SteppIR ™

Yagi ● Dipole ● Vertical

(Patent Pending)

Radial Systems for Elevated and Ground mounted Vertical Antennas

All vertical monopoles need some form of counterpoise in which antenna image currents flow to work efficiently. This counterpoise usually consists of a system of radial wires placed either on the ground or elevated above ground.

This is not an in depth publication but simply a general guide on installing and using the SteppIR verticals. There is much more information available in various publications if you need it. The ARRL Antenna Handbook is a good source for additional information.

By following a few simple guidelines, you can obtain excellent performance from vertical antennas mounted on the ground or elevated above the ground. There are a number of verticals available that say “no radials required”, but they do have “radials”, in the form of a shortened, tuned counterpoise system. As you might expect, you pay a price for such a small counterpoise system—less efficiency.

As you will see in the following pages, you can get fairly high efficiency with a relatively modest radial system that will far outperform small counterpoise systems. It should be noted that counterpoise systems are only good for curing near field losses caused by losses from the earth, which is a poor conductor of RF, even with good soil. There is nothing you can do about far field losses that reduce the signal strength and low angle radiation, except get to some saltwater. We briefly discuss salt water locations later on in this article.

Ground Mount or Elevate?

Ground Mounting:

PROS	CONS
• The radials can be any length and they work on all frequencies • Easy to mount • Easy access • Lower visual profile • Eight to twelve 0.1 wavelength radials gives 60% - 65% efficiency (one set of 8 - 12 radials cut to 0.1 wavelength at lowest frequency)	• Takes 120 radials to equal an elevated vertical with 2 resonant radials (90% efficient) • Surrounding objects can reduce signal strength

Elevated Mounting:

PROS	CONS
• + 90% efficient with two .25 wavelength radials • Antenna is generally more "in the clear", so surrounding objects don't cause as much attenuation • A peaked metal roof will make a very good all-frequency radial system	• Requires two .25 wavelength radials for each band of operation (radials interact, so spacing will affect length) • Mounting is generally more involved • Visually higher profile • Must be mounted high enough that people won't walk into it • Needs to be about .2 wavelengths high to get an ideal 50 ohm match • Radials need at least a 20° slope to get a good match • Involves adjusting and fine tuning the radial lengths in some cases

Ground Mounting:

If you chose to ground mount the vertical, pick a spot that will allow you the best chance of spreading your radials evenly around the antenna, and away from trees and other objects if possible. Mount the antenna within one foot of ground if possible, the closer to ground the better. Next, you will need to determine how much effort and wire you are willing to invest in this installation. The tradeoffs are as follows:

1. More radials equals higher efficiency (see figure 1)
2. More short radials are generally better than a few long ones
3. If only a few radials are going to be used, they need not be very long
4. If you have very good earth (very few of us actually do), you can obtain good performance with very few radials.

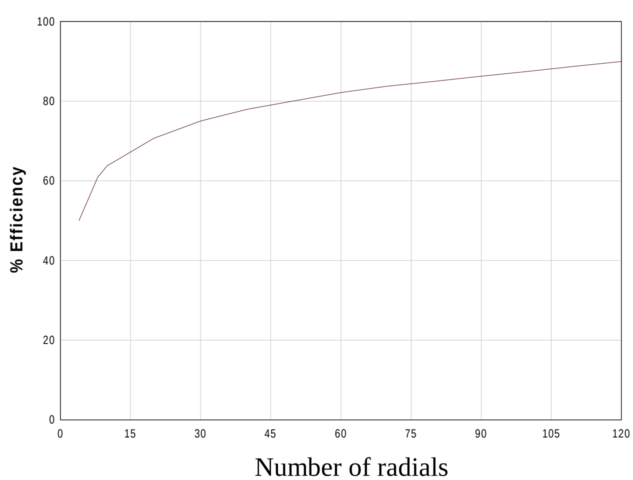

Figure 1

Four radials are what we consider to be the absolute minimum in average soil. How much you have to gain with good a radial system depends on how good your earth is. Most of us have poor earth conditions, so the radial system is important. The worse the earth is, the more can be gained with radials. Figure 2 shows a graph produced by Brian Edward (N2MF) that illustrates the relative signal gain you get with the radials and varying length over poor earth. With better earth, the gain difference between 4 radials and 120 radials will be about 2.5 dB, as opposed to 4 dB with poor earth.

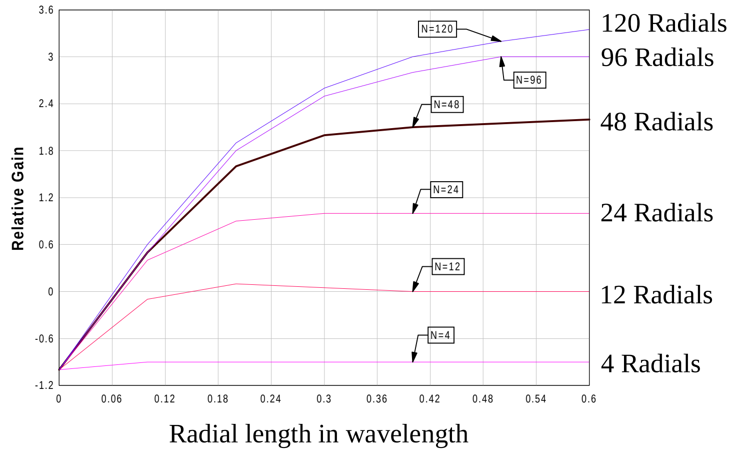

Figure 2

If you are restricted to .1 wavelength radials there is not much advantage to using more than about 24 radials. You can see from figure 3 that if more radials are used there is a huge advantage to making them longer.

If you cannot lay the radials out in a symmetrical radial pattern, don't worry too much - it will distort your omni-directional pattern a bit but won't reduce your efficiency very much. Lay the radials out in the best manner possible given your situation. There are various ways to accomplish laying a radial system, including turning corners, etc. Good results are limited only to your creative energy and determination! Be aware that very high voltages can exist at the ends of radials, so be certain that no one can come into contact with them. It is a good idea to use insulated wire to protect from corrosion, and don't bury the radials any deeper than necessary, one to three inches is sufficient.

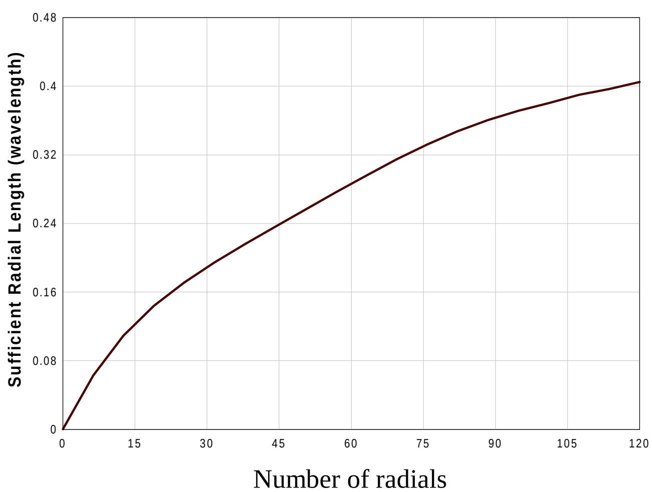

Figure 3

Elevated Mounting:

You can elevate a vertical just a few feet from the ground (4 feet for 20m, 8 feet for 40m) and get fairly good performance with just 2 radials (elevated as well). The problem is you won't have a very good match to 50 ohms, and the close proximity of the earth will degrade the signal - especially if it is poor earth. For ideal matching, we recommend .2 wavelength (about 15 feet on 20m and 30 feet on 40m) at the lowest planned frequency of operation As the height decreases below .2 wavelength, the ground losses start to increase, unless you have very good ground. When a vertical is raised off the ground the impedance drops fairly rapidly from 36 ohms (Over perfect ground or with many radials it will be close to 36 ohms, over real ground it is generally 40– 60 ohms) to about 22 ohms when .3 wavelength is reached. This would make a pretty poor match to 50 ohms, so a couple of tricks are in order. Once you elevate a vertical, two radials are all you really need. It is important that you try to keep a 180° angle between the two (opposed, directly in line) for the best pattern. Spread the radials out as far as possible to reduce interaction, if they are less than a foot apart it can be difficult to get a good match on all bands. To facilitate a match to 50 ohms you can angle the radials downward, this raises the impedance of the antenna as you increase the angle downward. Figure 4 shows the approximate relationship of radial angle to impedance:

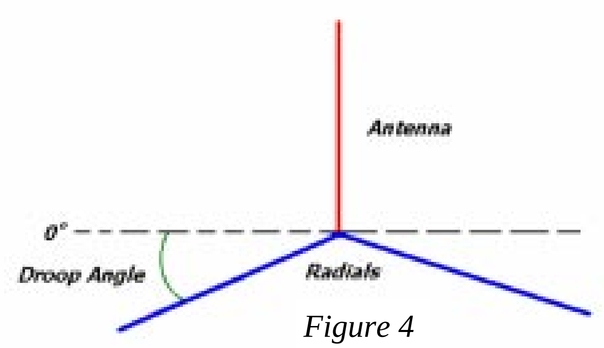

Figure 4

Radial Droop Angle	=	Antenna Impedance
0°	=	22 Ohms
10°	=	28 ohms
20°	=	35 ohms
30°	=	47 ohms
40°	=	53 ohms
50°	=	55 ohms

Note: above 50° results in diminishing returns

Elevated Mounting (continued)

Can't get enough droop angle to achieve a good match? Simply adjust the antenna element slightly longer than the factory 1/4 wavelength (up to 20% longer) settings and the impedance will rise. This will cause the radials to be too long, so they may need to be pruned a bit. Be aware that increasing the antenna 2% to 3% longer may require radials to be 5% to 7% shorter. Once you have a good match, replace the factory default values by saving the new antenna (to do this you will use the "create, modify" feature in the setup mode).

When the vertical is elevated you can get away with just one resonant radial, however, the pattern won't be omni-directional. You will have -12 dB to 15 dB null in one direction

Using a Vertical in on or Near Salt Water:

If you are lucky enough to have a dock over salt water, a vertical can offer unparalleled performance for low angle DX. Simply mount the vertical to the dock and attach two radials for band of operation. They can be stapled right to the dock if it is non-metallic. Mounting the vertical in ground flooded by salt water a couple of times per day can be equally effective. Proximity to the ocean improves the far field loss of a vertical and allows very low angle radiation - get as close to the water as possible to enhance performance.

Due to the fact that RF does not penetrate more than 2 inches into the water, direct coupling (a wire in the water) is difficult. Objects like metal floats or boats, providing they are large enough, can make good grounds in salt water. If you are using a metal boat or large metal object, corrosion is no longer a problem because the large surface capacitively couples to the water. When using a small metal float (3 ft x 3 ft is just enough to "connect" to salt water), you want to be certain that the metal does not corrode over time. For long term immersion, Monel is a good (but fairly expensive) choice.

SteppIR Antennas

TM

SteppIR

Yagi ● Dipole

(Patent Pending)

Specifications	BiggIR	SmallIR
Weight	15 lb 6.8 kg	12 lb 5.44 kg
Max. wind surf. area	1.9 ft^2 0.17 m^2	1.0 ft^2 .09 m^2
Guyed wind survival (w/ 2 guys@ 8’)	80 MPH	100 MPH
Un-Guyed wind survival	60 mph	80 MPH
Element length	32 ft 9.75 m	18 ft 5.49 m
Maximum power	2000 W PEP	2000 W PEP
Frequency coverage MHz	6.9 -54.0	13.8 - 54
Cable Requirements	4 cond	4 cond
Tuning Rate	1.17 MHz / Second	1.17 MHz / Second
Radial System Required?	YES	YES
Feed Type	End fed	End fed
Wavelength	1/4 - 3/4*	1/4 - 3/4*

* Can be used as a 3/4 wavelength antenna on certain bands

Operation Reminder:

When operating with 200 watts or more, do not transmit while the antenna is changing bands or damage could occur in the antenna housing.

SteppIR Antennas

BiggIR (40m - 6m) and SmallIR (20m - 6m) vertical antennas

BiggIR micro-processor based controller

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