Simple 5/8-Wave Verticals for 12 and 17 Meters

Here's how to turn a 30-meter quarter-wave vertical into a 5/8-wave radiator for the 12-meter band. And there's a bonus: You can use the same approach to use your quarter-wave 40-meter vertical as a 5/8-wave antenna on 17 meters!

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Need an antenna for the 12-meter (24.89 to 24.99 MHz) band? A quarter-wave vertical for 30 meters works great on 12 meters—as a 5/8-λ antenna. A simple feed-point modification is all that's necessary to use the 30-meter vertical as a low-angle radiator for 12 meters. The same principle can be applied to a 40-meter antenna: Using the same technique, a 7-MHz quarter-wave vertical can serve as a 5/8-λ antenna on the new 17-meter (18.068 to 18.168 MHz) band.

Antenna Characteristics

The characteristics of the quarter-wave vertical are generally familiar to us, but because 5/8-λ verticals aren't as widely used on the HF bands, their characteristics aren't as commonly known. I recommend Paul H. Lee's (N6PL) book on vertical antennas[1] to anyone interested in learning more about verticals and antenna analysis in general. Much of the information presented here came from ideas I got from this book.

The 5/8-λ vertical is a good low-angle radiator that, when properly designed and adjusted over average ground,[2] produces useful radiation from about 8 to 40° above the horizon. Maximum radiation is at about 18°. In addition, a 5/8-λ vertical has considerable gain at low angles over a quarter-wave vertical.

A half-wave dipole would have to be installed at a height of about 0.8 λ to achieve an 18° angle of radiation; thus, for those of us who don't have towers, masts or trees tall enough to achieve such heights, the 5/8-λ vertical is a practical alternative.

Over average ground, the quarter-wave vertical produces useful radiation from 10 to 55° with maximum radiation occurring at about 30°. For the antenna system described here, this radiation angle is an advantage—signals in the 17-meter band arrive at lower angles, in general, than those on 40 meters. Thus, this antenna performs nearly optimally for both bands.

Construction Details

I decided to ground mount my vertical after reading an article on the 5/8-λ vertical by Don Reynolds, K7DBA, in *The ARRL Antenna Compendium, Volume 1*.[3] K7DBA points out that if the 5/8-λ vertical is operated as an elevated groundplane antenna, it has little or no advantage over a quarter-wave vertical operated in the same manner. Both the low-angle radiation and gain advantages of 5/8-λ verticals are lost. This is because of edge diffraction around the finite ground plane. K7DBA's conclusions are based upon actual measurements taken at the University of Washington antenna laboratory.

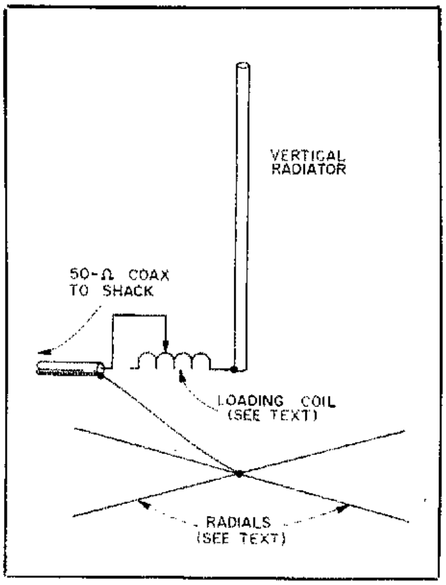

Fig 1—The ⅝-λ 17-meter/¼-λ 40-meter vertical. A switch or relay can be used to remove the loading coil from the circuit for 40-meter operation. Move the coil tap for best SWR on the higher-frequency band. The radial system should be as extensive as possible for maximum efficiency. See *The ARRL Antenna Book*, Chapter 3, for more information on ground systems for verticals.

The 12-Meter Vertical

When I designed the 17-meter vertical, the band was not yet available to US amateurs, so I decided to erect a 5/8-λ vertical for the 12-meter band to test the principle. As mentioned earlier, such an antenna also functions as a quarter-wave vertical on the 30-meter band. It seemed best to me to test the concept on the 12- and 30-meter bands, and then provide parameters for the 17- and 40-meter bands based upon my results.

The antenna I used is an old aluminum multiband vertical I had lying around—a veteran of many previous vertical-antenna experiments. I chose a length of 25 feet, 3 inches based on scaling N6PL's 20-meter 5/8-λ vertical[4] for the 12-meter band. The length-to-diameter (L/D) ratio of my antenna is about 460. The input impedance of a vertical that is substantially longer than a quarter wavelength (ie, 5/8 λ) is particularly sensitive to the L/D ratio of the radiating element. If you decide to duplicate my design with a vertical having a different L/D ratio, your results may be a bit different. The design frequency of my vertical is 24.95 MHz.

After installing the ground system (a description follows), I measured the input impedance (Z_i) of the antenna with a noise bridge. On 24.95 MHz, Z_i had a resistance of about 50 Ω, and a capacitive reactance of about $j155$ Ω. On 10.125 MHz, Z_i was just under 50 Ω, and was purely resistive. To tune out the reactance at 24.95 MHz, I installed a series inductor (see Fig 1), and moved a tap along the coil until I found resonance at the design frequency. The easiest way to find resonance is by measuring the antenna's SWR. Use a good-quality coil for the series inductor. The loading coil I used has a diameter of 2½

[1] Notes appear on page 20.

inches, and has 6 turns per inch (B & W stock no. 3029[5]). 3¼ turns were required to establish resonance on 12 meters. The SWR on 12 meters is 1.1:1, and on 30 meters, 1:1.

To change bands from 12 to 30 meters, I just move the coil tap to the end of the coil closest to the vertical element. Alternatively, a single-pole switch or relay can be installed at the base of the antenna for band switching.

The Ground System

The importance of good ground systems for vertical antennas cannot be overemphasized. Maximum RF current density—and therefore maximum ground losses—for quarter-wave verticals occurs in the immediate area of the base of the antenna. Conversely, maximum current density and the associated ground losses for a 5/8-λ vertical occur about ½ λ away from the antenna base. It is important to have the lowest possible losses in the immediate ground area around both types of antennas.

Excellent articles discussing radial systems and vertical-antenna systems have been written by John Stanley, K4ERO, and Charles J. Michaels, W7XC.[6,7] Pertinent portions of these articles are reprinted in *The ARRL Antenna Book*.[8] This material is recommended reading for those who plan to build antenna systems like those discussed here. Remember: A poor ground system results in decreased efficiency, and thus weaker low-angle performance—which is what we *don't want*.

As an adjunct to a radial system, I decided to use a 6- × 6-foot aluminum ground screen at the base of the antenna. (I prefer copper screening, but I couldn't locate any.) The aluminum screen makes a good tie point for the radials and conducts ground currents efficiently. You can do without the ground screen if you like, but it does help to cut losses.

I installed 17 copper-wire radials, each about 33 feet long, spaced evenly around the ground screen. More radials would be better still. Each radial is bolted to the screen using corrosion-resistant no. 10-24 hardware. (*Do not attempt to connect copper directly to aluminum.* The electrical connections between these metals will quickly deteriorate.) My radials are made of insulated wire, and lie on top of the ground. Radials can also be made of bare wire, and can be buried a few inches. My yard is so rocky that burying radials is unthinkable, but if you need to mow the grass in the area of the antenna, you can bury the wires to avoid damaging them (or yourself!).

The rocky ground around my house, it seems to me, must be a very poor RF ground—but I always have good results with vertical antennas, provided I use a good radial system. The ground screen is bolted to the ground side of the antenna via heavy gauge wire. Use large wire or braid for this connection, because current flow is fairly heavy at this point.

Table 1

Band	*Height*	*Required matching inductance (μH)*
12 meters	23′5″	0.99
17 meters	32′3″	1.36

Results

When I put up my 30/12-meter antenna (spring 1988), propagation was erratic on 12 meters, but I made a number of contacts. For a comparison antenna, I used a phased array of extended double Zepps (EDZs) for 12 meters.[9] Not surprisingly, the phased array, with its 7 or 8 dB gain, gives signal strengths several decibels greater—in its favored directions—than the 5/8-λ vertical. Nevertheless, the vertical gives a respectable account of itself.

The vertical performs very well on 30 meters. I have worked into the New England states (a distance of about 2300 miles) several times using a 100-W rig. Using the same rig, I've also worked several Japanese stations—a distance of about 4800 miles—and received good reports. Although I need to further evaluate this antenna, it appears to work very well.

Adapting the Antenna to the 17- and 40-Meter Bands

Table 1 gives specifications for the 5/8-λ vertical on 12 and 17 meters. If your existing 40-meter vertical is a few inches longer than 32 feet, 3 inches, try using it anyway—a few inches isn't too critical to performance on 17 meters.

Summary

I have presented nothing new in this article—I have merely followed the precepts of wiser and more experienced minds. Thanks to all who have gone before.

Notes

[1] P. H. Lee, *The Amateur Radio Vertical Antenna Handbook*, 2nd edition (Hicksville, NY: CQ Publishing, 1984).

[2] For more information on the effects of ground on antenna systems, including definitions of ground types, parameters for ground constants and geographical factors, see G. L. Hall, ed, *The ARRL Antenna Book*, 15th edition (Newington: ARRL, 1988), chapter 3.

[3] G. L. Hall, ed, *The ARRL Antenna Compendium, Volume 1* (Newington: ARRL, 1985), pp 101 to 106.

[4] See note 1.

[5] B & W coil stock is available from RADIOKIT, PO Box 973, Pelham, NH 03076, tel 603-635-2235.

[6] J. Stanley, "Optimum Ground Systems for Vertical Antennas," *QST*, Dec 1976, p 13.

[7] C. J. Michaels, "Some Reflections on Vertical Antennas," *QST*, Jul 1987, p 15.

[8] See note 2.

[9] J. Reh, "An Extended Double Zepp Antenna for 12 Meters," *QST*, Dec 1987, p 25.

Amplifier-Driver Compatibility

(continued from page 18)

the cathode(s) of the amplifier tube(s). This technique reduces drive and tends to improve amplifier linearity through degeneration. Finding the proper cathode resistance often involves cut-and-try experimentation.

If you would like to discuss this subject with me on the telephone, call me. I can usually be reached at 805-482-3034. Three minutes on the telephone is more effective than my spending 30 minutes at my typewriter!

Notes

[1] Push-pull and push-push oscillations can occur only in an amplifier stage that uses more than one active device. A push-pull parasitic oscillation is much less destructive than the dreaded push-push parasitic oscillation, which can make an amplifier go bang and parts go kaput. A push-pull parasitic is characterized by both amplifier tubes getting very hot and drawing maximum anode current; it does not cause destructive arcing as does a push-push parasitic, and can be stopped by unkeying the amplifier. (For more information on parasitics, see "Improved Anode Parasitic Suppression for Modern Amplifier Tubes," *QST*, Oct 1988, pp 36-38, 66 and 89.)

[2] A linear amplifier is said to be in gain compression when its output increases with increasing drive but does not increase in linear proportion to drive. Gain saturation is reached when increasing drive causes no further increase in output.

[3] As commonly defined, an S unit represents a 2:1 signal voltage change, which is equal to a 4:1 power ratio—a 6-dB change.

[4] You can observe this phenomenon in your own amplifier if you can receive on two frequencies at once and feed the audio from each frequency to its own channel in stereo headphones. Tune one receiver/ear to your SSB signal, and apply enough RF attenuation at the receiver input to keep the signal from driving the S meter offscale. (RF attenuation is necessary because receiver overload can cause splatter to be generated in the receiver.) Tune the other receiver/ear off-frequency about 4 kHz. When the amplifier is overdriven—usually at the beginning of words and strong speech components—splatter will be audible in the off-tuned receiver/ear.

[5] This depends on the voltage applied to the tube anode. For a given power output, drive power requirements decrease with increasing anode voltage. Drive power requirements for a given tube type also vary with circuit configuration, and class and frequency of operation.

[6] This can be conveniently done by temporarily paralleling C1 with a mica-dielectric, compression-tuned variable capacitor. Alternately adjust the variable capacitor and L1 until the input SWR is acceptable. Remove the variable capacitor and measure its value with a capacitance meter. Install a fixed, mica capacitor of the nearest standard value in parallel with C1.

[7] Metal-film resistors decrease in resistance under conditions of prolonged overload. Under sudden, catastrophic overload, they open like fuses.

[8] R. Measures, "Calculating Power Dissipation in Parasitic-Suppressor Resistors," *QST*, Mar 1989, pp 25-28. Despite what some amplifier instruction manuals may state, it is *impossible* to adjust an amplifier for linear operation without applying *maximum peak drive* in the form of pulses (such as a string of CW dits) or a steady carrier, or as part of the two-tone linearity test. See R. Measures, "Adjusting SSB Amplifiers," *ham radio*, Sep 1985, pp 33, 35-36.