impedance can now be changed by simply moving the feed point up or down the stub. As an added advantage, the closed end of the matching stub may be grounded, thus placing the entire antenna at DC ground potential and simplifying mounting problems.

Now for some gain. If the length of the antenna is increased to two half-wavelengths, the antenna will exhibit only slight (0.5 dBd) gain. This is because the currents along each element are out of phase and cancel each other out (Figure 1B). However, if each of the two half-wave elements are fed in phase, the gain will be 1.9 dBd because the RF currents reinforce, rather than cancel, each other. In order to achieve this phasing, the signal must travel an extra half wavelength before arriving at the second element. The phasing stub is a half-wavelength conductor folded so that the sides are parallel and closely spaced (Figure 1C). RF currents along the stub are then equal in intensity but opposite in polarity, causing the currents to cancel and preventing the stub itself from radiating.

Antenna gain is further boosted to 3 dBd by increasing the spacing between elements. This is accomplished by lengthening the radiating elements to 5/8 wavelength and shortening the phasing stub by an equal amount (Figure 1D). The added length of antenna is out of phase, and causes some signal cancellation. However, since the current on the added length is small, and the section is short, the radiation is insignificant. Further lengthening of the elements will cause more cancellation, and the gain will actually decrease. The finished antenna is shown in Figure 1E.

Construction

Figure 2 illustrates the dimensions and layout of the antenna. Construction is straightforward and requires only the use of common hand tools. The majority of the antenna is made from 3/4" aluminium tubing, although any diameter from 1/2" to 1" should work fine.

Start by cutting the matching stub (23"), the lower radiating element (78-3/4"), and the upper radiating element (48-3/4") to length. Use a hacksaw to cut a 1-1/2"-long slit into the bottom end of the upper radiating element, and the top end of the lower radiating element. This will allow the tubing to clamp firmly around the insulator.

Next, drill the mounting holes in the matching stub and lower element. Position the top of the matching stub 48-3/4" down from the top of the lower radiating element and tape them together. This will keep them lined up while drilling the mounting holes. Make drilling marks on the matching stub 19" and 22" down from the top of the stub. Clamp the assembly in a vise (being careful not to crush the tubing) and drill through both pieces at the same time. Mount the matching stub to the lower radiating element with 3/16" galvanized washers, nuts and bolts (you'll need bolts that are threaded all the way to the head).

The insulator is a plastic or Fiberglas rod (obtainable at plastics supply houses) or wooden dowel waterproofed with either urethane or spar varnish. The insulator should be at least 9" long to provide good mechanical support between the two radiating elements and should be of a diameter that provides a snug fit inside the tubing. Slide the upper and lower elements over the insulator, leaving 1/2" exposed between sections.

Next, drill a phasing stub mounting hole in each element. The holes must be parallel and spaced 2" apart. The phasing stub is made from a 22" length of 10-24 threaded rod. Bend the center of the rod over a 2"-diameter pipe to produce a smooth bend. Then

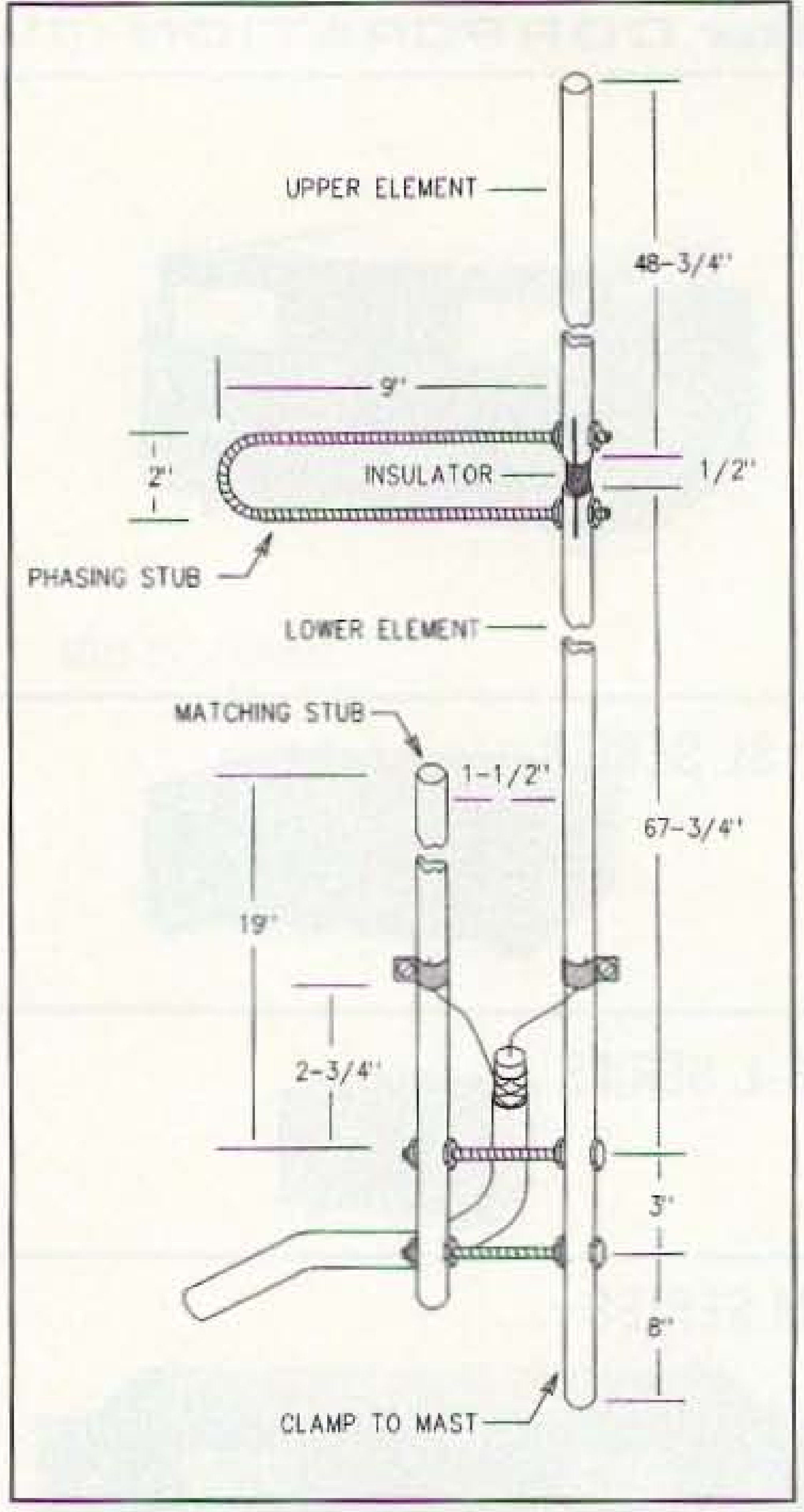

Figure 2. Construction details.

fasten the phasing stub to the antenna with 10-24 hardware. Stainless steel hose clamps are used to connect the coax to the matching stub, and the end of the coax is sealed with RTV sealant or electrical tape.

Adjustment

This antenna delivers good performance and has a respectable SWR curve over the entire 2 meter band. Tuning is accomplished by sliding the feed point (where the coax is clamped to the antenna) either up or down to secure the best match.

Bibliography

1988 *ARRL Antenna Book.*

1991 *ARRL Handbook.*

DeMaw, Doug, *W1FB's Antenna Notebook,* 1987.

Honeycutt, Richard A., *Popular Electronics,* August 1992, p. 65.

Parts List

Upper element	3/4" x 48-3/4" aluminum tubing
Lower element	3/4" x 78-3/4" aluminum tubing
Matching stub	3/4" x 23" aluminum tubing
Phasing stub	10-24 x 22" threaded galvanized rod
Insulator	Plastic, Fiberglas or wooden dowel, 9" long, diameter to fit tubing
4	10-24 nuts
4	#10 lock washers
2	3/16" x 3-1/2" bolts
6	3/16" nuts
6	3/16" lock washers
2	1" stainless steel hose clamps