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A Triband Dipole for 30, 17, and 12 Meters

W1VT describes a dipole antenna that can fill in some gaps in band coverage for many stations.

Here is a simple wire dipole that works well on the 30 meter, 17 meter, and 12 meter amateur bands. A cleverly designed section of 600 Ω ladder line allows the use of a 1:1 choke balun and 50 Ω coax back to the radio with good efficiency, although a tuner at the radio is necessary to get the very low SWR most hams desire.

If your radio has a built-in autotuner, you can have the efficiency and ease of use of a coax fed monoband dipole on three bands, without the hassle of bringing open wire into the shack. The SWR is below 3:1 over these three bands — low enough to allow efficient matching with a tuner at the radio. This antenna would be a good complement to the many popular antennas that don't cover one or more of these bands. The popular G5RV and ZS6BKW multiband wire dipoles have high SWR on 30 meters — resulting in very poor system efficiencies, if a match can be obtained at all.

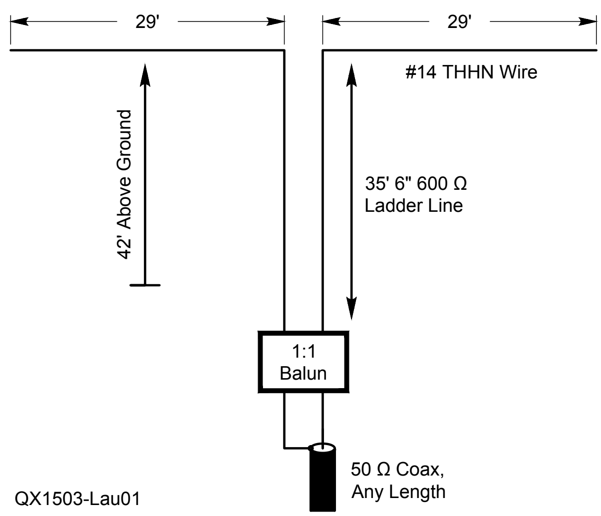


Figure 1 — Here is the basic configuration of the triband dipole. It consists of a 58 foot doublet fed with 35.5 feet of 600 Ω open wire feed line that works with good efficiency on the 30, 17, and 12 meter amateur bands.

I discovered this antenna while running computer simulations based on the ⅓ wavelength dipole — by adding ⅙th wavelength of feed line to this particular length of dipole — one obtains resonances on many harmonics, making it quite useful for multiband operation.[1, 2] I looked at two more variables besides dipole and feeder length — height above ground and ladder line impedance. I found that if I increased the ladder line impedance, I could tweak the harmonic resonances to land precisely on the 10 and 25 MHz bands. The article by Taft mentions harmonic displacement and suggested tuning the transmitter to compensate — I used it to advantage! It helped that I was not looking for a perfect match, or I may not have looked at matching impedances far from the optimum value of 375 Ω for the ⅓ wavelength dipole.

Height above ground has a large effect on antenna impedance — from 45 to 98 Ω for the classic half wave dipole — so you should determine the optimum height first, before optimizing anything else.[3] It does little good to design the perfect antenna only to find out that you have no way of putting up your antenna that high, or finding out that your trees are too close together! In designing this antenna, I maximized the height and length of the antenna, while making sure I didn't exceed the practical limits of my support structures. I set the height at 42 feet, the height of the support ropes I have between two trees.

You want a choke balun between the open wire feed line and the coax, to prevent the outside of the coax shield from becoming a radiating antenna element. While it is possible to decouple coax with an excellent ground, such as a radial system, choke baluns are more practical if that is all you need to do. A vertical antenna makes much better use of a radial system; not only is the feed line decoupled, but system efficiency is much improved with a radial system. Either way, you still need a single point entrance panel bonded to a ground rod for lightning protection.

[1]Notes appear on page 38.

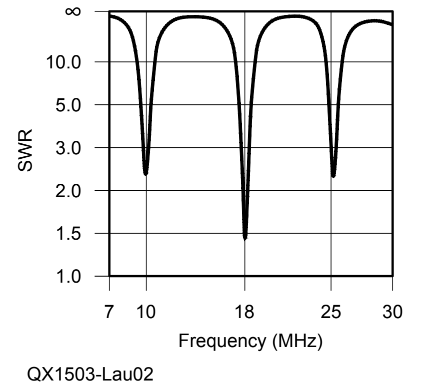


Figure 2 — I used *EZNEC* to calculate the SWR across the entire frequency range. You can see that around 10 MHz there is a dip that results in an SWR of about 2.4 and around 24 MHz there is a slightly deeper dip to an SWR of about 2.3. The lowest SWR is 1.47 at 18 MHz.

I'd suggest using a coaxial choke wound on a ferrite toroid — 11 turns of RG-58A/U on an FT-140-43 core works well from 10 to 30 MHz. Steve Hunt, G3TXQ, published an excellent balun design. He used 11 turns of RG-58 on a stacked pair of FT-240-52 toroids.[4] He measured impedances in excess of 8000 Ω between 10 and 25 MHz. Steve's design is better able to handle the high differential impedances encountered if you want to use this antenna on another band.

The balun is a weak point of many multiband systems — many folks have seen their SWR drift as the balun heated up to destruction when the impedance was just too high for the balun to handle. Fortunately, with this antenna, impedances on 30, 17, and 12 meters are all moderate; you don't really need Steve's design, unless you want to operate on yet another band. Assuming the choking action of the balun is perfect, you can model its effect on the system as a short length of 50 Ω coax. This is easily handled in Roy Lewellan's *EZNEC*, using virtual wires.

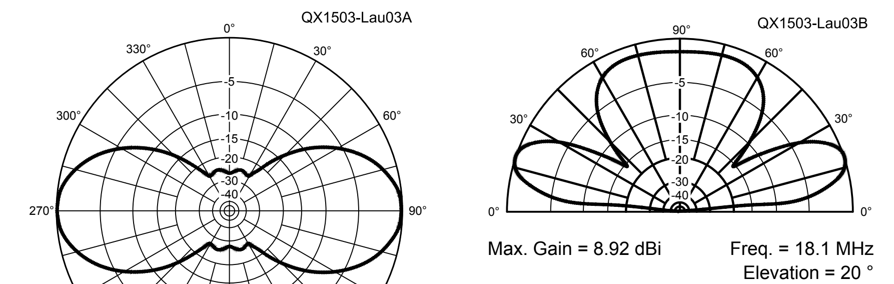


Figure 3 — Part A shows the 17 meter azimuthal radiation pattern, which is close to the pattern we normally expect to see from a dipole, with maximum signals at 90° to the wire orientation. Part B is the elevation pattern. The maximum signal is at an elevation angle of about 20°, but there is a broad lobe at very high elevation angles.

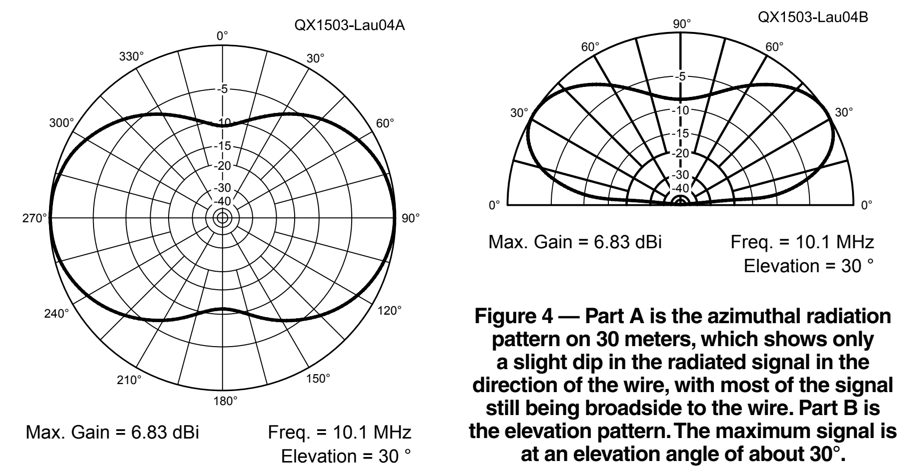


Figure 4 — Part A is the azimuthal radiation pattern on 30 meters, which shows only a slight dip in the radiated signal in the direction of the wire, with most of the signal still being broadside to the wire. Part B is the elevation pattern. The maximum signal is at an elevation angle of about 30°.

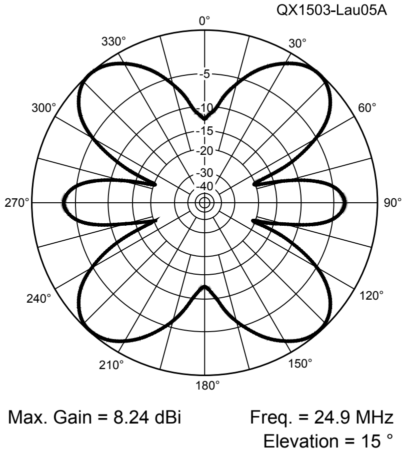
I found that a few feet of coax drastically lowers the impedance on 15 meters, making it much harder for an autotuner mounted at the balun to operate efficiently. One solution is to add more coax. An electrical multiple of a half wavelength will reflect the input impedance to the output. The cost to efficiency is high, however. You can expect to lose an S unit with 20 feet of RG-8X, and yet another one with 40 or 60 feet of RG-8X, assuming 6 dB/S unit.

The triband dipole is a 58 foot doublet made out of #14 THHN solid house wire fed with a 35.5 foot matching section of 600 Ω ladder line having a velocity factor of 91%. See Figure 1. The somewhat low velocity factor of the ladder line assumes you are using insulated wire. The #14 THHN house wire has two layers of insulation: 15 mils of PVC and another 4 mils of nylon. While the nylon typically flakes off in less than a year, I modeled the antenna in *EZNEC* using an insulation thickness of 19 mils and a dielectric constant of 3.5. Changing the insulation thickness to 15 mils doesn't appreciably change the resonance points. The length of the 50 Ω cable isn't critical, unless you have tweaked its length to accommodate another band, like 15 or 20 meters. I suggest using the shortest length of 50 Ω coax that will comfortably reach the single point entrance panel for your station.

I used *EZNEC* to determine the theoretical SWR values. I set the loss of the 600 Ω ladder line to 0.20 dB/100 ft at 50 MHz. Figure 2 is the SWR plot across the bands. I later determined that identical impedance values were obtained at 30 MHz with a line loss of 0.153 dB/100 ft and at 10 MHz with a line loss of 0.090 dB/100 ft, in case you want to know how *EZNEC* extrapolates the loss with frequency. I chose a slightly low velocity factor of 91%, as most modern implementations of ladder line use PVC insulated wire as opposed to bare copper. If you wish to use another type of 600 Ω line, I'd suggest using a length of (velocity factor) × 39 feet. I'd avoid extremely low loss 600 Ω open wire — the 6 inch spacing is likely to bring on issues with feed line radiation. *The ARRL VHF Manual* by Ed Tilton suggests 1.5 inch spacing at 50 MHz, which translates to 3 inch spacing at 25 MHz.[5]

On 17 meters, you get a clean bidirectional pattern, with maximum gain broadside to the wires, just like a dipole. Here in New England, this pattern works great when pointed at Europe. Figure 3A gives the azimuthal radiation pattern and Figure 3B shows the elevation radiation pattern.

On 30 meters, you also get gain broadside to the wires, but due to the relatively low height, there is a fair amount of signal in all directions. Figure 4A is the azimuthal radiation pattern and Figure 4B is the elevation pattern.



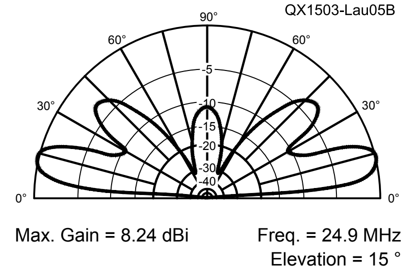


Figure 5 — On 12 meters, the azimuthal radiation pattern, shown at Part A, has four strong lobes at about 50° from the direction of the wire. There is a pair of weaker lobes at 90° to the wire in this case. Part B shows the elevation pattern, with the strongest radiation at an elevation of about 15°. There are also lobes at about 40° and 90°.

On 12 meters, as the antenna is higher and longer, the antenna has an azimuthal radiation pattern with four main lobes, 50° off broadside. You still get some gain broadside, but they are small lobes 3.5 dB weaker than the main lobes. See Figure 5A. The elevation pattern is shown in Figure 5B.

Notes

[1]Andrew Griffith, W4ULD, "The ⅓-Wavelength Multiband Dipole," *QST*, Sep 1993, pp 33 – 35.

[2]Taft Nicholson, W5ANB, "Compact Multiband Antenna Without Traps," *QST*, Nov 1981 pp 26 – 27.

[3]Ward Silver, NØAX, *The ARRL Antenna Book for Radio Communications,* 22nd Edition, p 3-5.

[4]Steve Hunt, G3TXQ: **www.karinya.net/g3txq/chokes/**

[5]Tilton, Edward P., W1HDQ, *The Radio Amateur's VHF Manual*, p 163 (ARRL 1972)