

Considering a VHF/UHF Antenna for Your Home?

Are you ready to establish a home station for FM ops on the VHF and UHF bands, and are you wondering what you need to do about an antenna? Let's review some of the things you need to consider in establishing a highly performing antenna for your home station, including antenna types, coaxial cable characteristics, connectors, and more!



During the recent devastating Black Forest fire in central Colorado, my good friend and colleague, Randy, had great difficulty maintaining solid radio communications through our local repeater from his home. His signal just wasn't quite strong enough to be readable. Our local hams kept the repeater very busy during the days of the fire relaying the latest information gleaned from emergency response links, commercial sources, AREA and RACES volunteers, and more. It was a valuable resource in our community for rapidly disseminating fire information.

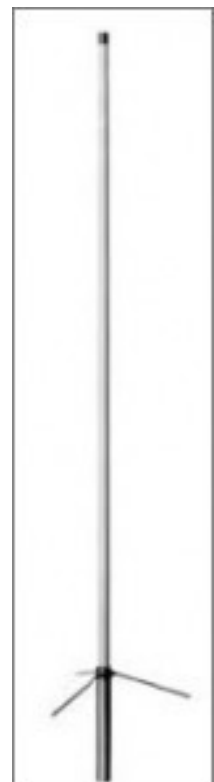
Randy has been using a 2m/440 MHz dual band HT with one of those really convenient, crappy antennas we refer to as a rubber duck. His home is located just on the leeward side of a hill from the repeater that is about 7.5 miles distant. The 5 watts of his HT coupled with the really convenient, crappy antenna just didn't quite provide the performance he needed to reliably hit the repeater with a readable signal.

After the fire emergency, Randy decided it was time to upgrade his station for more reliable operations in the local area. While he plans a future station upgrade to a more powerful mobile-base transceiver, he sought first to improve his home antenna such that he can use the HT in the short term and integrate a mobile-base transceiver later. I had a terrific time helping Randy review some of the factors involved in erecting a VHF/UHF dual band antenna for 2m and 70cm bands and then helping him install and test it out. Let's take a look at some of the things Randy and I considered for his antenna project and wrap up with a description of his solution.

Some Antenna Considerations

In one brief article we can't cover every detail that you might want to think about in selecting a VHF/UHF antenna for your home or shack, but let's hit a few important factors, including those that Randy had to consider with his project. We'll start with a few important decisions you need to make.

Commercial purchase or homebrew? There are many, many fine commercial antennas on the market for VHF/UHF operations. I use three or four different ones in my home and in portable station operations of various flavors. Most commercially available antennas are going to provide great performance and even greater convenience! In virtually all cases you can simply buy-and-install with only the requirement of connecting a feed line to the antenna. If you want to open the wallet instead of



the tool box, a commercial antenna is your best choice. For a typical dual-band "base" VHF/UHF antenna designed for exterior mounting on a structure or mast you can expect to pay from \$35 to \$300, depending on quality, durability, and performance factors such as gain.

But if you're the crafty type and enjoy a good challenge, you may want to homebrew your own antenna. There are many simple designs provided by a whole world of hams to choose from. For instance, the J-Pole antenna design for 2m/440 ops is a very popular homebrew project, and it can be created with simple aluminum from the hardware store or even from segments of twin lead feed line. Even easier to construct is a single-band, half-wave dipole, and you can also find plans online for 2m/440 dual band dipoles. Yagi directionals for VHF ops are great projects, if you seek that directional boost in signal gain for your situation. With a homebrew solution you can save some money, but be prepared to invest the time and effort necessary. And remember, every antenna is a compromise, so carefully check out the design and performance reports before finalizing your decision.

Single band or multi-band antenna? With multi-band radios now so readily available to hams, the majority of folks are likely to desire a multi-band antenna with which a single feed line can be used. Probably the most popular combination is the 2m/440 dual band scenario mentioned above, but tri-banders that include the 220 MHz band or the 6m band are very popular, as well as combinations of 2m/220, and other combinations. I highly recommend a dual band radio and antenna for the new Technician Class ham as a starter station, most typically the 2m/440 combo with an antenna to match. However, if the only repeater you intend to use from your home is a 2m machine, and you have no interest in other VHF/UHF band operations, then a single band VHF antenna may be your choice. (Ditto for only 220, 440, or 6m band ops). Consider the local radio resources available to you and how you wish to use them, and then decide what band capability your station and antenna require for those operations.

Antenna location? The type of antenna you obtain and even the specific model or design will likely be influenced by your chosen mounting location. Many hams who live in covenant protected neighborhoods like to mount antennas in the attic to keep them out of sight. The height of your antenna may be limited by your attic's apex, and some signal attenuation may be expected from roof materials, so an antenna that exhibits some gain may be desirable. If you plan to mount your antenna outdoors you may wish to ensure you get a sturdy model that can withstand high winds and that provides moisture protection at the coaxial cable feed point. If you mount in a tree, be sure the motion of tree and limbs will not damage or dislodge the antenna. Location and antenna selection are closely coupled, so think it through before you purchase or brew.

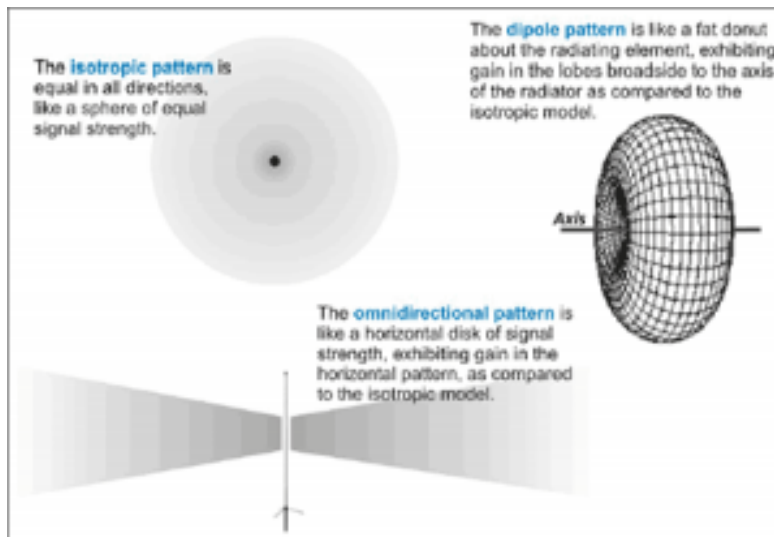


Trees can help conceal antennas or even serve as a growing, green mast!

Antenna gain? Depending upon your situation you may need a little boost in your effective radiated power, or the effective signal strength from your antenna. Many antennas provide signal gain, boosting the effective transmit power at the antenna. If you live quite a distance from a repeater that you'd like to use, and if your transmitter is somewhat limited in its power output, a high gain antenna may help your signal make it there.

Antenna gain is defined in comparison to a reference antenna. Comparing antenna gain to a half-wave dipole is common, and the gain is designated in decibels with the unit reference dBd (the last 'd' for 'dipole'). A model isotropic

antenna is also a common reference point, designated by dBi ('i' for isotropic). Recall that a 3 dB increase or decrease is a factor of 2 comparison. So, an antenna offering 3 dBi will provide double the signal strength (in its main lobe transmission pattern) as compared to the same transmission with a theoretical isotropic antenna that



Comparison of isotropic, dipole, and omnidirectional patterns of signal strength.

radiates equally in all directions, like a sphere. If your antenna specification says 6 dBd, it provides main lobe gain 4X that of a dipole antenna.

For a typical commercial vertical VHF/UHF antenna the gain will usually be compared to the isotropic reference. The signal pattern from such antennas tends to be disk-like in a horizontal omnidirectional pattern, 360 degrees around the antenna. So, the signal strength that the theoretical isotropic antenna spews in every direction of the spherical pattern is vertically squeezed into this disk pattern, providing relative signal gain.

A dipole antenna produces lobes with the strongest signals at right-angles to the radiating element orientation. The weakest signals are out the ends of the radiator. So, a dipole has gain as compared to the spherical isotropic antenna pattern. Thus, when your VHF/UHF antenna is compared to a dipole (dBd gain figures), it is being compared to a higher performing standard than the isotropic reference. Pay attention to whether the gain is expressed as dBi or dBd when comparing antenna performance, and realize that a lower gain figure in dBd may actually be better than a higher figure in dBi. Compare apples to apples,

oranges to oranges. [See more about dBi versus dBd gain comparisons in this [Question of the Week article](#).]

Lastly regarding gain, if you choose a directional antenna with high gain figures, you will usually want to plan for a mounting scheme that allows pointing, or rotating, the antenna. A directional VHF/UHF antenna can help you reach out and tag that distant station, but unless you can readily rotate it you're very limited in your direction of propagation.

Additional Considerations? Other antenna factors that you may want to consider include the height at which you mount your antenna (generally, higher is better), the mounting method you plan to use (mast, tree, attic clamp, strap to chimney, etc.), the length of coaxial cable necessary to reach the location from your transceiver (consider loss), and the polarization you desire (vertical for most FM ops, horizontal for SSB). If you go for that Yagi directional for FM ops, don't forget to mount it with the elements running vertically instead of horizontally. If you need a 150 foot run of coax to get to your antenna, you'd better check your coaxial cable loss figures, as we'll discuss below.

Some Coaxial Cable Considerations

Impedance: It is very important to select coaxial cable with a characteristic impedance that matches your transmitter output and your antenna feed point impedance. For VHF/UHF commercial antennas you are virtually guaranteed to have something close to a 50 ohm feed point as long as you keep the antenna away from other significant conductors in the environment by a wavelength or two. (You probably don't want to mount your vertical antenna right next to the vertical aluminum downspout on your house, for instance.) But virtually all VHF/UHF transmitters and antennas are designed for 50 ohm coaxial cable, and there are many varieties of 50-ohm coax to choose from. How do you know what to get?

Cable Type	Frequency (MHz)	Loss (dB / 100 ft.)
RG-8/U	50	1.2
	100	1.7
	200	2.6
	400	3.9
RG-58/U	50	2.5
	100	3.8
	200	5.6
	400	8.4

Feed Line Loss: One of the chief factors to consider in selecting coax is its loss figures. As signals travel along the conductors they will be attenuated. Higher frequency signals will have more loss in the transmission line than lower frequency signals,

and different designs of coax cable will impose different magnitudes of loss overall. It is easy to compare loss figures among various coaxial cables – most distributors or manufacturers will publish the cable’s loss figures for various frequencies. The most common comparison metric is loss in decibels per 100 feet of cable, like the table here.

Notice that for RG-58/U type cable at 100 MHz (close to the 2m band frequency range) the loss for 100 feet of transmission line is 3.8 dB. That means that at the antenna feed point your transmitter’s signal power will be less than one-half its indicated value on your transmitter (3 dB = 2X).

Generally, lower loss cable types are more expensive than higher loss – you get what you pay for. But if you have a short run of only a couple dozen feet to reach your antenna, the loss may not be that significant and you can save your money. If you have a longer run, more than 50 feet, you may find it advantageous to pay a little more and preserve your effective signal strength at the antenna.

Further, you should also consider the gain of the antenna you select along with the loss imposed by the coax. While the comparison or compensation of antenna gain for feed line loss isn’t necessarily an apples-to-apples situation, you can get a general idea of the combined effects of pairing various cables/lengths and antennas when scheming on your antenna system design.

Coaxial Cable Gauge: How and where you need to route your antenna coaxial cable and the length of run necessary may impact your selection of a coaxial cable gauge, or diameter. Narrow gauge coax such as RG-58 or RG-174 is low profile and quite flexible. It requires smaller holes and it fits corners. However, as noted in the table above, narrow gauge cables tend to impose higher signal losses. Larger gauge coax, such as RG-8, 9913, or LMR 400 is much more noticeable and is usually stiffer and somewhat more difficult to work with. However, the larger gauge cables tend to offer the lowest loss figures. Additionally, some of these larger diameter cables are produced in flexible varieties, such as Belden 9913F7. It combines very admirable loss figures with high flexibility for ease of routing, but it is limited in its power handling capacity to about 300 watts. Still, for most VHF/UHF FM operations this capacity is much more than adequate. Consider the coaxial cable routing for your potential antenna locations and identify the best combination of cable type for location, routing, and loss.

Some Connector Considerations

Common Connectors: A few of the most common connectors used in amateur radio are:

- *PL259 / SO239* – The PL259 is the male connector while the SO239 is the female counterpart. This connector is sometimes referred to as a “UHF connector,” even though its performance at UHF frequencies is not that stellar. This connector combo is very commonly found on mobile and base station antenna connections, and it



serves very well in the HF and UHF ranges. You can obtain PL259 connectors for most of the coaxial cable gauges, although they usually will not be coupled with the narrowest gauge cables such as RG-316 or RG-174.

- *N-Connector* – The N-connector has excellent performance in the UHF range, although it is rarely found at the coax connect point on transceivers. The N-connector offers better protection against water intrusion than the PL259.
- *SMA Connector* – The small SMA connector is very popular on modern HTs, and it offers very good performance in the UHF range. It is comfortably coupled with even the smallest diameter cables.
- *BNC Connector* – This older connector is less commonly used with the advent of the SMA, but it will still be found on some products and older HT radios. It offers good performance for VHF and UHF, and it is mechanically very solid.

Adapters: Converting from one connector type to another can be done with adapters. Almost every conceivable combination is available as single adapters or as short cables with differing connectors on opposite ends. A common adapter is PL259 / SMA combination. With this connector you can readily attach a home antenna system to an HT radio that uses the SMA connector, or dispense with the adapter to connect the PL259 feedline connector into a base station transceiver. Barrel connectors are also useful for extending a cable's length or connecting two male-type connectors via a dual-female barrel.



An SO239 to SMA cable adapter helps connect many types of HTs to larger gauge feed lines.

Randy's Solution

Antenna: Randy wanted to go with an inexpensive commercial antenna, specifically a dual band 2m/440 product. He wasn't too concerned with high gain, as he was able to hit several area mountaintop repeaters with his HT, and he probably needed just a little more height to get over the hilltop for our local community machine. So, he was willing to trade off high gain for low expense.

He also had to consider his neighborhood HOA covenants that prohibit highly visible external antennas. His first preference was to try an attic antenna over his garage and close to his home office operating position. This option provided the shortest coaxial cable length requirements as well, but it was unclear what kind of attenuation he would get from his roof materials. His backup option was to mount a low profile rooftop antenna, strapped to a chimney box, positioned such that it was not obviously visible to surrounding neighbors. This higher, exterior location should provide improved performance over the attic option, if needed.

The attic option imposed a height restriction on the antenna of 66 inches maximum, and if the rooftop exterior option was necessary Randy wanted a low profile antenna. After evaluating several commercial options he selected the Arrow [OSJ 146/440 J-Pole](#) antenna. A J-Pole offers about the same gain performance as a half-wave dipole. It is a simple, inexpensive antenna, and this specific antenna stands about 60 inches high.

Randy's approach was a common one in ham radio: Let's just try it! We would try the J-Pole in the attic location first and see if the performance was



Arrow OSJ 146/440 J-Pole . ~\$39.

*Compliments of
Arrow Antenna.*

acceptable in that configuration, and we would go for the more difficult rooftop location only if necessary.

Feedline: The coax run from the attic location, along the ceiling and down a wall was about 50 feet total, and Randy had purchased 60 feet of Belden 9913F7. He examined several varieties of coax cable and settled on the 9913F7 due to its moderate expense, its flexibility for making tight turns, and its good loss performance in the 440 MHz range (2.8 dB/100' at 400 MHz) – the local community repeater is in the 70 cm band. Since he planned to use his 5 watt HT initially with the antenna system and would not have a higher power transmitter until later, keeping the transmission line loss low was a key consideration. Using the fully available 60 feet of this cable we estimated the loss to be approximately 1.8 dB in the 70 cm band. This would attenuate his 440 MHz effective power at the antenna by about 1/3, or resulting in about 3.3 watts at the antenna with the HT. Given the additional attenuation by the roofing materials, we were dubious that the attic solution was going to be sufficient!

Connectors: Randy purchased the coaxial cable prefabricated, or with connectors already attached. Because the J-Pole antenna was available with an SO239 only, and because most mobile/base transceivers also use the SO239 connector, Randy selected the male counterpart PL259 connectors for each end of the coax segment. Although the N-connector tends to offer better performance for UHF, this was not an option for this antenna. Once again, a bit more loss was to be expected for the UHF transmissions! Still, we would just try it and see! Finally, Randy used a cable adapter as pictured above with an SO239 connector on one end and an SMA connector on the other to attach the antenna to his HT.

Results: Randy mounted the J-Pole in a temporary configuration in the attic just adjacent to the garage pull-down stair access. He routed the coaxial cable down into the garage and connected to the HT. I listened from my truck's mobile station as he pushed-to-talk to the community repeater.



It worked! Randy hit the repeater with a moderately strong and perfectly readable signal. Although not full quieting with just a mild “popcorn” static behind his audio, the signal was clear, steady, and completely readable. We traded positions so that Randy could hear the signal from his new antenna, and he deemed it quite good enough.

Subsequently, Randy installed the J-Pole with more permanent mounting to a rafter in the attic. He routed the coaxial cable above the ceiling and down the

garage wall, and then into his office with a nice cover plate on the interior wall. He’s been on the air reliably ever since, and we hope it doesn’t require another emergency to test the robustness of his rig again!

Nice job Randy! Now, let’s talk about that base station...

~ WØSTU

Share this:



This entry was posted in Ham Radio 101 on July 22, 2013

[<http://www.hamradioschool.com/considering-a-vhfuhf-antenna-for-your-home/>] by Stu Turner.

One thought on “Considering a VHF/UHF Antenna for Your Home?”

Pingback: [I Got My License, Now What? | Ham Radio School.com](#)

Comments are closed.

