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A Wideband Dipole for 75 and 80 Meters

Covering all the way from 3.5 to 4 MHz with one antenna takes some tricks.

Ted Armstrong, WA6RNC

On most of our MF and HF bands, a single dipole is the most basic antenna. With one exception, it can be used to cover all the usual CW, data and SSB frequencies without any tuning, if adjusted for minimum SWR at or near mid band. The exception, and the antenna designer's challenge, has always been the band from 3.5 to 4.0 MHz, which is so wide, in terms of percentage bandwidth, that many have a separate name for each end — 80 meters for the low end and 75 for the high end!

Why Not a Dipole

There have been a few designs proposed to meet the objective of a single 75/80 meter dipole in the past, but most have been proven flawed or difficult to implement.[1] The challenge is clear if we look at the SWR of a typical wire dipole tuned to mid band as shown in Figure 1. Note that with the antenna tuned to an exact match at the center of the band, we can achieve less than a 2:1 SWR over (at most) about 200 kHz. For full band coverage we would need three separate thin dipoles.

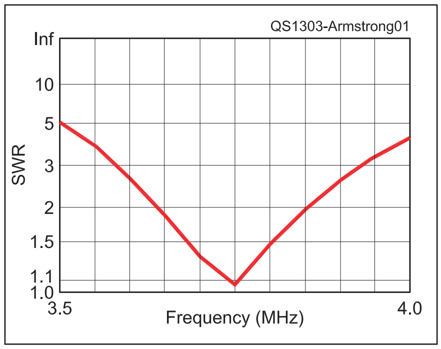

Figure 1 — Modeled 72 Ω SWR of a thin 80 meter dipole. Note the high SWR at the band edges.

The fraction of bandwidth to center frequency on 75/80 meters tells the story. If expressed as a percentage it is 13.3%, while for the full 10 meter band, for example, it is 5.8%, which would also be a challenge for a single antenna. My caveat about modes saves us here — on 10 meters, CW, data and SSB usage is generally in the bottom 0.5 MHz (1.8%), while FM is near the top. The two segments usually use different antenna types, often horizontal polarization for the low end and vertical for the high segment.

Similarly, 160 and 6 meters are 10 and 7.7% respectively, but they are not HF bands and also have usage divided among segments. Table 1 shows the percentage bandwidth of amateur bands from 160 meters through 70 centimeters. As indicated, 80/75 is the bandwidth challenge champ, even through our VHF and UHF bands. The other HF bands, with the caveat about 10 meters can usually fit onto a dipole, with 40 meters usually just making it to 2:1 on the edges.

Making it Work

Most of us are familiar with using over-coupled tuned transformers to make wide-band RF coupling transformers or filters. The same approach can be applied to antennas, with similar results. I investigated this approach using *EZNEC* antenna modeling software and have modeled a number of broadband antennas that work as designed over their frequency range with the SWR not

[1]Notes appear on page 36.

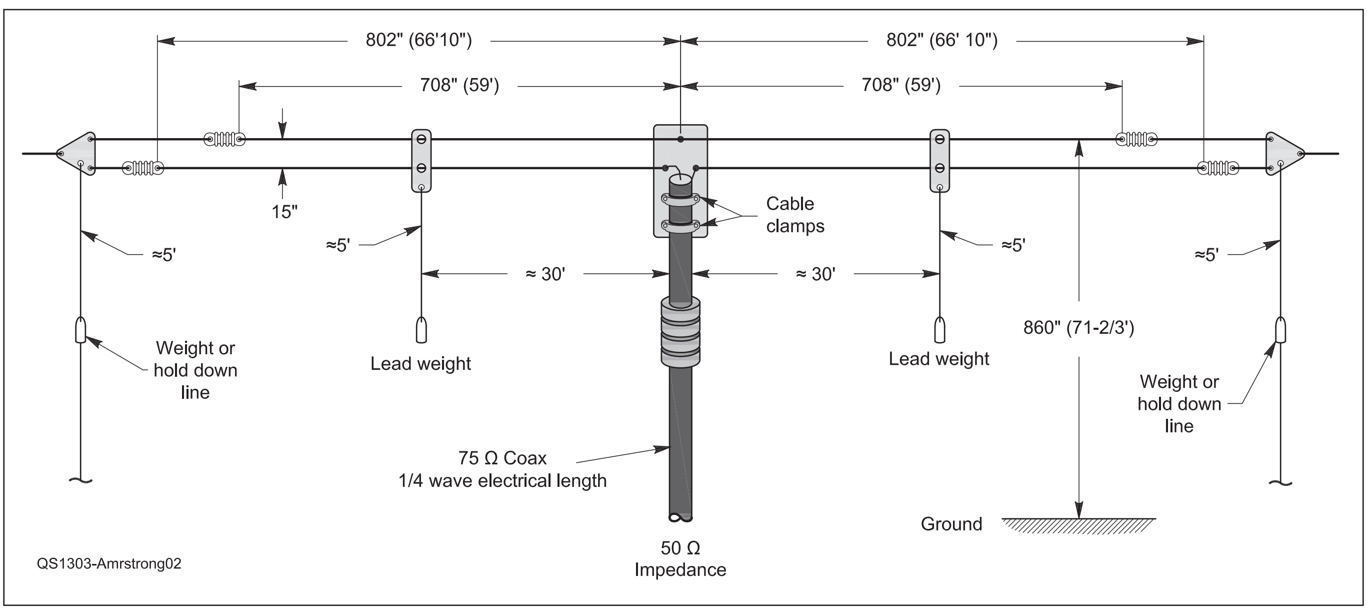

Figure 2 — Construction details and dimensions of the coupled resonator 75/80 meter antenna including ¼ wave impedance transformer of 75 Ω coax. The ¼ wave transformer should be an electrical quarter wave long, 65.6 feet in free space, 43.3 feet in standard (0.66 V_R) solid polyethylene dielectric coax. For RG-9 coaxial cable use type 43 shield beads (Fair-Rite part # 2643102402), for RG-59 use type 43 (Part # 2643540402). For Fair-Rite Products see **www.fair-rite.com**. If you have surplus 75 Ω coax and want to use it for the transmission line transformer, first measure its velocity factor and trim to a ¼ wave at 3.74 MHz. A support at the center will reduce sag.

Table 1
Percentage Bandwidth of Amateur Bands

Band (meters)	Frequency Range (kHz)	Bandwidth (kHz)	Bandwidth (%)
160	1800 – 2000	200	10.5
75/80	3500 – 4000	500	13.3
60	5330.5 – 5405	74.5	1.4
40	7000 – 7300	300	4.2
30	10,100 – 10,150	150	1.5
17	18,068 – 18,168	100	0.6
15	21,000 – 21,450	450	2.1
12	24,890 – 24,990	100	0.4
10	28,000 – 29,700	1700	5.9
6	54,000 – 58,000	4000	7.7
2	144,000 – 148,000	4000	2.7
1.25	222,000 – 225,000	3000	1.3
70 cm	420,000 – 450,000	30,000	6.9

exceeding 1.5:1 across the band.[2, 3] [Note that successful *NEC* modeling of closely coupled antenna elements requires that the segment size of the coupled segments be the same and that they need to be in alignment. — *Ed.*]

There are a number of interacting parameters in the design of such an antenna. Unlike the two-band coupled resonator dipoles described in other articles, this antenna requires greater spacing than can be provided by window line. This results in a higher resonant impedance than the usual transmission line — 112 Ω in my design. Fortuitously, 112 Ω can be transformed through a ¼ wave section of 75 Ω coax to provide a good match to our usual 50 Ω systems. The resultant antenna is shown in Figure 2, while the 112 Ω SWR of the antenna itself is shown in Figure 3 and the transformed 50 Ω SWR is in Figure 4.

Validating the EZNEC Results

This horizontal antenna will not fit on a small city lot such as mine, so I needed to scale the frequency up to where it will fit and then verify that the antenna would work as predicted. The antenna would have the identical percentage band width except now it would be at a higher frequency. I scaled the frequency up to 60.5 MHz model in the built the antenna and obtained similar results to those of my larger modeled antenna. I also modeled and constructed some vertical “half antennas” fed against ground (see Figure 5) and duplicated the model results.

Putting Up the Antenna

This construction project requires lots of open space to work properly, but you will no longer have to use a tuner or multiple dipoles to cover the entire 75/80 meter band from one antenna. You can jump from the low end to the high end or anywhere in between

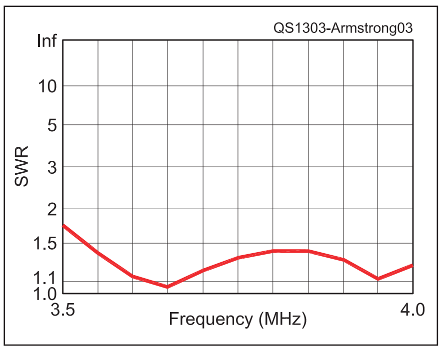

Figure 3 — Modeled 112 Ω SWR of the coupled resonator dipole of Figure 2 without quarter wave matching section.

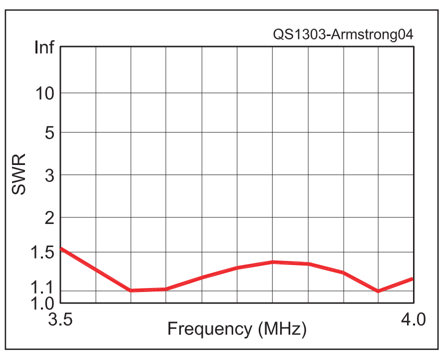

Figure 4 — Modeled 50 Ω SWR of the coupled resonator dipole of Figure 2 with the quarter wave matching section of 75 Ω Coax.

without a tuner and still have low SWR.

The design height of this antenna is 72 feet; a bit more then ¼ wavelength. At its design height and perhaps 10 feet above and below it will be less than a 1.7:1 SWR, rising to 2:1 at a height of 40 or 100 feet, all based on typical soil (conductivity of 0.005 S/m, dielectric constant of 13). Dry, sandy soil

Figure 5 — View of the 10-12 meter coupled resonator monopole, one of the smaller antennas used to validate the design process. It had a bandwidth of 17.7%

makes it look like the antenna is higher; wet soil makes it seem lower.

This broadband antenna uses two #14 AWG uninsulated antenna wires separated by 15 inches for the entire antenna length. A single spreader on each side (B in Figure 2) and the antenna end supports (C) help to maintain that separation. Don’t let the wires get twisted, as that will kill the antenna’s performance.

To keep the wires from getting twisted, attach a hold down nonconductive line or weights on a five foot nonconductive line to the bottom of B and C. The minimum weight of each lead weight should be

1 pound. In areas subject to heavy winds, it might be a good idea to use more weight. The center feed point is kept vertical by the weight of the transmission line transformer. That line should run as close to vertical as possible to reduce antenna currents coupled to the coax shield.

The feed point of the antenna is balanced, but the coax is unbalanced. The four ferrite shield beads on the coaxial cable help make the coax at the feed point appear more balanced and reduce the coax shield currents below the ferrites as detailed in Figure 2. Sketches of my implementation of the various support pieces are provided on the QST in Depth web page (**www.arrl.org/qst-in-depth**).

Notes

[1]One successful implementation is the four wire cage in use at W1AW. The solution presented here requires two rather than four wires, is more compact and needs a simpler support structure.

[2]J. Hallas, W1ZR, "A Folded Skeleton Sleeve Dipole for 40 and 20 Meters," *QST*, May 2011, pp 58-59; J. Hallas, W1ZR, "The Folded Skeleton Sleeve on Other Ham Bands," *QST*, Oct 2011, p 48.

[3]Several versions of *EZNEC* antenna modeling software are available from developer Roy Lewallen, W7EL, at **www.eznec.com**.

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New Products

DXtreme *Station Log* — Multimedia Edition Version 9.0

DXtreme *Station Log* Version 9.0 offers multimedia and advanced functions. The *Station Log* window includes the expected logging functions and also retrieves the frequency and mode from supported rigs through integration with Afreet's *Omni-Rig*. This window displays ARRL DXCC and grid/VUCC status information for logged stations and tracks QSLs sent and received. If the computer is connected to the DX spotting network, the DX Spot Checker queries the *Station Log* database and alerts the operator to spots needed for DXCC or VUCC awards. Multimedia functions let users listen to previous contacts and view QSLs whenever they browse their logs. The software can also be used to create QSL and address labels for physical QSLs; create signed TQ8 files automatically for uploading to ARRL's Logbook of The World (LoTW) server; produce ADIF-based electronic QSLs for uploading to eQSL.cc; and produce a variety of reports. New features in Version 9 include a grid at the bottom of the window that shows up to 500 of the most recent log entries (providing the look and feel of a paper logbook); integration with the Afreet *Band Master* lists to indicate the DXCC entities and IOTAs needed for all bands or individual bands; advanced searches filtered by user selected criteria; and IOTA updates directly from the RSGB website. DXtreme *Station Log* runs in 32- and 64-bit versions of Microsoft *Windows 8*, *7*, *Vista* and XP. Price: $89.95 (North America) for new users; special upgrade pricing is available for current users. For more information or to order, visit **www.dxtreme.com**.

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David Bartholomew, ABØTO	446	22-Mar-02	John Hauner, KØIH	323	11-Jan-85
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