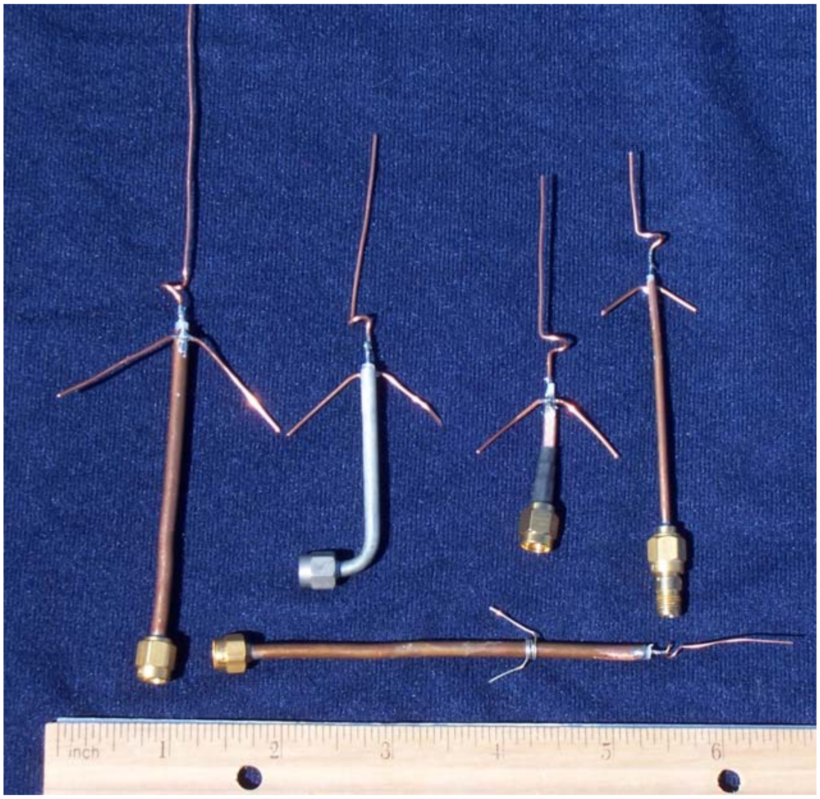
Simple Antennas for Data Services

Kent Britian   WA5VJB

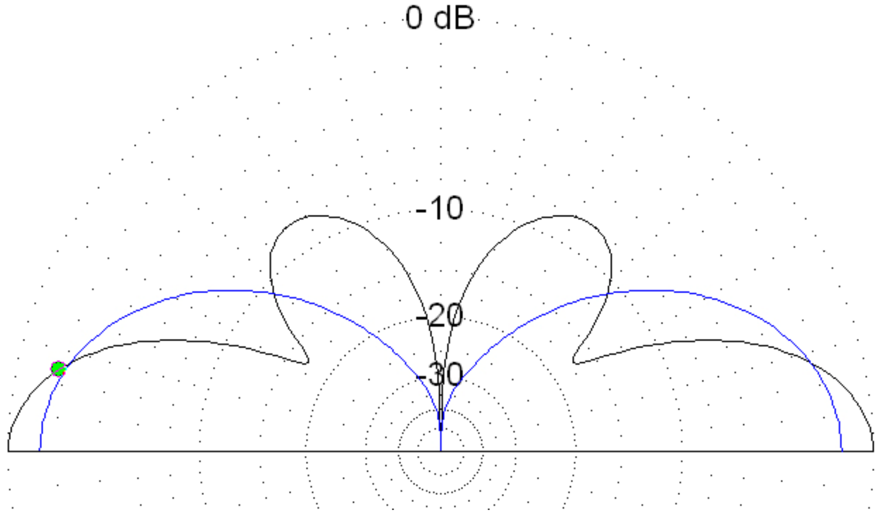


Here are some easy to build 5/8ths antennas for the 2.4 GHz, 3.4 GHz, and 5.8 GHz bands.   These can be used with WiFi, 802.11, Zigbee, ATV, Bluetooth, and any other services on these bands.

There are some on-line calculators for these and similar antennas. One particular website calculated the dimensions to the nearest 0.000000001 inch. Yep, there are 8 zeros in there, someone needs to slap that lad up side of the head with a slide rule and take away his scientific calculator. And the worse part is, his dimensions were WRONG.

As Dr. Tom Clark, K3IO likes to put it, “Why be approximately correct when you can be precisely wrong?”   Several factors that affect the length of the elements such as the diameter of the wire were not even allowed for.   All these designs were actually construction and adjusted on an 8719 Network Analyzer.   I much prefer to publish tested dimensions, and actual, rather than theoretical dimensions.

First some overview of the 5/8ths wave antenna.   You can match to a good SWR virtually any length of wire, that’s why we often use antenna tuners on the Shortwave bands. You can build a 5.8 GHz antenna tuner, but you had better find a BIG magnifying glass for that weekend project.   ¼ wave and ¾ wavelengths are pretty easy to tune in a 50 Ohm system.   But while a ¾ wavelength has a good impedance match, or SWR, it has a poor pattern.   Much of the signal ends up going into upward lobes, not towards the horizon where you usually want the signal.



But if you bend up a 3/4ths length of wire until it is 5/8ths wave long, we get a very nice pattern back at the horizon as also shown above. The loop, or partial loop in the center element is not a loading coil like you might see on many HF antennas. In this case it is a delay line. It is instead a way of delaying the wave so that it is seeing ¾ ths wavelength in a 5/8 wavelength space. This delay line can be a loop, part of a loop, a stub, or a zig-zag.

Construction: Start with a piece of coax and some 18 Gauge wire. Most any coax can be used, braided or simi-rigid as long as you can solder to it. The wire can be 16 or 20 gauge, but I wouldn't got beyond those sizes and stay with 18 gauge if you can.

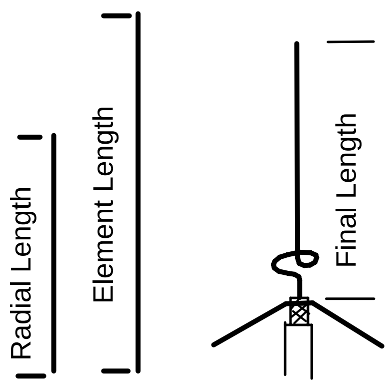


Figure 1

Using Figure 1, cut your center element to length. Now bend it around a small screwdriver, drill bit, etc until the total length is correct per chart 1. Now solder the element to the center of the coax.

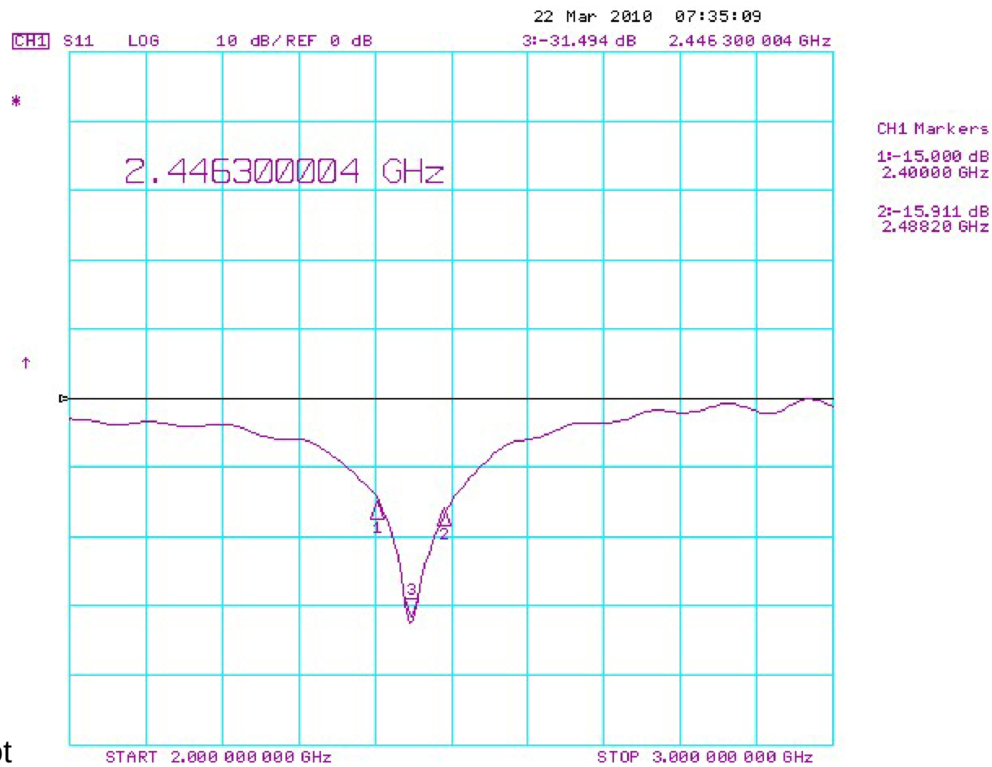
Next cut your radial per Chart 1 and solder the middle of the wire to the coax at the end of the shield or braid. In effect we are using one wire as two radials. Now bend them back about 30 degrees. This doesn't have to be precisely 30 deg, but it does help the impedance match or SWR to bend them back a bit. That's it, your 5/8ths ground plane is ready to go like the ones in Photo 2.

Scaling: Lets say you need a test antenna for 4.9 GHz, just take the 5.8 GHz dimensions and multiple the lengths by 5.8/4.9 or 1.18. Or perhaps you wish to build a 1.8 GHz version, then take the 2.4 GHz dimensions and multiply by 2.4/1.8 or 1.33
This scaling is OK for small changes, if you wish to make big jump in frequency, then you need to scale the diameter of the 18 gauge wire as well.

Chart 1

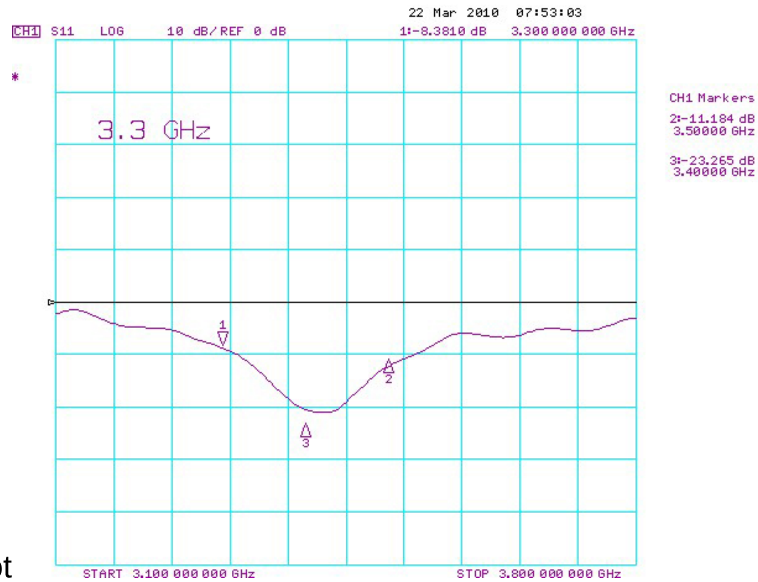
Band	Radiator	Radials	Final Length
2.4 GHz	3.5"	2.4"	3.25"
3.4 GHz	2.5"	1.8"	2.3"
5.8 GHz	1.45"	1.0"	1.25"

Performance



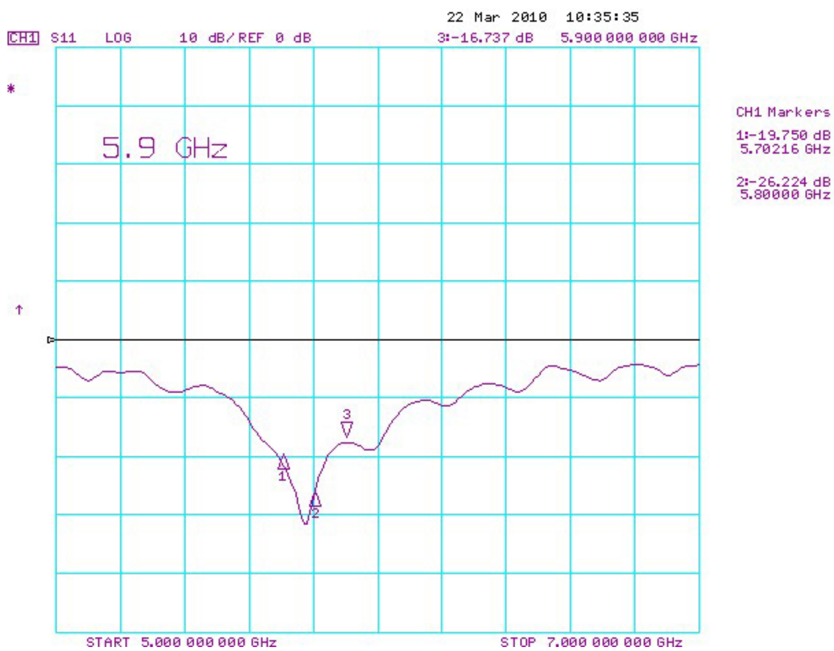
2400 MHz Plot

Here is the Network analyzer plot of the 2.4 GHz antenna.
The antenna has a better than -15 dB return loss over the entire 2.4 GHz band.
This works out to a better than 1.5 to 1 SWR over the entire 2.4 GHz band and a 1.05 SWR in the middle of the band.



3400 MHz Plot

Next is the Network Analyzer plot of the 3.4 GHz antenna. Not a lot of WiFi type activity on 3.4 GHz, but it is growing quickly. The antenna has a -10 dB return loss from 3.3 to 3.5 GHz. Or a 2 to 1 SWR over the band.



5800 MHz

Now for the 5.8 GHz Network Analyzer plot. This antenna has a better than 2 to 1 SWR from 5.5 to 6.1 GHz with a SWR of 1.05 at 5.8 GHz. More than enough bandwidth to cover the WiFi part of the band.

The antennas work just a well hanging upside down as they do pointing upwards. This means you can just build one on the end of a length of coax and hang it from the ceiling or off a shelf. And don't be disappointed at only 3 ½ dBi of gain. As I have mentioned before, several years ago I sent up the antenna range for 2.4 GHz and invited over the local computer WiFi club. It was amazing how many of the "+7 dBi" gain computer antennas measured less than 0 dBi. I have never seen one of those small computer WiFi antennas come even close to their published gains. So while the numbers are not impressive, the little guys probably work better than the high dollar antennas at the computer store.