The 160-Meter Antenna Dilemma

If you're not getting the top-band results you expected, you'll find these antenna tips of use.

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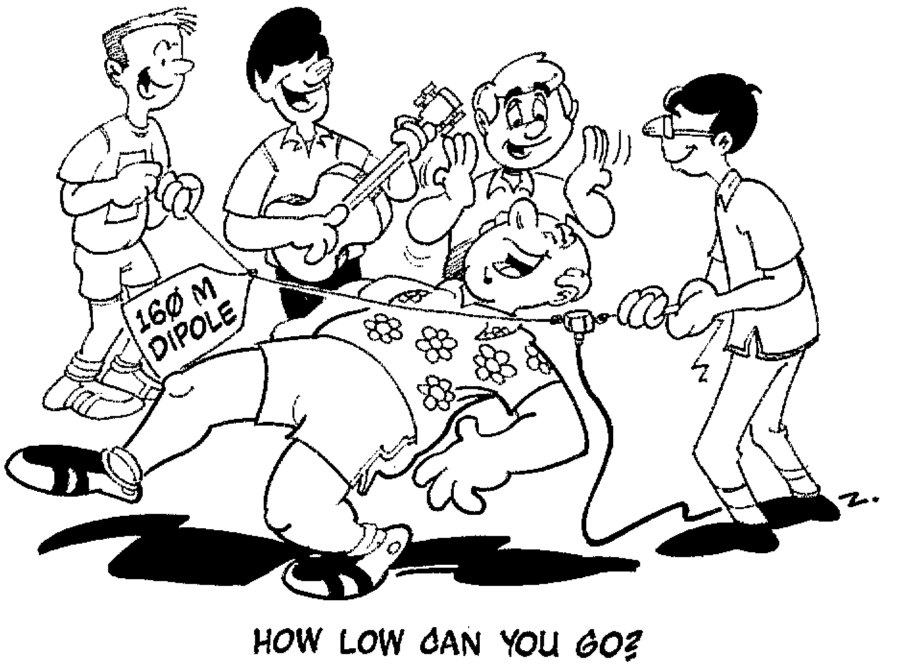


It is always a pleasure to welcome newcomers to the "gentlemen's band," as 160 meters has been called for many years. But few have signals that rattle the walls in my shack. In fact, they are often barely readable, or at best an S unit or so above the noise threshold.

When first-timers give me a call to ask for a signal check, I always inquire about their antenna. "I'm using my 35-foot-high 75-meter dipole with a Transmatch" is one common response. Another is, "Antenna here is a 100-foot, end-fed wire about 15 feet above ground." When I hear 160-meter antenna descriptions of this type I say "ouch!" The majority of these newcomers are using barefoot transceivers, which at times must look into high values of SWR.

There seems to be a misconception that leads some to believe that good antennas, at a suitable height, aren't necessary on 160 meters. In fact, the opposite is true! This is because 160 meters is generally a noisy band—more so than the 3.5-MHz and higher bands. This is a result of the vigorous atmospheric noise we must deal with, along with greater man-made noise. You can add to this hodgepodge the presence of TV "birdies" (15.75-kHz horizontal-oscillator harmonic radiation) that can virtually wipe out reception if the other station is weak. (TV birdies are seldom a problem above 3.5 MHz.) It is prudent to locate your 160-meter antenna as far from your TV antenna as possible. A brute-force ac-line filter on your TV receiver helps keep TV-birdie harmonics from radiating via the ac line in your home, and via those conductors outside your house.

The Matter of Height

We hams tend to think of height in terms of physical feet or meters, rather than with regard to wavelengths or fractions thereof above earth ground. Whereas a height of 50-60 feet may seem high above ground, it's very low in terms of wavelength at the lower frequencies. An ideal horizontal

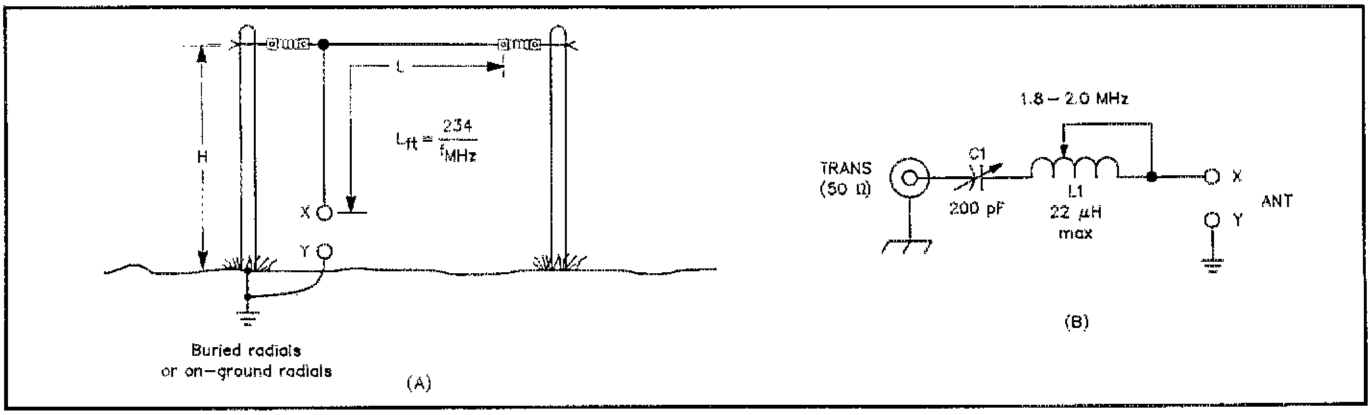


Fig 1—Example of a ¼-λ inverted-L antenna. Dimension H should be as high as practicable for best performance. The support poles may be metal or wood, or they can be trees. Illustration B shows a simple matching network that works very well with inverted-L antennas. The capacitor can be motor-driven from the ham shack to provide a 1:1 SWR across the band. A single value of inductance normally permits full band coverage with C1. Once the tap is selected, no further adjustments are required for full 160-meter coverage.

antenna height for working distant stations is ½ λ or greater above ground. This is relatively easy to achieve on, say, 20 meters (35 feet). But, for 3.5 MHz it is 141 feet, and at 1.8 MHz we need to have this ideal antenna 273 feet above ground! Not practical for most of us.

By way of example, a 160-meter dipole that is 35 feet above ground is equivalent, in terms of wavelength height, to a 10-meter dipole at about 2 feet above ground. None of us would consider erecting a 10-meter beam at 2 feet above ground!

What Happens at Low Height?

We can expect dreadful antenna efficiency when we use a 160-meter horizontal antenna at typical ham-antenna heights. Ground losses become high and the antenna has no directivity. In fact, the radiation is pretty much straight up, in the shape of a sphere. This can actually be very good for short-range QSOs at night, out to some 600 miles. Inverted-**V** antennas do somewhat better because they have a vertically polarized component (if the enclosed angle is between 90 and 110 degrees). They also have an omnidirectional radiation pattern. I prefer a 160-meter inverted **V** to a horizontal dipole at heights less than 100 feet. The feed impedance of a dipole at low height will be affected; a matching network at the antenna feed point may be required if you use coaxial cable for your transmission line. A dipole that is ½ λ high has a characteristic feed impedance of 75 ohms. This isn't so at other heights (for details, see *The ARRL Antenna Book*[1]).

An Answer for the Urban Dweller

Most hams who live in metropolitan areas do not have sufficient property to erect a full-size 160-meter horizontal dipole. In fact, the urbanite may have difficulty accommodating a 160-meter inverted **V**. An old expression is, "If you can't go out, go up." Vertical antennas for top band are popular and practical. A full-size ¼-λ vertical for 1.9 MHz is 123 feet high. Not many hams are willing to go to that extreme, especially in the city! You can, however, erect a short vertical antenna with some form of top loading (coil and capacitance hat near the upper end). If you have a tower, you may elect to shunt feed it (with your HF beam antenna in place) and add some top loading. *W1FB's Antenna Notebook* and *The ARRL Antenna Book* describe methods for doing this.[2]

A popular and effective antenna for 160 meters is the inverted **L**. It works well for local and DX communications if a ground-radial system is used with it. In fact, all ¼-λ antennas fed against ground require a radial system if losses are to be kept low. A couple of metal rods driven into the soil will *not* take the place of a radial system. Beware of this approach to an antenna ground. If the rods are at least 8 feet long and driven into the soil, however, the rods *will* provide a dc ground for your antenna and station.

An inverted-**L** antenna consists of ¼ λ of wire, shaped like an upside-down **L** (Fig 1). The greater the length of the vertical portion of the wire, the better the antenna will perform. The horizontal portion carries less current and does less radiating. So, the antenna radiation is predominantly vertical in polarization. This antenna has a fairly low radiation angle (typically 20-35°), which makes it useful for all-around communications. A number of hams have earned their 160-meter DXCC while using simple inverted-**L** antennas.

The major trade-off with verticals is that they pick up far more noise than do horizontal antennas. This is because most man-made noise is vertically polarized. Also, you may find that you have a "dead zone" with your vertical antenna. There will be times when signals out to a couple of hundred miles are very weak. Your signal will also be weak at the other ham's location, since it is skipping over his area. This does not always happen; it depends on propagation conditions at a given time.

Short verticals (30 feet long or greater) can be effective, too. You may want to make one from aluminum tubing or a telescoping steel mast. The shorter the vertical, the lower the antenna efficiency—unless you add many more radials to your ground system. Likewise as you add more inductive loading. But a short loaded vertical is often more effective for working distant stations than a full-size horizontal antenna near ground. I had good luck when I lived in Detroit during the 1950s while using a 16-foot helically wound vertical antenna on 160 meters. It was wound uniformly with ½ λ of no. 14 insulated wire. A 16-foot wooden hand rail from the lumberyard served as the coil form after I applied two coats of spar varnish. An aluminum pie plate was used at the tip of the helix to provide top capacitance and to prevent corona discharge (resulting from the extremely high voltage at the antenna's end) during transmit periods. One-half λ of wire results in ¼-λ resonance (approximately) when winding helical antennas of this type.

The Ground System

Some amateurs rebel at the thought of deploying a ground-radial system. Sure, it takes a bit of time and effort, but the reward is well worth the hours you invest in the project. You may hear that it is necessary to use 120 radials that are each ¼ λ long. Although such a ground system would be nice to have, it's not mandatory. You can do quite well with 15 or 20 radial wires. They need not be extended linearly away from the feed point of your vertical. If your house is in the way of your work, simply route the radials around the house. If there is not enough space for ¼-λ radials, make them as long as you can. I used a 55-foot top-loaded vertical when I lived in Connecticut. I had 20 in-ground radials of mixed wire gauge. Some were only 40 feet long, while others were greater than 100 feet long. I worked all 50 states on 160 meters and confirmed 72 countries with this system while running 100 watts on CW.

Don't worry about ruining your lawn with buried radials. A lawn-edging tool can be used to cut the slits for the wire. The

[1]Notes appear on page 32.

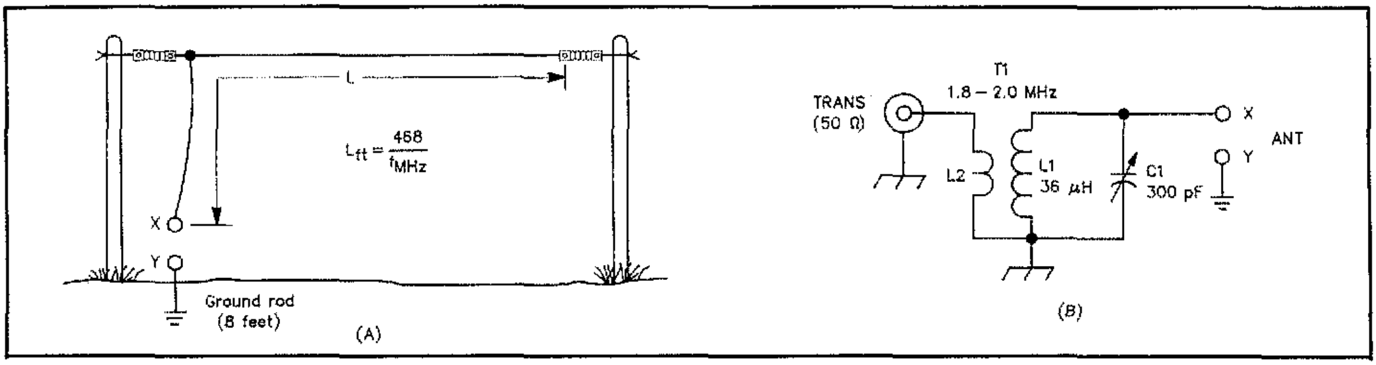


Fig 2—A ½-λ version of the antenna in Fig 1. This antenna is similar to one used at W4ZCB. L1 may have a relay-selected tap to permit operation on 80 meters as well. L1 and C1 are outside the house at the antenna feed point in a weatherproof box. C1 is motor driven and should have wide spacing or be a vacuum variable capacitor. Illustration B shows a suitable matching network.

lawn will heal in a month or two, and no one will know about the copper screen you have under the grass!

Other 160-Meter Antennas

Some amateurs obtain good performance with end-fed ½-λ wire antennas. Results depend on the height of the wire above ground. An antenna erected over poor ground (deep shale, granite or desert sand) may appear to be many feet higher over ground than it is. W4ZCB is situated on a small mountain in North Carolina. His end-fed wire for 160 meters (Fig 2) is only 50-60 feet above the surface of the earth. His signal in Michigan is always very loud. I expect that there's a lot of rock below his property. His antenna is tuned remotely and works equally well on 75 meters (1 λ overall).

I use a full-λ horizontal loop for 1.9 MHz. The corners are only 50 feet above ground, but I live over very dry, sandy soil. I suspect that the virtual (or effective) antenna height is considerably greater than 50 feet. I feed this loop at one corner with 450-ohm ladder line. It works exceptionally well on all of the bands from 160 through 10 meters with the help of a 4:1 balun transformer and my Transmatch. Loops are inherently quiet receiving antennas. My noise level is often S0 to S1, whereas the reading was generally S3 to S6 when I was using an inverted L. Lee, K8CLI, in Loveland, Ohio also uses a full-λ horizontal 160-meter loop at approximately 50 feet. His signal is always among the loudest I hear on 1.9 MHz.

Summary Remarks

I can't stress strongly enough that we need to take our 160-meter antennas seriously if we are to enjoy the benefits of this wonderful band. A hunk of wire a few feet above ground will surely deprive you of the fun that awaits you on 160 meters. If the other guy has to struggle to copy your signal he may choose to sign off with you. A little thought and effort are required when you erect your first top-band antenna. Don't settle for mediocrity—it's better to apply the same tender loving care you do when erecting an antenna for 40 or 20 meters. Although I do not advocate using amplifiers when they aren't needed, I suggest that you consider acquiring one for your 160-meter work if you intend to chase DX and have a consistently good signal. Amplifiers provide those extra decibels that are often needed to break through the noise. They are a definite asset when band conditions are poor, which is not atypical on 160 meters.

Finally, every decibel is important. I urge you to make an effort to match your feed line to your 160-meter antenna and to match your end-fed wire to the transmitter.

Notes

[1] *The ARRL Antenna Book* is available from ARRL HQ for $18 plus $2.50 shipping and handling ($3.50 for UPS), or from your local dealer.

[2] *W1FB's Antenna Notebook* is available from ARRL HQ for $8 plus $2.50 shipping and handling ($3.50 for UPS), or from your local dealer.

New Products

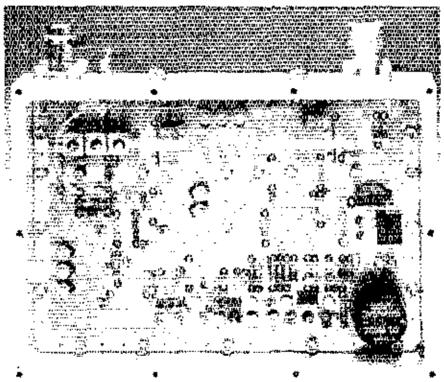
QUORUM COMMUNICATIONS DOWNCONVERTERS

Two new 1691-MHz to 137.5/141-MHz downconverters, models SDC-1691B and SDC-1691BWP, from Quorum Communications, Inc, are designed for reception of WEFAX and other services available from the US GOES, European Meteosat or Japan's GMS geostationary weather satellites. Except for weatherproofing, the two units are identical. The suffixes denote the difference between the two converter models; for ready-to-go outdoor use, the BWP model is installed in a weatherproof, mast-mountable case. Because the B-only-suffix unit is *not* weatherproof, it must be used indoors or housed in a weatherproof enclosure if used outdoors. (An optional weatherproof housing/mast-mountable case is available to upgrade the B-only-suffix version.)

The converter consists of a low-noise (typically 1-dB noise figure) RF amplifier, a bandpass image-rejection filter and a high-stability local oscillator (LO). To enhance frequency stability, the LO crystal is contained in an oven that maintains the crystal temperature at 75 °C. The LO circuit is also temperature compensated. As a result, the converter's output frequency remains within ±2 kHz with ambient temperature variations from −20 to +50 °C. Because of its low noise figure, the SDC-1691B requires no external preamplifier. The converter has a conversion gain of 30 to 33 dB.

Because the converter uses a wideband IF, no crystal switching or swapping is necessary to receive the existing geostationary weather satellites. For European Meteosat reception, the IF output is at 141 MHz with the supplied crystal. An LO-crystal option for Meteosat reception, providing an IF output of 137.5 MHz, is available at no additional cost.

Converter power requirements are +12 to 14 V at 500 mA. (Average current drain is 250 mA; power-up current drain is approximately 500 mA because of crystal-oven cycling.) Power is fed to the converter via a feedthrough capacitor or through the IF-output cable. A milled-aluminum case houses the electronics (see the photo). A female N connector is used for the 1691-MHz RF-input port, and the IF-output connector is a female BNC.



An illustrated installation and operation manual tells you how to integrate the converter into your weather-satellite receiving system. The manual includes an appendix with a wealth of information on receiving WEFAX transmissions (antenna recommendations, gain figures, system trade-offs, etc).

Price class: 1691B, $449; 1691BWP, $498; weatherproof housing/mast-mount case, $49. To order or obtain more information, contact Quorum Communications, Inc, 1020 S Main St, Suite A, Grapevine, TX 76051. Tel 817-488-4861; fax 817-481-8983. Quorum also operates a BBS (817-421-0228) that provides weather-satellite-picture files and other software. On the BBS, you can also find the latest version of the software used with Quorum's scan-converter card.—*Paul Pagel, N1FB*

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