shield to one radial and the center conductor to the other.

The VSWR meter is the tool used to determine the resonant frequency. Watch for the dip and not the value of the VSWR at the dip. If the frequency is low, shorten the radials. If the frequency is high, lengthen the radials. What frequency do you tune the radials to? There are many preferences to this question. Team Vertical took N6BV's suggestion and we tune them slightly below the band.

When you have tuned the radials, remove the ends from the meter. Re-attach them to the base of the vertical. If you had already tuned / matched the vertical as a whole, you might have to touch it up again.

Radial Size and Type

What size radial wire should I use? Should I use stranded or solid? Both are excellent questions.

In general, the fewer the radials, the larger the wire should be. This holds true if you are running QRP or QRO. That is not the issue. The issue is efficiency and if you are running QRP, efficiency should be more important to the installation than ever before. You only have 5 watts to start with, so don't lose any!

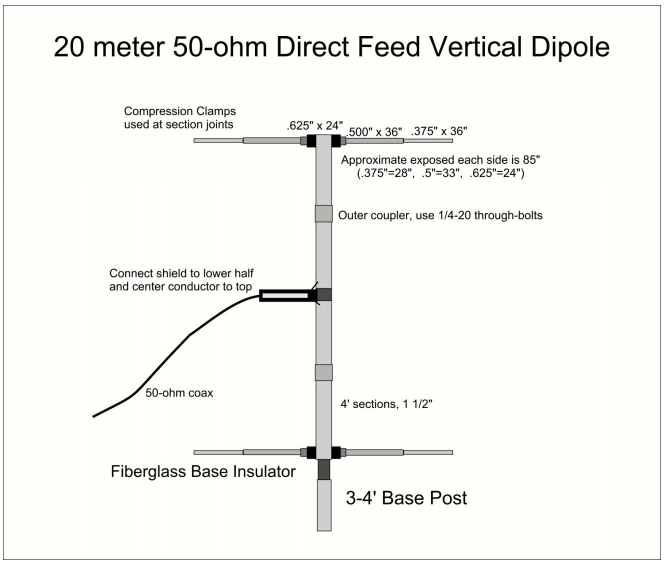
Elevated radials, even with many radials on the ground, should be as large as possible. They are carrying the majority of the current. The radials on the ground are acting more to improve the near field conductivity. We use small wire for the ground radials, going down to #22 if we run a lot of them. They are all attached together at the antenna base. That is also a great question.

Should you attach the ground radials to the antenna, or just leave them in the vicinity? We have done it both ways. We start with the system tuned using two elevated radials. After laying out the ground radials, we try it without and with them connected. Usually, it makes none, or very little difference. We normally connect them for grounding sake, meaning for electrical storms to be sure it has a low impedance ground. The hairpin match is a direct path from the antenna to the ground system.

Which is better, stranded or solid wire? Solid and the theory behind it has been around for a long time. Mechanically, this is especially true if the wire will be in salt spray. If you are using wire with a steel core, be sure it is copper clad, not copper plated. The latter is very thin and less than the skin depth, which means the current will penetrate into the very lossy steel core. Cladding is many times thicker and the current will flow in the copper, not penetrating to the undesirable core material. The core is fine for strength, but not for conducting RF.

Some Vertical Dipole Models to Follow

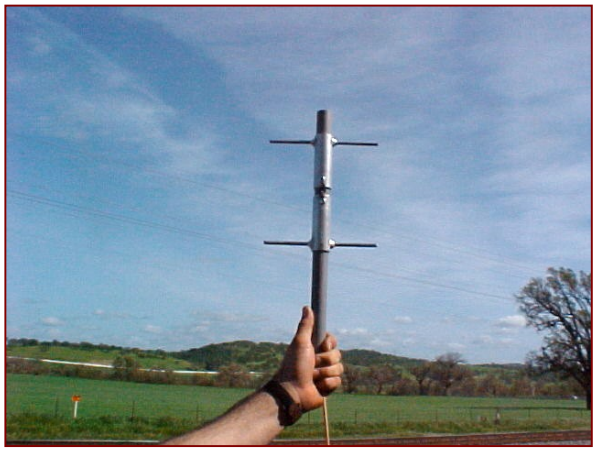
The following are some models of vertical dipoles and the first is a full size for 20 meters. This is a lightweight design using 1 ½" tubing for the center radiator. This can be increased to 2" for a very strong antenna. If the lighter design seems to bend in your weather, it can be guyed using insulators where the guys attach. If insulators are not used (tie wraps work just great for this), you might fins that a high voltage point travels down the guy line and burns right through it.



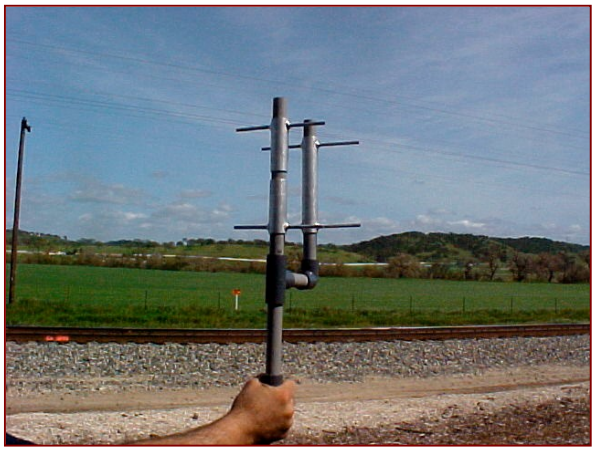
This design can be center loaded to get down to 30 and 40 meters. The prior photo of the 2-element 40 in Jamaica is showing lightweight designs, too. This was because of taking them as baggage. For permanent installations, you might not want a lightweight one, even if you guy it. The next photo shows one made of 3" tubing at the base and tapering down to 2" for the top section. It is loaded

at the center using 3/8" diameter soft drawn tubing. This tubing is refrigerator tubing, available just about anywhere. You can go down to ¼", but when you flatten out the end to through-bolt it, there will be very little material to work with, so it might be wise to use long 10-24 machine screws, rather than ¼-20 bolts.

You can even make 50-ohm direct feed vertical dipoles for much higher frequencies.



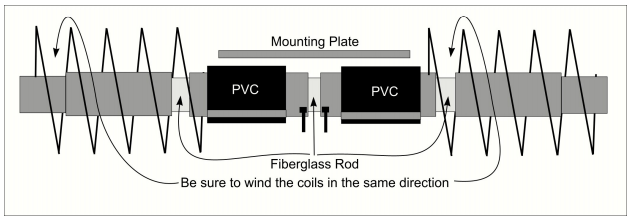
This little antenna is for 461 MHz. You can even make a small 2-element, vertically polarized array like this:



A "Rule of Thumb", or maybe two

A good "rule of thumb" pertains to one that you want to possibly use on two bands. It is wise to make the antenna no smaller than full size of the higher frequency band you want to use. For example, if you want to make one for 80 and 40, make it full size for 40 and load it for 80/75. If you want it for 40 and 20, make it full size for 20 and load it to 40. Remember that photo of the center loading on a length of ABS? That was a full size for 20, loaded down to 40 meters.

Loading coils can be set to the side of the vertical, or have the vertical tubing run through them. Setting them to the side is certainly the easiest, particularly if you want to have access to them, such as when changing bands manually. A permanent installation, like the 40-meter in the other column, would prefer to have the coils more secure and larger for a higher Q. To do this, the element passes through the



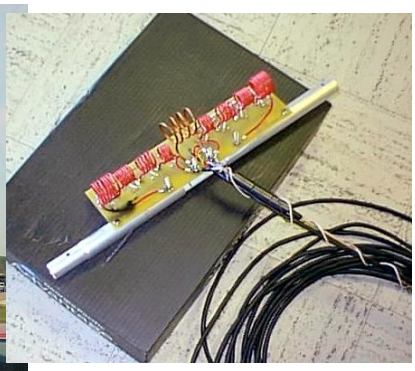
coil(s). Remember this drawing?

It is from a coil-loaded dipole, but shows the same technique used on a vertical to add in loading coils. You will not need the mounting plate and PVC insulators, of course. What to notice is that the coils bridge the fiberglass insulators outboard of the center. The tubing is passing right through the coils. This decreases the inductance of the coils, so make them maybe one turn more than the formula or software says.

When the coils are in place, temporarily clamp the outboard end (called the "cold end") of each coil and adjust it for the desired frequency. Expand the coil turns to raise the frequency and compress them to lower it. Once you are there, drill through the flattened end of the coils and the tubing for a 10-24 machine screw or ¼-20 bolt. Covers can be made using styrene drain pipe, schedule 10, which is the thinnest. The end caps are available for all sizes and 4" works well for 40 meters. For 80 meter loading coils, 6" will probably get the nod.

Making more Bands using Relays

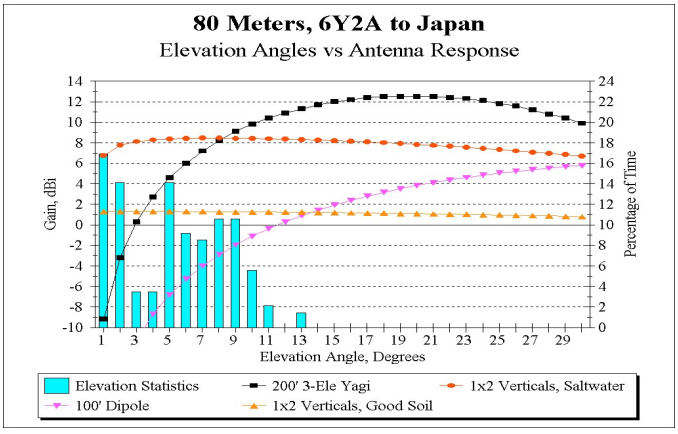
This idea became the Sigma-5 product line, which was a full size 10-meter vertical dipole, loaded with coils for 20-17-15 and 12 meters and a single hairpin coil that matched all the bands. Actually, it was slightly smaller than 10 meters, due to stray inductance in the relay switching system. The prototype is shown on the front cover of this book. A couple photos of the relay board follow.



This same board was used for a 40-30-20 model. It was close to full size on 20 meters, then loaded for 30 and 40, with three segments on 40 meters for full band coverage. The hairpin match was not quite so simple to match all of these bands, however.

Another look at the 2 x 2 array

This is an impressive, simple array to construct and tune. We have used it many times on DXpeditions and I have used it at the home QTH. It has been used on 80, 40, 20 and 15 meters. It has lots of useful gain and a very narrow beam width. Since it is not rotatable, it is mandatory to accurately aim it for the proper path. When you have a ½ power beam width of about 40 degrees, be careful, as it is no fun changing it after the installation. You would rather be on the air having fun.

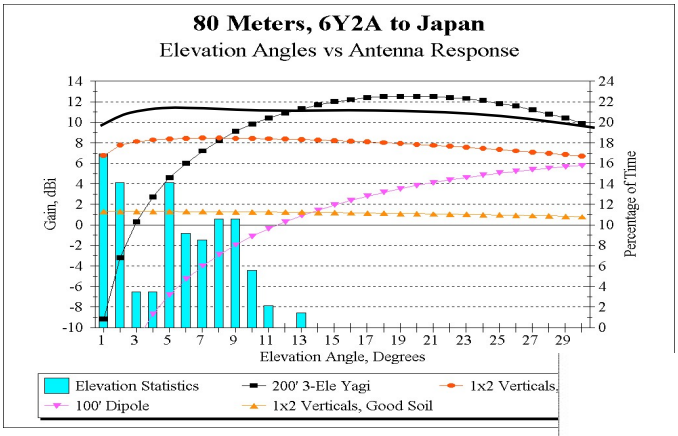


Team Vertical had many charts prepared by Dean, N6BV, comparing several antennas on 80/75 meters. If you look at that chart, you will notice that the big arch and small rectangular boxes is a full size, 3-element Yagi at 200'.

The lower sort-of arch in the chart with small diamonds is a full size dipole at 100'. The comparison between it and the 3-element should be logical. The taller 3-element has energy much lower in take-off angle, plus it has several dB gain over the dipole. The two tracks in the middle are the intriguing ones.

The lower of the two that is more of a horizontal line is a 1x2 vertical over good soil. A 1x2 is a 2-element parasitic array with a driver and reflector. The other track above it is the same 1x2 array, but over salt water. We don't have a plot of a 2x2 over salt water to compare on this band, but it would be fair to bump the 1x2 track up by about 3dB. I'll just draw one on the same chart to see what it looks like.

This really looks promising, as the 4 ground-



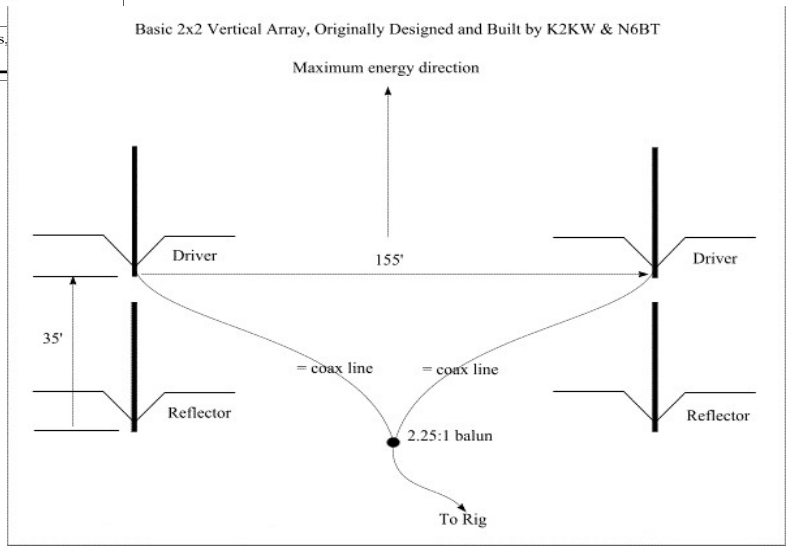
mounted verticals have much more gain at low angles than a full size 3-element Yagi at 200'. It also looked promising to Mike, K6AJ and I to give it a try. We decided we should set up a 2x2 for 75 meters aimed at 210°, which is long path from the central coast of California to Europe. A generous local amateur offered that we could use his property on the coast and off we went.

We built 4 verticals of a known, tested design. These were 34' tall, linear loaded and very strong. The location was right on the Pacific Ocean, with a drop-off of about 20' to the surf. We carefully laid out the locations for the antennas, being more than careful to aim the array. This is not a simple task, if you haven't done it before.

We set up the first pair of verticals aimed the right direction and tuned them. We then set up the other ones, spaced the right amount and aimed them properly, too. The two were fed in phase using through a 2.25:1 balun at the feed point junction. We were also able to switch and run only one array to make comparisons to the pair. We did not add any radials on the ground, only had one pair of elevated radials on each antenna.

We then realized there were cattle sharing the land with us, or maybe it was the other way around. Big Mike put up a fence in about two hours to keep them away form the antennas and our operating table (aka picnic table). We dutifully got up at 4AM, made the trip to the coast, set up the gear, cranked up the generator and were on the air by about 5:15AM. Well, how did it do? Was it even close to the charts, to the predictions?

It is important to know that the West Coast actually does have several BIG 80/75-meter stations, which is why we chose 75 meters long path. There are 3-element Yagis at tall heights perched on hilltops with clear views to long path. They are up and down California and also in Oregon. This was going to be a real challenge even power-wise, as our generator



limited our amplifier to about 1,200 watts output. We had no spare power for a heater, just one light bulb. When we wanted to heat water in the microwave, it was done quickly.

All in all, the 2x2 array was ahead of all the stations on the West Coast. One has to be careful to make comparisons when the long path is favoring the same areas and we did that. We also compared when the path was south of us and north of us. It was rare that anyone got better reports than our vertical array, unless the sun was already up and the path was way north. It was common for us to work stations unheard, or barely heard by others.

An interesting receive phenomenon was noticed. There was no man-made noise within at least 10 miles of us, there were hills behind us to any possible noise source and the antenna was aimed out to sea. There was a noise that apparently was coming from the sea and at a very low angle. It would hover at around S 4. With all my operating from lots of places in the States, Pacific, Caribbean

and Asia, I had never heard this before. We would then switch off the phasing and listen on a single 2-element, at which time the noise rose to S 7. The phasing was certainly working, as that narrow beam pattern cut the noise about in half. No other station heard this noise except us. Besides the convincing on-air performance, this noise was also convincing that the array definitely was superior to anything else on the coast, with very low angle radiating properties.

showing the antennas and cattle fence, with me walking around doing something useful. Mike is taking the pictures.

One thing nice about being on the coast is that the ocean is a big heat sink. This means when we were driving and the temperature indicator in the truck was saying "ICE", we always knew it would warm up. Sometimes, not much, but enough.

Can't make out the verticals very well, but they are out there. This view is towards Japan and it looks the same to long path. The next photo is better at

This project was a lot of work, but enjoyable. It was also worthwhile to verify predictions made over many years. We did this all without getting on an airplane, too. I hope this might encourage you to try some trips like this, too. We had also went to the beach on occasion with a single vertical before sunrise. You can do the same, or go to a local hilltop and try something you might like.

There is another unique vertical antenna that might be a good one to close this section with. It was made for our troops over in Afghanistan.