A Ten Meter Vertical Antenna for All License Classes
by Rich KR7W

The intent of this article is to show how I built an effective 10 meter vertical antenna. My goal is to reveal, in some kind of logical way, my thoughts, methodology, and how I came up with the final result in an easy to understand way. Hopefully, what I did will inspire others to create their own version of this type antenna… Especially since Technician class license holders will soon be able to operate SSB in the 10 meter band.

For quite some time now I've wanted to improve my receiving of signals on 10 meters when checking into the Sunday night net and the Monday night informal CW practice. I wanted to be able to choose between my existing horizontally polarized multi-band dipole and a vertically polarized antenna to receive (and transmit) the best signal. I do know that in VHF there is a difference of 20 to 30 decibels between a horizontally polarized antenna on one end… and vertical polarization on the other. So there is a chance of making a big difference in signal strength… depending on who I am having a QSO with.

I decided to erect a 10 meter half wave vertical on top of my garage where there are already some spare coax cables that route back to my ham shack.

I mentioned this project to some of the members at the Saturday gathering at the clubhouse. Someone asked me, "Why half wave? Why not a quarter wave arrangement? Quarter wave would not need to be so tall". My answer was that I did not like the radiation pattern of the quarter wave antenna… as a lot of the RF energy goes straight up… and with the half wave antenna, more of the RF energy is radiated toward the horizon. Also, an effective ¼ wave vertical needs a lot of radials to make it efficient.

Most hams, including Ole Joe, will attest that the vertically polarized two meter J-Pole antenna is one of the best antennas around. Did you know that this antenna just happens to be a half wavelength vertical antenna?

The J-pole consists of a half wave radiator (the part above the U shaped bottom of the J) … with a quarter wave U shaped matching stub. (Diagram 1) The top and bottom ends of the half wave radiator are HI impedance (Hi Z) points. The top of the U shaped matching stub is also HI impedance. The Hi Z ends of the ½ wavelength radiator may not be the same impedance as the stub… but it is close enough to work well by adjusting the length of the ½ WL radiator. Somewhere along the bottom of the U stub is a 50 ohm point where the coaxial cable feed line attaches. Note that the U shaped stub does not radiate… only the half wave section does the radiating.

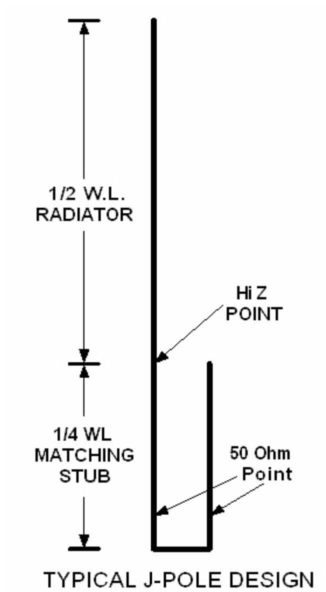

Diagram 1

I could build a 10 meter J-Pole… but the half wave radiator of 16.5 ft. plus the U shaped stub of 8.5 ft. would be more than 23 feet high… and that would be difficult to support atop my garage without guy wires. So my idea is to design a matching stub device that matches the 50 ohm feed line from the rig to the Hi Z end of the half wave 10 meter radiator.

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Joe will attest that the following figure shows how the end of the half wave radiator is high impedance. Notice that the voltage is maximum and the current is lowest at the end of the radiator. Using Ohm's law… Resistance (or Impedance) is equal to the high voltage (E) divided by the low current (I)… which will be a high number.

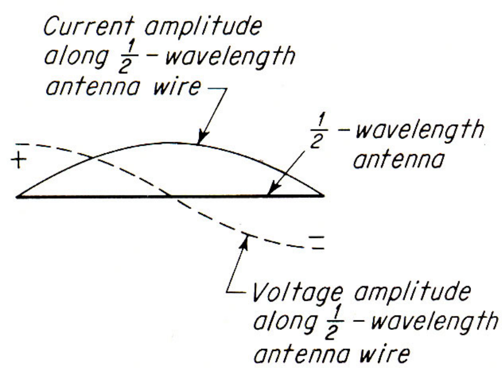

Diagram 2 shows Current VS Voltage along a 1/2 wavelength radiator. There is always high voltage at the end of the antenna.

Ever notice that gizmo at the base of your ½ wave or 5/8 wave two meter mobile antenna? It's a cylinder about 2 to 3 inches tall and about an inch round. Within that gizmo is the 50 ohm to Hi Z matching device. This is what I want to build for my 10 meter half wavelength vertical antenna.

I read about RF tuned circuits in the ARRL radio handbook. I found that parallel tuned circuits are very high Z at resonance (where the inductive reactance equals the capacitive reactance) across the circuit.

This type of tuned circuit consists of a capacitor in parallel with an inductor. (Diagram 3) I wanted my circuit to be resonant at approx 28.200 MHz, between the CW practice frequency and the Sunday night net frequency, 28.150 and 28.375 respectively.

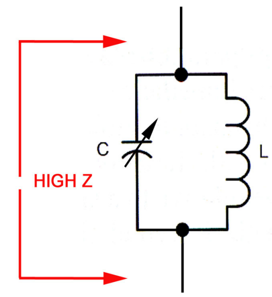

Diagram 3: A circuit like this that is tuned for resonance on the desired frequency will always be hi Z and have a high voltage

The search was on to find an inductor (L) and capacitor (C) combination that is resonant at 28.200 MHz.. I found some ¾ inch diameter coil stock and some variable capacitors in my junk box and built a circuit like shown. To measure the resonant frequency of the L-C combination… I used my MFJ-269 antenna analyzer with a three turn coil of wire plugged into the antenna jack. By placing the MFJ-269's coil next to the tuned circuit and tuning the analyzer… I found a dip in SWR reading at 24 MHz. Note: This method works like the Grid Dip Oscillator of vacuum tube days of past.

I found that if I reduced the value of C… then the frequency would go upwards. I connected the two variable capacitors in series to lower the C value. By adjusting the two caps while the antenna analyzer was set to the desired frequency… I located the dip at 28.200.

The ARRL handbook also says that I can find the 50 ohm point on the inductor coil by placing a tap somewhere along the length of the coil and the bottom of the coil. Note: this is similar to finding the 50 ohm point on the ¼ wavelength U shaped tuning stub on the J-pole antenna.

Once the Inductor and Capacitor were at the desired resonant frequency… I placed the tuned circuit into an old surplus plastic enclosure. I installed a PL-259 coax jack at the bottom of the box to attach the feed line to the

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shack…and an aluminum stand-off stud on the top of the box to attach the half wave-length radiator.

To find the 50 ohm point on the inductor coil… I connected a substitute hi Z antenna (a resistor) to the combination of L and C to take the place of the half wave radiator. By guessing… I chose a 3.3 K ohm resistor to take the place of the radiator. Why 3.3 K ohms? Well, I remembered that my Icom automatic antenna tuner will match a Z of 5 to 5 K ohms. The closest resistor I had was 3.3K Ohms. (Diagram 4).

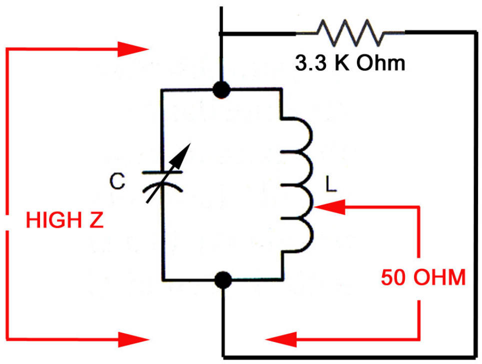

Diagram 4: Schematic diagram showing how the 3.3 K resistor substitutes for the antenna wire. Also the possible location of the 50 ohm point that the coax feed line connects

I then connected the antenna analyzer set at 28.200 MHz to the PL-259 jack. By moving the clip lead up and down the inductor coil… I found the coil's 50 Ohm location that gave me a very low SWR.

Because of the HI Z and high voltage across the parallel tuned circuit…I thought that the small variable trimmer capacitors would arc across which would cause very high SWR and perhaps damage my transmitter. I learned by reading… a piece of coaxial cable with an open end is a capacitor. I also realized that coax cable can handle the everyday high volt-age of standing waves (VSWR) in a feed line. So to make an equivalent value capacitor from coax cable… I needed to find the value of the variable capacitors in the tuned circuit.

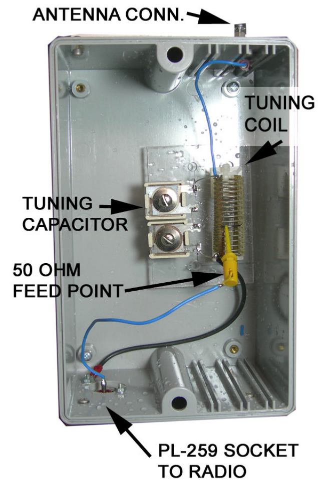

Photo 5: The inside of the enclosure reveals the variable tuning caps and the coil. The yellow alligator clip is moved up and down the coil to achieve the best SWR.

Photo 6 shows the L-C meter and the coax capacitor connected. The L-C meter outputs the value in Morse Code.

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I carefully removed the two variable trimmer caps from the tuned circuit and measured them with my **ELSIE-2 L-C** meter and came up with 24 pico-farads (PF). Then I prepared an 18 inch piece of RG-58 coax and connected it to the **L-C** meter. (Photo 6) I measure 88 PF. Reducing the length of the coax reduced the value of capacitance. So, trimming a small bit of coax off and re-measuring finally got it down to 24 PF, which was about 7 inches long. The coaxial capacitor was rolled up and cable tied to fit in the enclosure in place of the trimmer capacitors. (Photo 7)

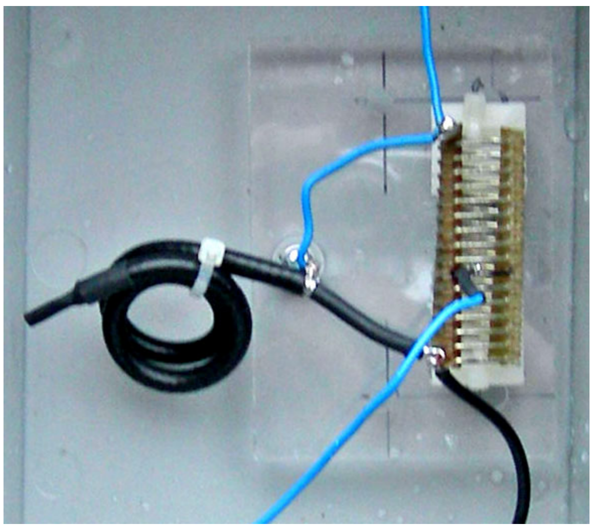

Photo 7 shows the final installation of the coaxial capacitor, the 50 ohm impedance tap on the coil, and the connection to the radiator wire (top of coil).

It all comes together…

The radiating element, a piece of # 12 stranded wire, calculated to be about 17 ft long. To support the wire vertically… I taped it to a 20 ft long collapsible fishing pole (left over from another project). I built a small wooden support from scrap lumber that supports the fishing pole vertically (radiator hose type clamps) and provides a place for weights (two cinder blocks) to keep the whole thing on the flat roof of my garage. The plastic box that holds the parallel tuned circuit was screwed to the wooden stand. The coax enters the box via the PL-259 socket on the bottom and the #12 wire enters the box on top via an aluminum stand off.

Tuning it up:

I set up the whole assembled unit on the picnic table in my back yard and plugged in my antenna analyzer. The best SWR was at 29 MHz. Remembering "Lower is Longer" from the technician class… I needed to make the wire element longer in order to lower the frequency.. So, I added about 24 inches more wire that took me to the best SWR at 27 MHz. Carefully cutting an inch at a time and retesting brought the length of the vertical wire to 17 ft 4 in and I had a SWR of 1.1 to 1 at 28.200 MHz. I had good SWR of 1.4 from 28.000 to 29.000 MHz.

Photo 8 Final assembly: Plastic enclosure connected to wooden stand and fiberglass fishing pole connected to stand.

After placing the antenna assembly at the desired location on the garage roof… I measured a poor SWR of worse than 3.0 to 1. Some experimentation determined that I located the antenna too close to some metal flashing and the phone line to our house. By moving the antenna assembly towards the

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rear of the roof the original good readings were achieved.

Testing:
In the shack... I connected my rig to the new antenna. At my desired frequencies of 28.150 and 28.375 MHz, using 50 watts output… I measured SWR or around 1.25 (or less) to 1. At 28.001 to 29.000 MHz I read about 1.4. At 29.699 (the end of the band) the SWR was over 2.5… but my radios internal tuner adjust it down to 1.0

On the 2 meter repeater I asked for others to listen for me at 28.150 MHz, take a reading on the original multi band dipole and then take a reading on the new vertical. Three folks rated the vertical as stronger… with the best difference of 1 S-unit, which equates to twice the power received (3 dB). I suspect the higher readings with the new vertical antenna are not because of vertical VS horizontal polarization… but because the multi-band dipole (with tuner) is like the Swiss Army Knife of antennas… where it does a lot of functions (multiple bands) OK… and the vertical antenna is self resonant and more efficient for this purpose.

Conclusion:
If you choose to build a 10 meter vertical antenna like this one… please know that it does NOT have to be exactly the same. A 17 ft wire hanging from a tree or other high object will substitute for the fishing pole I used. The coax cable matching unit could be built in a small Tupperware like container. A Toroid inductor or a coil of wire wound on an discarded pill bottle would make a nice tuning coil. There are lots of possibilities and a lot of information in books and on the web at your disposal. Also, please don't forget there is a wealth of knowledge at your radio club's gathering spot: The Clubhouse or the 2 meter repeater. So, Joe… be safe in that tree or atop that ladder and thanks for reading this far. -30- Rich Kr7w.