On-Ground Low-Noise Receiving Antennas

There is much discussion about low-noise receiving antennas for 160 and 80 meters. Here are the results of some of my experiments with these antennas.

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Most of you know about Beverage antennas and their value for unidirectional, low-noise response during receive.[1,2] Unfortunately, few amateurs have the available real estate to accommodate a classic Beverage antenna. The typical alternative is to build and use a small receiving loop.[3] These antennas provide bidirectional, low-noise response in the plane of the loop. If a sense antenna is added we can obtain a relatively unidirectional response (cardioid) with a loop. Normally, a preamplifier is used with a Beverage or loop antenna to compensate for the loss in antenna gain over a conventional dipole or vertical system.

The So-Called Snake Antenna

I am hearing considerable talk about "snake" antennas these days on 160 and 75 meters. Some users report excellent low-noise reception with the snake. Others complain that their receivers seem to be dead when they attach this signal grabber. My curiosity prompted me to become involved in several QSOs wherein the topic was snake antennas. Some interesting information evolved.

Here is a description of this strange antenna. You place a long piece of RG-58 or RG-59 coaxial cable on the ground, then short circuit the far end of the line (shield braid to center conductor). The near end of the cable is attached to the receiver antenna jack. Theoretically, this represents a 50- or 75-Ω dummy load if a long enough piece of cable is used (long enough so the total line loss is greater than 20 dB). The line is lossy and somewhat leaky. This enables it to provide a 50- or 75-Ω termination while receiving signal energy along its length. The term "snake" seems to have been assigned because the cable lies in or on the grass, as snakes are known to do.

I do not see anything wrong with this approach to low-noise reception, provided certain rules are followed. The longer the piece of coaxial line (in terms of a wavelength), the better the antenna performance. The velocity factor (VF) of the line should be taken into account when constructing a snake antenna. For RG-58A and RG-59A the VF is 0.66. It is 0.79 for RG-58 and RG-59 foam-dielectric cable. This means that 1 λ (wavelength) of RG-58A for 1.9 MHz is

$$L_{ft} = \frac{984 \times VF}{f_{MHz}} = \frac{984 \times 0.66}{1.9}$$

This equates to a length of almost 342 feet. If the velocity factor were not used, we would have an antenna that was almost 518 feet long. The snake does indeed offer the advantage of reduced length over a Beverage antenna of the same electrical length.

Some users told me that the snake antenna was no good; the receiver went dead, or nearly so, when it was attached. Investigation showed that an exact half- or full-wavelength dimension was being used (inclusive of the velocity factor). Assuming no cable losses, a half wavelength line or multiple thereof repeats what it sees at the terminated end. Since the far end is shorted, a dead short is seen at the receiver end! No wonder things seemed unusually quiet! Other hams reported good results, but only when random lengths of cable were being used. No doubt these odd lengths were not multiples of ½ λ!

I constructed a ½-λ RG-58 snake antenna for 3.9 MHz. Sure enough, my receiver appeared dead when it was attached. Signals were heard, but they were some 50 dB weaker than when I used my 80-meter transmitting loop for receive. I added a ¼-λ line section at the station end of the snake, and signal levels jumped up by 20 or 30 dB on receive. My next test was to return to the ½-λ antenna. I removed the short circuit at the far end and placed a 51-Ω, 1-W carbon resistor between the inner and outer conductor at that point in the line. Reception was as good as it was when the 0.75-λ snake was used. I recommend that you use a 51-Ω terminating resistor, irrespective of the electrical length of your snake antenna. This antenna is shown in Fig 1A. (Use a 75-Ω resistor with RG-59 cable.)

Why are On-Ground Antennas Quiet?

A good on-ground antenna has the ability to perform nearly as well as a Beverage antenna, assuming it is terminated properly and it is one or more wavelengths long. To be specific, it will have a unidirectional response off the terminated end. This means that it will reject noise energy off the end opposite the termination. It will also reject much of the noise off the sides of the antenna. My experimental snake antenna exhibited these desirable characteristics.

An on-ground antenna may be well removed from the immediate field of a

[1]Notes appear on page 32.

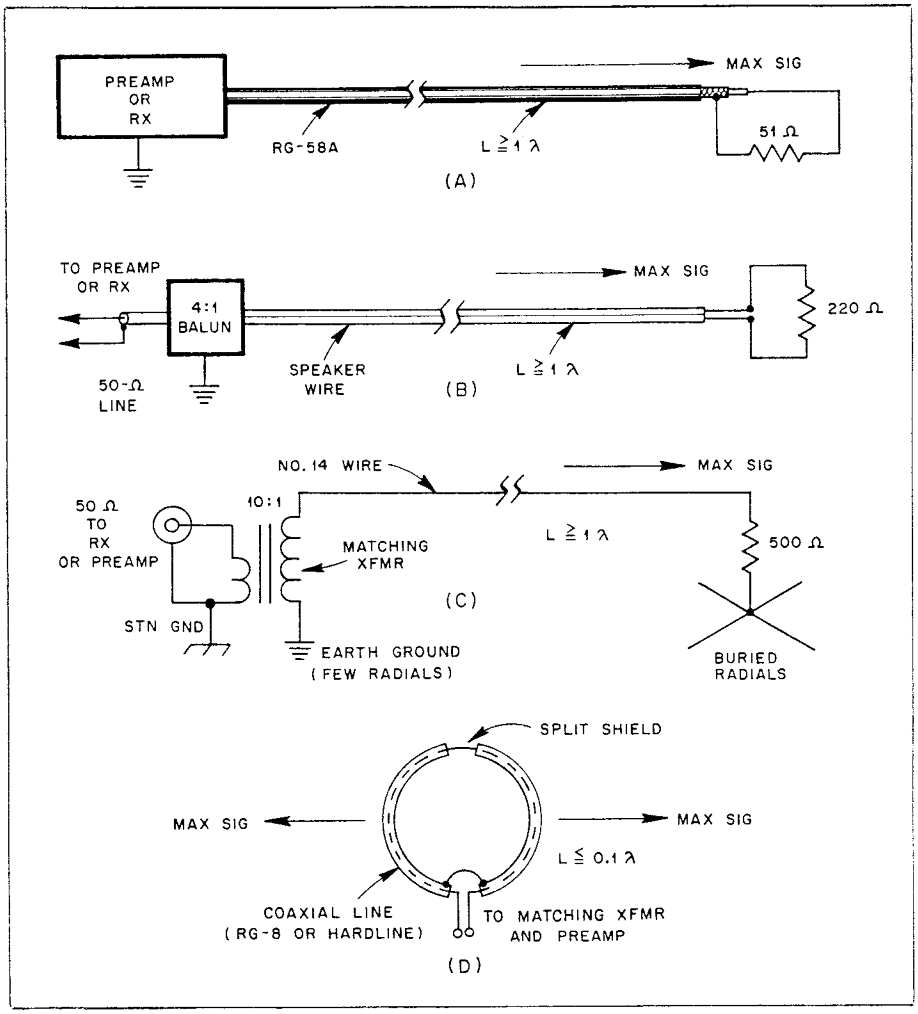


Fig 1—Examples of low-noise receiving antennas. The snake antenna with coaxial cable is shown at A. A 51-Ω terminating resistor is used rather than short-circuiting the far end of the line (see text). Example B shows the W1FB parallel-wire snake antenna that uses no. 22 speaker wire. A 220-Ω termination and a 4:1 balun transformer provide a 50-Ω match to a preamplifier or receiver. Antenna C is a classic Beverage antenna. The earth supplies the missing conductor for this two-wire transmission line. A shielded receiving loop is shown at D (see note 3).

local noise source, whereas a dipole or other transmit-receive antenna may be in the major part of this noise field. I have laid a random length of wire (long) on the ground in urban locations to test this theory. The wires were not terminated, and the signal response seemed to be omnidirectional. But man-made noise dropped markedly from that picked up by the main antenna. Of course signals dropped in strength also, but not by the amount noted for the noise. In other words, the effective signal-to-noise ratio improved substantially.

You may want to try a simple on-ground wire for 160 or 80 meters on your city lot. It need not be in a straight line. You may route it around the perimeter of your yard. I have also used large wire loops that were simply laid on the ground. Excellent results were obtained with these antennas on 160 meters. Don't hesitate to experiment. Use whatever system reduces the noise pickup without seriously degrading the level of the received signals. I once discovered that the frame of my metal ham-shack desk was a better receiving antenna on 160 meters than was my ¼-λ vertical. I could copy weak signals with the desk antenna that were not discernible with the vertical, owing to reduced noise pickup!

Parallel-Wire Snake

I object to the high cost of a coaxial cable snake antenna. Furthermore, cable without a noncontaminating jacket will become contaminated in due course (a year or two) from soil acids, alkalinity and moisture. In a cost-saving move, I developed a two-wire balanced snake antenna that uses inexpensive speaker wire. This is the clear plastic insulated wire that has a copper and a tinned conductor. I bought a 1000-foot spool of no. 22 speaker wire from ORA Electronics for $31.[4] From this wire I was able to make two on-ground receiving antennas for 1.9 MHz. See Fig 1B.

The characteristic impedance of this wire is approximately 190 ohms, according to the two-wire transmission-line formula (1/16 inch conductor spacing and 25.3 mil wire diameter). I assumed a VF of 0.7, which is midway between that of RG-58A and 300-Ω TV ribbon. I cut the antennas to a length of 362 feet, 6 inches for 1.9 MHz. The far ends are terminated by 220-Ω, 1-W resistors. A 4:1 balun transformer is used at the receiver end of the antennas to provide a 50-Ω characteristic for the receiver.

Information about how to construct a 4:1 balun transformer may be obtained from *The ARRL Handbook* and from the book by Jerry Sevick, W2FMI, *Transmission Line Transformers*.[5] Since these are receiving antennas, the wire gauge and core size for the matching transformer may be relatively small.

I find the performance of the parallel-wire snake to be as good as that of the coaxial snake antenna. Certainly the cost is much lower per antenna. Ultraviolet radiation from the sun, plus soil contaminants and moisture, will cause the wire insulation to deteriorate eventually, but the replacement cost will be relatively modest.

Some Problems

I have received reports about snake antennas exhibiting unusual noise pickup. Amateurs have also mentioned a lack of unidirectional response with these antennas. Investigation revealed that the installations were less than ideal. For example, the snake antennas were lying on the ground under which the radial system for a vertical antenna was placed. The proximity of the two systems apparently results in unwanted mutual coupling. The noise picked up by the vertical antenna is transferred, in part, to the snake by way of the radials. This unwanted coupling also spoils the directional characteristics of the snake antenna. Try to remove your on-ground receiving antenna from the vicinity of the buried radial system. In an ideal installation, it should be a wavelength or more away from any other same-band resonant antenna. This is generally impractical in an urban setting, so do the best you can to isolate your antennas from one another.

Preamplification

Most low-noise receiving antennas have a substantial loss compared to a ½-λ dipole. This includes the Beverage and the small receiving loop (shown in Fig 1 at C and D). Although the noise may be reduced considerably with an on-ground, a loop or a Beverage antenna, the signal energy is reduced also. It is possible to have an already weak signal too low in level to override the receiver noise. Also, the overall receiver gain may be too low to provide ample headphone or speaker output for Q5 copy. A preamplifier has an obvious advantage in this situation.

Be sure to apply the same rules for low-band preamplifier design that are used for VHF and UHF reception. A low-noise first stage is mandatory. The overall gain of the preamplifier should be 30 to 40 dB. Variable gain is useful for matching the receive-antenna gain to that of your transmitting antenna. I prefer a unity-gain situation when using a low-noise receiving antenna.

A common-gate JFET first stage in the preamplifier will yield a low noise figure and provide approximately 10 dB of gain. This may be followed by an IC amplifier, such as the Motorola MC-1350P. This chip has provisions for a manual gain control. It is necessary only to vary the IC bias by means of a potentiometer when changing the gain. An MPF102 or 2N4416 FET that is used with an MC-1350P IC will provide up to 50 dB of gain. I hope to develop a preamplifier of this type for presentation in *QST* later on.

Summary

When it comes to low-noise MF and HF reception, the name of the game is *experimentation.* A number of makeshift systems offer the promise of improved reception. This depends on your location, available real estate and the type of man-made noise in your immediate area. A good low-noise receiving antenna may be the tool you need to obtain your DXCC award on 160 meters. Don't be reluctant about experimenting!

Notes

[1]B. Boothe, "Weak-Signal Reception on 160—Some Antenna Notes," *QST*, Jun 1977, pp 35-39.
[2]H. H. Beverage and D. DeMaw, "The Classic Beverage Antenna Revisited," *QST*, Jan 1982, pp 11-17.
[3]D. DeMaw, "Beat the Noise with a Scoop Loop," *QST*, Jul 1977, pp 30-34.
[4]ORA Electronics, 20120 Plummer St, PO Box 4029, Chatsworth, CA 91313. To order, phone 1-800-423-5336. Catalog available.
[5]J. Sevick, *Transmission Line Transformers*, 1st edition (Newington: ARRL, 1987). Available from HQ for $10 plus $2.50 (book rate) or $3.50 (UPS), or from your local dealer.

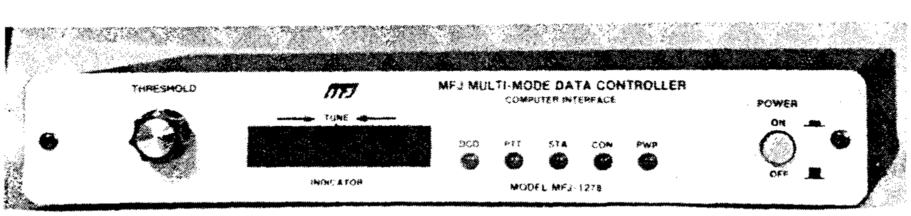
New Products

MFJ MULTI-MODE DATA CONTROLLER

□ MFJ has introduced the model 1278 data controller. The unit supports packet radio, ASCII, Baudot, CW, SSTV, HF FAX and CW contest-keyer operations. The 1278 features high-performance HF, VHF and CW modems, software-selectable dual-radio ports, a tuning indicator and 32 kbytes of RAM. An ac-operated power supply is built in. External equipment requirements include an HF or VHF radio and a computer with a serial port and terminal software.

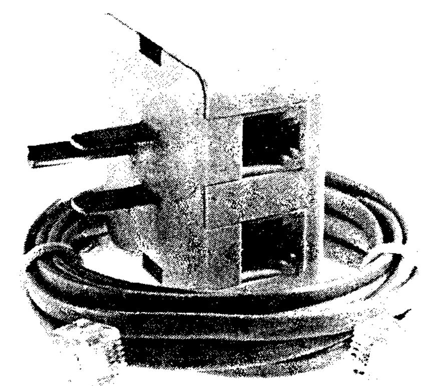
MFJ offers a package of materials to get you started with the 1278. The Starter Pack includes a computer interface cable, terminal software and an instruction manual. Versions are available for the Commodore 64/128™, VIC20™, and the IBM® PC or compatible computers.

The 1278 automatically sets itself to match your computer data rate. It also features a threshold control to compensate for varying band conditions, lithium battery backup, a tune-up command, RS-232-C and TTL serial ports and a watchdog timer. Included with the 1278 is a package of test and calibration software and instructions for use. Price class: 1278 7-mode data controller, $249.95; Starter Pack, $19.95. Manufacturer: MFJ Enterprises, Inc, PO Box 494, Mississippi State, MS 39762, tel 800-647-1800 or 601-323-5869.—*Rus Healy, NJ2L*



KALGLO TELEPHONE LINE/MODEM SURGE PROTECTOR

□ The KALGLO Electronics TLP-2 is a surge suppressor designed to eliminate damaging transients from telephone lines.



The TLP-2 plugs into any three-prong ac wall outlet, and has modular telephone jacks for phone and modem cables. The transient discharge system is a two-stage circuit using MOVs and gas-discharge tubes that shunt transient energy to the ground pin of the ac outlet. Response time is rated at 1 ns and maximum energy dissipation is 142 joules. Maximum voltage and current ratings are 6 kV and 14 kA, respectively. Price class: $39.95. Manufacturer: KALGLO Electronics, Inc, 6584 Ruch Rd, East Allen Twp, Bethlehem, PA 18017-9359, tel 800-524-0400 or 215-837-0700.—*Rus Healy, NJ2L*

NCG TRIBAND BASE AND MOBILE VHF/UHF ANTENNAS AND TRIPLEXER

□ Two series of VHF/UHF triband antennas are available from NCG Co of Anaheim, California. The CX-901 is a one-piece fiberglass antenna for base-station use on the 144, 440 and 1260-MHz amateur bands. Power handling is rated at 150 W on all three bands. The antenna comes with a type-N connector, and has a 50-Ω feed impedance. Overall length is 3 ft, 4 in. The CX-801 mobile antenna covers the same bands as the CX-901, with a folding 3-ft, 3-in. stainless-steel whip. Power handling capability is 100 W on all three bands. The connector and feed impedance are the same as those of the CX-901.

The CX-801 and CX-901 are designed to operate with the CFX-4310 triplexer, allowing simultaneous use of one antenna and feed line on more than one band. (The triplexer can be used with antennas other than the CX-801 and CX-901.) Triplexer passbands are 1.3 to 150 MHz, 400 to 500 MHz and 900 to 1300 MHz. Power ratings are 1000 W from 1.3 to 60 MHz, 800 W from 100 to 150 MHz, 500 W from 400 to 500 MHz and 200 W from 900 to 1300 MHz. For more information on the CX-801, CX-901 and CFX-4310, contact the NCG Co, 1275 North Grove St, Anaheim, CA 92806, tel 714-630-4541. —*Rus Healy, NJ2L*