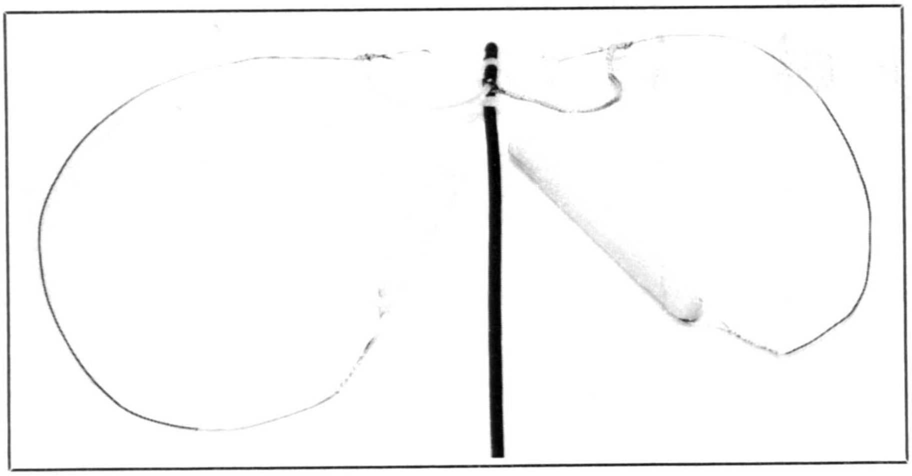

Wire Antennas for the Beginner

Every ham knows how to make and install wire antennas. But if you've never done it, you probably have a few questions. Here are some answers.

By George H. Woodward,* W1RN

Ah, spring — when girls' thoughts turn to boys and boys' thoughts turn to baseball. But if you're a ham of either sex the pleasant weather probably inspires thoughts of improving your antenna farm. Although many experienced amateurs insist that an antenna will work best if it's installed during a howling blizzard, such an approach is a bit intimidating for a newcomer. There's no need to fight the natural elements until you've mastered the electrical and mechanical elements.

Do it With Wire

Almost every ham likes to experiment with antennas. Your first antenna very likely won't be your last, but you have to start somewhere. Towers and beams are great, but save all that money and effort for later and start with a wire antenna. Why wire? "Skyhooks" made with wire are relatively inexpensive compared to aluminum-tubing types. And they're easy: easy to build, easy to install, easy to disguise and easy to modify.[1] Further, wire antennas are fun to experiment with. Your practical experience will bring your antenna textbooks and tutorial articles to life. Finally, making wire antennas is a rite of passage — you haven't really paid your dues until you've successfully deployed one or two.

Convinced? Good. But there are so many different antennas — which one should you start with? Here are several considerations that will influence your decision:

1) Safety
2) Available real estate
3) Available supports
4) Single-band or multiband operation
5) Possession of or need for a Transmatch
6) Type of operation (stateside or DX)

There may be some compromises inherent in these conditions. For example, if your goal is to work the long path between New England and Japan consistently on 80 meters, you won't make it with a 40-foot wire that's only 20 feet above ground.[2] Above all, follow this safety rule: *Never install an antenna where it can contact a public utility wire.* You may have a pair of 70-foot trees perfectly positioned to support a wire beam aimed at your favorite DX area. But if a power line runs between the trees, forget it.

If you have plenty of room for a real antenna "farm," then a separate antenna and feed line for each band is the way to go. Space is a real constraint for most of us, though, and we usually must ask a single antenna system to work on several bands. A modest multiband radiator can provide satisfactory results if your expectations aren't too high. A reasonable and realizable goal for a Novice station using one antenna on four bands is to work all states and Canadian provinces, along with some casual DX (Europe and South America for East Coast stations, and Japan and Australia for West Coast stations).

The most common multiband system in use today is a random-length wire coupled to the transmitter or transceiver through a Transmatch, as sketched in Fig. 1. The beauty of the method is its simplicity — just get the flat top portion of the radiator as high as possible, using whatever safe supports are available. Here's the major drawback: You'll need a Transmatch (also called an antenna tuner or antenna coupler) to transform the antenna feed-point impedance to a value the transmitter can deliver power into. A Transmatch is an extremely useful device, but it would be nice if you didn't have to use one, especially if you've just spent your last penny on a transceiver.

The other "rub" is the ground connection. If the radiator is near an odd multiple of a quarter wavelength, a poor ground connection will degrade the radiation efficiency. If the radiator is near a multiple of a *half* wavelength, a poor ground can introduce "rf-in-the-shack" problems. Symptoms of this malady include rf burns from equipment chassis, erratic keyer operation, automatic shutdown of solid-state transmitters and poor VFO notes. If you can locate your station

[1]Notes appear on page 38.

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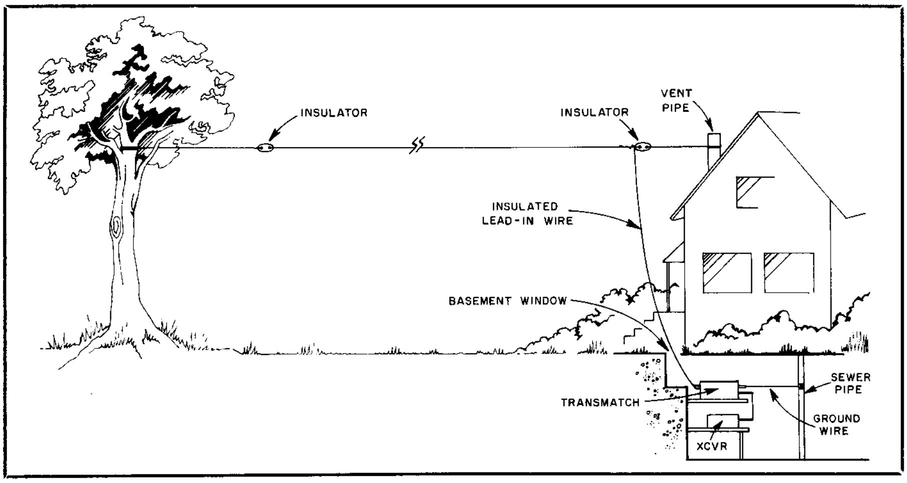

Fig. 1 — A typical end-fed random-wire antenna usable on all hf bands. The assets and liabilities of this system are discussed in the text.

in a basement utility room, the cold water inlet and/or sewer pipe will provide a good ground almost free. The shield braid from RG-8/U coaxial cable makes a good grounding strap. Sand, scrape or brush the pipe and attach the strap with an automotive hose clamp. Test your grounding pipe with a VOM — you should read full ac line potential between the "hot" side of a power outlet and the pipe. If you don't get this reading, your pipe probably has plastic couplings, which must be shunted with braid.

If you can't operate from the utility room, the next best spot is a ground-floor room with a window. A few 6- or 8-foot copper-clad stakes driven into the soil just below the window may provide an acceptable ground.

It's still possible to use an end-fed antenna from an upper floor, but it can get a little tricky. Water pipes aren't much good as rf grounds up there, so you'll have to use a *counterpoise* to create an artificial ground. A counterpoise is a quarter-wavelength wire (radial) that is connected to the Transmatch chassis at one end and open at the other end. One such wire is required for each band. They needn't be straight, but can run around the baseboards. The open ends will have high rf voltage, so make sure they're well insulated. A counterpoise supplies the "missing half" of the antenna system and will radiate a fair amount of energy. Your shack will be in the rf field when you use a counterpoise, but the equipment chassis should be cold. It should be possible to tame the rf in the shack by bonding all the chassis together and keeping all cables short. For safety you should still have a water-pipe connection or ground rod.

Whys and Hows of the Hardware

There's a lot of information in Fig. 1, but you might still have some nagging questions. For example, what size wire should you use? Electrically, it doesn't matter. Here's why: The current in an antenna varies along its length, being zero at the ends and maximum at the center of a half-wavelength section. (A current maximum is called a current *loop,* and a minimum is called a *node.*) The ratio of voltage to current at any point along an antenna is called the *radiation resistance.* This has nothing to do with the wire resistance, but accounts for the work the antenna performs as a *transducer* in converting the electrical energy produced by the transmitter into an electromagnetic field. The radiation resistance is the equivalent value of resistance that would dissipate the transmitter energy as heat instead of radiating it as an electromagnetic wave.

A half-wavelength antenna installed at a typical height over typical earth has a radiation resistance of about 50 ohms at the current loop. The transmitting equipment used by most Novices can produce about 100 watts of rf output. These two pieces of information and Ohm's Law will allow us to calculate the maximum current in the wire.

Recall that voltage equals current multiplied by resistance:

$$E = I \times R \qquad \text{(Eq. 1)}$$

and that power equals voltage multiplied by current:

$$P = E \times I \qquad \text{(Eq. 2)}$$

Substituting I × R for E in Eq. 2 we get:

$$P = I^2 \times R \qquad \text{(Eq. 3)}$$

Solving for I yields:

$$I = \sqrt{\frac{P}{R}} \qquad \text{(Eq. 4)}$$

When we plug in 100 watts for the power and 50 ohms for the resistance, the current comes out to be $\sqrt{2}$, or about 1.4 amperes. A bare no. 20 copper wire is good for 11 amperes dc in free air, so we can get away with a pretty small conductor for only 100 watts.

But the direct current rating can't be strictly applied to rf service because of the *skin effect,* which causes rf current to flow only on the surface of the conductor. This means that a no. 20 wire couldn't be counted on to withstand 6 kW in an antenna. On the other hand, the current has its maximum value in only one place in every half-wavelength section — the current gradually decreases toward the ends, so the low-current portions can act as heat sinks for the current loops. Perhaps that's more theory than you were expecting, but now you understand why you can use skinny antenna wire with your 100-watt transceiver even though the power-supply cable is fat.

With the electrical matter disposed of, the question of wire gauge becomes one of strength, ease of handling, cost, availability and visibility. The strongest wire that's suitable for antenna service is copper-clad steel, also known as Copperweld®. The copper coating is necessary for rf service because steel is a relatively poor conductor. Practically all of the rf current is confined to the copper, because of the skin effect. Copper-clad steel wire is outstanding for permanent installations, but can be difficult to work with. Kinking, which severely weakens the wire, is a constant threat when handling any solid conductor.

Enamel-coated "magnet wire" is a good choice for experimental antennas because it's easy to manage and the coating protects the wire from the weather. Although it stretches under tension, this will have no serious electrical consequences in a random-length antenna such as the one sketched in Fig. 1. If periodic adjustment of the tension is a nuisance after the antenna has been installed, the wire can be prestretched. A local electric motor rebuilder might be a good source for magnet wire.

It doesn't really matter whether the wire is insulated or bare (in the hf range, at least). Portions that could be touched by persons or animals, however, should be insulated to prevent shocks and burns. The lead-in in Fig. 1 is an example of a wire that should be insulated. This wire may be subject to some movement, so it's best to use stranded conductors. Hook-up wire, speaker wire and even ac zip cord are suitable for this service. Solid or stranded wire can be used for the main radiator, provided the ends are properly prepared. This subject will be taken up shortly.

The next question might be "how high should the antenna be?" Almost invariably the answer is "as high as possible." The height affects the radiation angle, azimuthal directivity, radiation resistance and ground losses. For Novice work, there's no need to be concerned much about directivity, and matching the radiation resistance isn't a problem. But ground losses can eat up a large chunk of your signal if the antenna is too low. The "high as possible" rule has its limitations, too — DXers often argue that 200 feet is too high because of unfavorable radiation angle and other considerations such as feed-line loss. These arguments are academic for most of us — if you can get most of the radiator up 25 feet or higher, that should be satisfactory for many good contacts on all bands. *The ARRL Antenna Book*[3] has a thorough treatment of the effects of antenna height.

What about length? So far, all we've said is "random," along with some references to fractional wavelengths. A *wavelength* is the distance between two points in the radiation field having equal intensity and phase. Wavelength is related to the speed of light and the signal frequency:

$$\lambda = \frac{c}{f} \qquad \text{(Eq. 5)}$$

where
λ = wavelength in feet,
c = velocity of light in space ($\approx 9.8 \times 10^8$ ft/s)
f = frequency in cycles/s (Hz)

A wavelength at 7.1 MHz would be

$$\frac{9.8 \times 10^8}{7.1 \times 10^6} = 138 \text{ feet.}$$

Using the metric conversion factor given in note 2, $138 \times 0.3048 \approx 42$ meters, which explains the name for the "40-meter" band.

To exhibit reasonable radiation efficiency an antenna should be at least a quarter wavelength long. Shorter antennas can be made to work well, too, but only if you pay careful attention to conductor and ground losses. So if you want the antenna of Fig. 1 to work on 80 meters, it should have a total length (flat top plus lead-in) of at least 60 feet. An end-fed antenna that is near a quarter-wavelength long is called a *Marconi,* and one that is near a half-wavelength long is called a *Hertz.* A 60-foot end-fed wire is a Marconi on 80 meters and a Hertz on 40 meters. If a 30-foot length is all you can manage, then 40 meters might be your lowest band, but you should give 80 a try anyway — you might be suprised.

You'll need insulators at the ends of the wire. High voltage exists at the free end of an antenna, so you can't just tie the wire to a tree. The tree is neither a good insulator nor a good conductor — it's a resistor. And a resistor is what's inside your dummy load. A perfect insulator would be transparent to your signal and a perfect conductor would reflect or reradiate it. But a tree will absorb and dissipate your signal and may even catch fire. For that reason, the radiator should terminate in an insulator outside the branches. Antenna insulators can be purchased from several *QST* advertisers, but it's easy to make your own. Quarter-inch-thick Plexiglas® is excellent insulating material for the hf bands and can be cut easily with a hacksaw. Drill holes near the ends for the wire loops to pass through, and chamfer these holes to reduce wear on both the wire and insulator. Both commercial and homemade insulators are shown in the title photo. Don't make the loops too tight — they should bear freely on the insulator holes. Twist the wire end back on itself and solder the splice thoroughly, filling in the crevices. Do this indoors if possible, because a cool breeze blowing on a long copper wire will suck the heat out of a soldering iron in no time. You may have to use a propane torch to solder outdoors. A liberal coating of clear acrylic lacquer will retard corrosion of the splice.

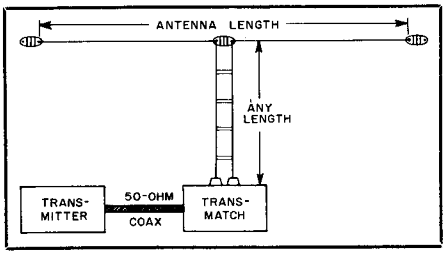

Fig. 2 — This classic antenna is back in vogue because of the widespread use of Transmatches with modern transceivers.

Putting It Up

Buildings often have built-in antenna supports, or at least the inspirations for supports. Examples of these are chimneys, vent pipes and balcony railings. A couple of sections of TV mast strapped to a chimney can really put an antenna up in the clear. Watch those power lines, though!

Use nylon cord for the halyard between the antenna end insulators and the supports. Nylon is the material to use because it can withstand high shock loads. A diameter of 1/8-in. is sufficient for all but the heaviest antennas. Depending on the weave, this cord is called either no. 4 mason line or parachute cord. The halyard can be passed through an eye hook screwed into the top of a mast for hoisting.

The support for the antenna end away from the house is likely to be a tree. Getting a halyard into the highest part of a tree can be a challenge. The most direct approach is to climb the tree, but this is often impractical. The alternative is to propel the line by some mechanical means. Many ingenious methods have been devised for this task, including using a bow and arrow, fishing rod or slingshot. Stay away from harpoon guns and nautical shot lines unless the tree is really high and the area is free of persons, animals or property that could be damaged.

If you're striving for only modest height, a small power transformer will carry a line over a branch and to the ground. Hold the line about 2 feet above the weight and sling it underhand for a healthy centifugal boost. Streamline your projectile as much as possible to keep it from snagging branches and to make it easier to retrieve — several tosses will probably be necessary to get the halyard where you want it. Use very small line on the projectile and then tie on the heavier halyard and hoist it with the light line. Tape your knots to prevent snagging.

What About Center Feed?

A random-length, end-fed wire can perform well, but there are situations that call for a different approach. Perhaps your house is *between* two good antenna supports. In such a case a center-fed antenna may be a good idea. A significant advantage of the center-fed configuration is that you don't need a ground to establish an rf current return. You still need one for electrical safety, but its length isn't important. A flat top of 65 feet or longer that is center fed with open-wire line is usable over the entire hf spectrum. Fig. 2 illustrates this versatile antenna. The lead-in doesn't radiate because the current in the two conductors is flowing in opposite directions at any instant. Because the conductors occupy almost the same space, the two fields cancel each other almost completely. The feeder should be dropped at right angles to the flat top to preserve the current balance.

A half-wavelength flat-top center fed with open-wire line is sometimes called a center-fed *Zepp,* after its end-fed cousin that was trailed from airships called zeppelins. Operated at the second harmonic, it becomes a *double Zepp.*

The Transmatch used to couple the open-wire feeder to a 50-ohm transmitter must be capable of working into a balanced load. Many commercial Transmatches have ferromagnetic baluns that are somewhat particular about the impedance they look into. A link-coupled Transmatch[4] is especially well suited for feeding open-wire line.

Resonant Antennas

Most modern transceivers are designed to work into a 50-ohm resistive load. If the load deviates too far from this value, a solid-state transmitter will reduce power or trip off completely. Most hams who have solid-state rigs have resigned themselves to the seeming necessity for a Transmatch. Is there a way out? Of course — use an antenna whose feed line presents a proper load to the transmitter.

The simplest antenna that can be made

to present the proper impedance to a solid-state transmitter without a Transmatch is a half-wavelength dipole fed in the center with coaxial cable. A miniature model is featured in the title photograph.

Coaxial cable is a convenient transmission line because the rf current flows (in opposite directions) on the outside of the center conductor and the inside of the outer conductor. The field is contained within the outer conductor, so the cable is *shielded.* Ideally, no current flows on the *outside* of the outer conductor. This property makes coaxial cable easy to handle because it can be installed anywhere (and the outer conductor can contact anything) without upsetting the internal rf currents. (Practical considerations sometimes deface this beautiful picture, but we'll deal with them later.)

How long should a dipole be? Earlier, we derived a crude formula for wavelength, but the effects of insulators and loops at the wire ends weren't considered. The formula most often used for cutting an hf dipole is

$$\ell = \frac{468}{f} \qquad \text{(Eq. 6)}$$

where
ℓ = length in feet
f = frequency in megahertz

This is the total length between the far ends of the insulator loops. The pigtail leads from the coax cable to the flat top are part of the radiator, too. Their length is significant at 28 MHz but practically unnoticeable at 3.5 MHz.

A popular variation of the horizontal dipole is the inverted V. This antenna is supported in the center and the ends droop to form an interior angle of 90 to 120 degrees. Don't make the angle any more acute than this because the fields from the two radiator halves will cancel just like a transmission line.

As you might expect, drooping the ends modifies the resonant frequency and feed-point impedance. Antenna impedance has been neatly explained by Hall in a recent *QST* article.[5] Bill Orr recently reported some length formulas developed for inverted Vs by Ohi, JA5COY.[6] The total length for a 120° inverted V is

$$\ell = \frac{465.6}{f} \qquad \text{(Eq. 7)}$$

For the 90-degree model the formula is

$$\ell = \frac{463.3}{f} \qquad \text{(Eq. 8)}$$

where ℓ and f have the same meanings as in Eq. 6. Lengths for all three dipole configurations are given in Table 1. These are *starting* lengths. Proximity to metal structures (such as other antennas) may alter the resonant frequency and impedance.

The inverted V is attractive not only because it requires just one support, but also because it needs less horizontal space than a standard dipole. Some high-school geometry shows that the 80-meter Novice dipole from Table 1 needs only 109 linear feet when configured as a 120° inverted V and can be shoehorned into 89 feet if the apex angle is 90 degrees. The same geometry shows that the minimum pole height is 32 feet for the 120° model and 45 feet for the right-angle case. We'd like to keep the ends at least 10 feet off the ground to prevent detuning or accidents (the ends can have high voltage, remember?). That calls for an apex height of 55 feet, which may be difficult to achieve with an existing or inexpensive support.

Table 1
Half-Wave Dipole Lengths for the Novice Bands

	Configuration		
Freq. (MHz)	*Horizontal (Z ≈ 73 Ω)*	*120° inv. V (Z ≈ 50 Ω)*	*90° inv. V (Z ≈ 30 Ω)*
3.725	125',7-1/2"	125'	124',4-1/2"
7.125	65',8-1/4"	65',4"	65',1/4"
21.15	22',1-1/2"	22'	21',10-3/4"
28.15	16',7-1/2"	16',6-1/2"	16',5-1/2"

But we can soften the height requirement by taking some liberties with the antenna ends. For example, if you must use a 90-degree inverted V and have only a 45-foot apex support, the antenna ends would just touch the ground. If we can bend a dipole in the vertical plane, however, we can bend it in the horizontal plane as well. Simply tie off the last 14 feet of each leg horizontally. The horizontal portions will be the desired 10 feet above ground. The horizontal sections can extend outward in the plane of the V or can be perpendicular to the plane. If you run them perpendicular to the V, placing them on opposite sides of the V plane is preferable to placing them on the same side. This is because the fields from the extensions will partially cancel each other if the conductors are parallel. The small loss of radiation isn't important but the resulting change in impedance and resonant frequency may be tricky to deal with. Similarly, don't run the extensions in toward the support if you don't have to — this can also complicate the adjustments.

Dipole Details

Techniques for putting up a dipole are similar to those for putting up an end-fed random-length wire. The dimensions need to be measured carefully, of course, to permit feeding the antenna without a Transmatch. Other than that, the only new ground to cover is the center insulator and the feed line.

The center insulator serves as an attachment point for the feed line. In addition, this component is the suspension point in an inverted V. Center insulators are available commercially, but here again it's cheaper to make your own. A Plexiglas® center insulator is shown in the title photo. It's made in much the same way as an end insulator except for some additional holes to anchor the feed line. A hole or notch at the top of the insulator locates the coaxial cable and two smaller holes on either side allow a locking cable tie to be passed through the insulator and around the cable. Notice how the cable is routed up the back of the insulator, over the top and down the front.

This arrangement serves the dual purposes of strain relief and moisture resistance. Having the pigtail leads pointing down forces water to overcome gravity to enter the cable. Water can still migrate up (and down) the braid by capillary action, so a dab of RTV sealant at the cable end is in order. Solder the pigtail leads to the wire loops and spray some clear lacquer on the connections.

A dipole center insulator needn't be as long as an end insulator. That's because the center is a current loop, where the voltage is minimum (voltage node). Voltage as a function of power and resistance is given by

$$E = \sqrt{P \times R} \qquad \text{(Eq. 9)}$$

where
E = rms potential in volts
P = power in watts
R = resistance in ohms.

Since a typical Novice transmitter puts out about 100 watts and we're shooting for a resistive impedance of 50 ohms, the potential will be $\sqrt{100 \times 50}$ or 70.7 volts, which doesn't require much of an insulator.

Now we come to the feed line. I recommend RG-58/U cable because it's light, easy to handle and relatively inexpensive. True, it *is* lossier than the larger RG-8/U, but unless you're using 100 feet or more at 28 MHz, the difference isn't significant. For long runs, you can compromise by using RG-8/U for the major section and RG-58/U for the portion that hangs from the center insulator. The radiator doesn't support the feed line on an inverted V, so you can run RG-8/U all the way up if desired.

The title photo shows the center conductor and dielectric neatly separated from the shield braid, but it doesn't show how to separate them. This process is explained in Fig. 3. You'll need a connector at the station end of your feed line. Most likely, your equipment will have an SO-239 (UHF female) receptacle, for which you'll need a plug from the PL-259 (UHF male) family. Fig. 4 illustrates the assembly procedure for common combinations of cables and connectors.

If you use the solder-on style of connector, soldering the braid can be tricky. In general, coaxial cable braid coverage isn't what it used to be, so don't be discouraged if you're not successful on the

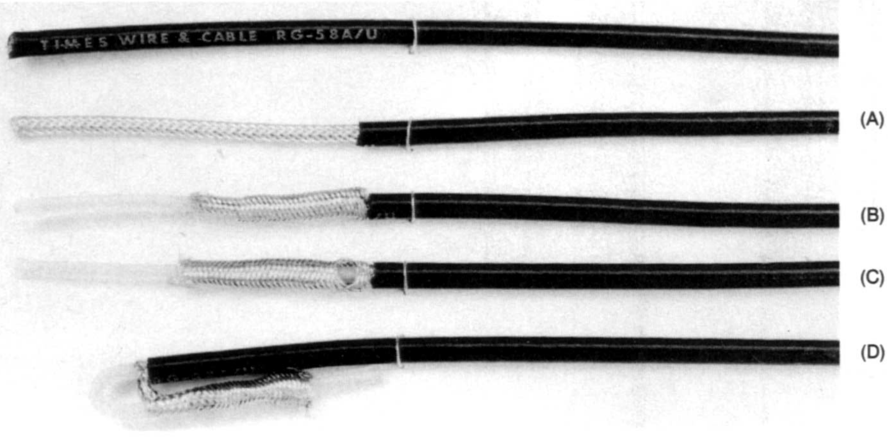

Fig. 3 — The conductors of a coaxial cable can be separated in four easy steps. A — Remove the outer sheath with a knife, being careful not to nick the braid. B — Push the braid accordian fashion against the sheath. C — Make a hole in the braid by separating the strands. D — Bend the cable at the hole and pull the center conductor and dielectric through.

first attempt. When the braid is sparse, pretinning it will ease the soldering job. Use a big iron or gun to solder the braid through the connector body holes — the pencil iron you use for pc boards just won't cut it. The idea is to heat the connector body *quickly* to soldering temperature and remove the iron as soon as possible. If you have foam-dielectric cable, the foam will bubble and ooze through the holes if you heat the body too long. When the connector assembly is complete, check for short circuits and continuity with a VOM.

Making it Work

Once the dipole is up, it's time to test it. The first thing to do is listen for signals. If the band isn't active, listen for natural or man-made noise — alternately connecting and disconnecting the antenna should have a marked effect on the background noise if the receiver sensitivity is adequate. Failure of this test means something has gone wrong — perhaps there's a short circuit or a connection has fallen apart.

The transmitting test depends on the equipment you have. If you have a transmitter with tube finals (and tune and load controls), just fire it up into the feed line. If the controls behave normally, that is, produce the proper plate dip and loaded current without running out of range, that's good enough — test no more.

You can try something similar with a solid-state rig, too. The test here is to see if the transmitter will draw the rated collector current with the same drive level used with your dummy load. These transmitting tests are best conducted when the band isn't too active, meaning daylight hours for 80 meters and late night for 10.

If the transmitter won't deliver power to the antenna, some different tests are called for. Ask a friend with a higher-class license to try to find the resonant frequency by trying several spots across the band. If the antenna resonates at a frequency that's 5% too low, shorten the wire by the same percentage and try again. If the antenna doesn't resonate inside the band, you can find the resonant frequency with a noise bridge and a general-coverage receiver.[7]

Suppose the antenna resonates in the band, but the system just won't take power. In that case, the SWR is probably too high for your transmitter. The radiation resistance of a horizontal dipole can be altered without significantly affecting the resonance by changing the height. Inverted V antennas are a little easier to tune. Lengthening the radiator will lower the resonant frequency, of course, but sharpening the apex angle will lower both the resonant frequency *and* the radiation resistance. The Novice subbands are only 50- and 100-kHz wide, so it should be possible to achieve an SWR of 1.5:1 or less across this segment. Any transmitter should be happy with that.

What if everything is cut right and it still won't load up? It sometimes happens, and to explain why we must expose the imperfection of coaxial feed. Recall that the transmission-line current in coaxial cable flows on the outside of the center conductor and on the *inside* of the outer condutor. The current is confined to the inner surfaces by induction and the skin effect. The skin effect completely isolates the inside of the shield from any currents that may be flowing on the outside. The outside of the shield becomes a *third conductor* connected to the feed point. Depending on the length and routing of the cable, this conductor can severely detune the dipole. It is this effect that sometimes causes the SWR reading to change radically with the length of the feed line, in apparent defiance of transmission-line theory.

The solution is to choke off or decouple the outside of the cable. One way is to attach an earth ground to the shield an odd number of quarter wavelengths from the feed point.[8] This ground will be transformed into a very high impedance at the feed point, keeping rf current off the shield. The limitation of this approach is that it only works on one band or bands that are odd multiples, 40 and 15 meters for example. If you need a broadband decoupler, some excellent designs are described by Cooper and Reisert.[9,10]

Antenna current can appear on your cable from *induction* as well as conduction. Induction can be minimized by orienting the feed line as symmetrically as possible with respect to the radiator, running the cable at right angles to the antenna. Chances are, you won't need any extra devices at the feed point. Direct coaxial feed usually works fine.

Multiband Dipoles

Separate dipoles for each band is an excellent antenna system if you have room. That's a pretty big "if"! A practical multibanding scheme that avoids a Transmatch is to excite several dipoles from a common feed point. Electrically, this arrangement places the antennas in parallel. The interaction isn't too severe, however, because a dipole exhibits a high impedance when operated at a frequency that is far removed from resonance. An 80-meter dipole, for example, shows a very high radiation resistance on 40 meters. Taking the opposite case, a 40-meter dipole fed with 80-meter energy has a low radiation resistance but very high reactance. In either case, the antenna current (and therefore the radiation) is very small. The current applied to the feed point of a multiband dipole takes the path of least impedance, automatically selecting the proper-length radiator.

A Four-band Novice Dipole

Here's one you can build! It covers the Novice segments of 80, 40, 15 and 10 meters, and you should be able to use it without a Transmatch, even if it takes some cut and try. Fig. 5 shows the configuration in a single plane. The radiating elements need not lie in a single plane, however. In fact, my model had the 40/80-meter inverted V skewed about 45° with respect to the 10/15-meter dipole.

Open-wire line is used for the elements for ease of fabrication. It's a simple matter to measure and assemble a 22-foot piece of the line and then cut back one conductor on each side to the proper length for 10 meters. You can do the same thing for the 40/80-meter sections, but you can reduce the amount of open-wire line needed by splicing on a single wire for the 80-meter extension. Open-wire line is sold by several *QST* advertisers, but you can probably obtain it locally from a TV parts jobber. It comes with a characteristic impedance of 300 or 450 ohms. Use either one.

Some of the element lengths given in Fig. 5 deviate considerably from those listed in Table 1. This is because the

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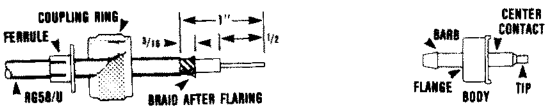
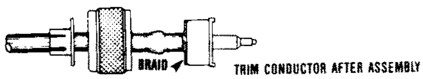
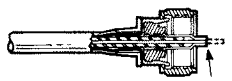


1. Strip cable — *don't nick braid, dielectric or conductor.* Slide ferrule, then coupling ring on cable. Flare braid slightly by rotating conductor and dielectric in circular motion.



2. Slide body on dielectric, barb going under braid until flange is against outer jacket. Braid will fan out against body flange.



3. Slide nut over body. Grasp cable with hand and push ferrule over barb until braid is captured between ferrule and body flange. Squeeze crimp tip only of center contact with pliers; alternate-solder tip.

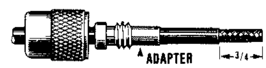
83-1SP PLUG (PL-259)

1. Strip cable, *don't nick braid, dielectric or conductor.* Tin exposed braid and conductor. Slide coupling ring on cable.

2. Screw body on cable. Solder braid through solder holes. Solder conductor to center contact.

3. Screw coupling ring on body.

83-1SP PLUG WITH ADAPTERS



1. Strip jacket. *Don't nick braid.* Slide coupling ring and adapter on cable. Note — use 83-168 (UG-175) adapter for RG-58/U and 83-185 (UG-176) for RG-59/U, RG-8M or RG-8X.

2. Fan braid slightly, fold back over adapter and trim to 3/8". Strip dielectric and tin exposed conductor. *Don't nick conductor.*

3. Screw body on adapter. Follow 2 and 3 under 83-1SP plug.

Fig. 4 — Cable stripping dimensions and assembly instructions for several popular coaxial cable connectors. This material courtesy of Amphenol Electronic Components, RF Division, Bunker Ramo Corp. (Dimensions on this drawing are in inches.)

Novice bands don't have an exact harmonic relationship and the nonresonant sections couple reactance into the working section. The only way to tune out this reactance is to adjust the element lengths. While the interaction necessitated a lot of adjustment, the shortening of the 80- and 40-meter sections is a blessing, in that less height and horizontal space are required. The 10-meter dipole (actually somewhat a "noninverted V") had to be made a little longer than formula, but the 15-meter antenna was about right. Start with the lengths in Fig. 5, but be prepared to make some adjustments for your installation.

The supports for this antenna need be only 22 feet apart. Perhaps your house has a chimney and vent having this much separation. Then the inverted V can straddle the peak of the roof. The test model had an apex angle of about 120°.

Here's a final word of caution about multiband antennas — they don't discriminate against harmonics. That means you must be careful to tune up your transmitter properly, especially if it's one of the older oscillator-multiplier types. If the plate current dips at more than one position of the tuning control, use the dip corresponding to maximum plate tank capacitance.

I installed this antenna on the roof of the headquarters building on Ground Hog's Day, with the help of Mike Kaczynski, W1OD. We put it up in a temporary fashion in balmy (for winter) weather. We didn't have the time-tested performance advantage gained from erecting it during a howling blizzard, but the thing (surprisingly) has survived three major snowstorms. As soon as it was up and trimmed, I answered the first CQ I heard on each of the four Novice bands. Starting at about 8:30 in the morning I worked Vermont on 80, Kentucky on 40, Luxembourg on 15 and Germany on 10, all with good signal reports. Not a world-beater by any means, but entirely respectable. Have fun with *your* antenna. Despite what others may tell you, start now, while the weather is nice!

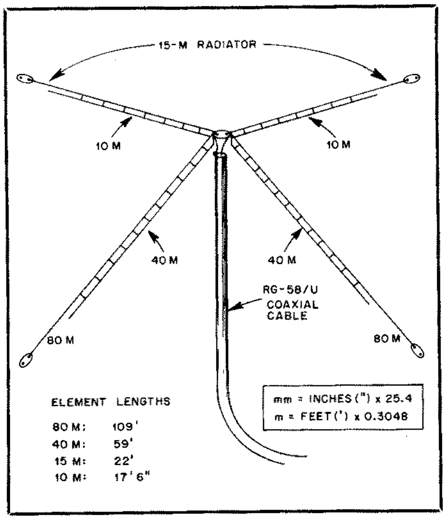


Fig. 5 — A multiband dipole that will work over all four Novice bands without a Transmatch. Construction details are given in the text.

Notes

[1]D. DeMaw, "Antennas for Those Who Can't Have Antennas," *QST,* Feb. 1983, pp. 15-17.

[2]meters = feet × 0.3048, mm = in. × 25.4.

[3]G. Hall, ed., *The ARRL Antenna Book,* 14th ed. (Newington, CT: The ARRL, Inc., 1982), pp. 2-16 to 2-23.

[4]*The ARRL Antenna Book,* pp. 4-5, 4-6.

[5]Hall, "A Simple Approach to Antenna Impedances," *QST,* March 1983, pp. 16-19.

[6]W. Orr, "Ham Radio Techniques," *Ham Radio,* Dec. 1982, p. 58.

[7]G. Woodward, ed., *The Radio Amateur's Handbook,* 60th ed. (Newington: ARRL, 1983), pp. 16-34 to 16-36.

[8]R. Dome, "Balanced Dipole Antenna Fed By Coaxial Cable," (Technical Correspondence), *QST,* May 1979, pp. 43-44.

[9]W. Cooper, "The Coaxial Cable Balun," *Hints and Kinks for the Radio Amateur,* 11th ed. (Newington: ARRL, 1982), pp. 5-10, 5-11.

[10]J. Reisert, "A Simple and Efficient Broadband Balun," *Ham Radio,* Sept. 1978, p. 12.

Feedback

☐ A number of readers have expressed dismay over Fig. 1 of "Wire Antennas for the Beginner," June 1983 *QST*, p. 34. Some type of stress relief should be used at either end of the antenna support cable to prevent damage to the vent pipe from tree movement. Thanks to the many who wrote us!