Six Band Loaded Dipole Antenna

W8NX's unique design technique makes trap look-alikes do double duty. Here's a wire antenna that covers 160/80/40/30/17/12 meters!

Al Buxton, W8NX

Figure 1 — W8NX Special antenna mounted at 47 feet on tower used to hold triband Yagi. This is an efficient antenna system that covers 160/80/40/30/17/12 meters with the dipole and 20/15/10 meters with the triband Yagi.

Introduction

This article presents a new loaded wire dipole antenna. It covers the classic 160, 80 and 40 meter bands, plus 30, 17 and 12 meters. I call it the *W8NX Special*. Any amateur who installs this antenna and who has a triband beam for 20, 15 and 10 meters has a very good antenna system for working all the amateur high frequency bands from 160 through 10 meters. I installed my W8NX Special as an inverted V, using the tower holding up my triband Yagi as the center support. See Figure 1.

This antenna is based on the highly efficient *dominant element principle*, requiring only two pairs of load elements to give six bands of operation.[1] The radiation patterns have a single pair of broadside lobes on the classic 160, 80 and 40 meters bands but are similar to those of long wire antennas on the 30, 17 and 12 meter bands.

Radiation takes place along the entire length of the antenna on all bands, providing small but useful antenna gains. Good bandwidth is provided on all bands when used in conjunction with an antenna tuner. With the exception of the 160 meter band, full band coverage is provided on all bands. On 160 meters the effective working bandwidth is typically limited by the size of the capacitors in the antenna tuner. The built-in antenna tuner in my FT-1000MP Mark V transceiver can cover 55 kHz on 160 meters using this antenna.

The antenna length is 134 feet, suitable for installation on most city lots. Mine is installed as a "droopy" inverted V dipole, with the apex at 47 feet on the beam tower and drooping to a height of 20 feet at each end. There is little mutual coupling between the triband beam and the six band dipole, since the working frequencies of the two antennas are sufficiently separated to prevent interaction. Some bending and folding at the ends of the dipole antenna is permissible to accommodate installation on a short city lot.

Antenna Performance

Figure 2 shows the schematic diagram of the antenna. The schematic looks the same as that of a standard three band trap dipole. However, the loads do not use the truncating capability of tuned parallel resonant traps. This new type of load acts as either a pair of inductors or capacitors to supply the necessary reactance to bring the antenna into resonance with a low feed-point impedance, on both fundamental and odd-order harmonic modes. This makes the antenna suitable for feeding via a 1:1 current balun with either 50 or 75 Ω coaxial cable.

I advise that you use 75 Ω cable because it makes a typical antenna tuner more effective, especially on 160 meters where the size and cost of the large high voltage tuner capacitors is the limiting factor in the effectiveness of a tuner. The innermost pairs of loads create fundamental resonance on both 160 meters and 80 meters. The outermost pairs create fundamental resonance on 40 meters and third harmonic resonance on 30 meters. The overall antenna gives fifth harmonic resonance on 17 meters and seventh harmonic resonance on 12 meters.

The loads are large physically, with significant stray capacitance. They exhibit a parasitic series resonance at approximately 45 MHz (not shown in the Figure 2 schematic). These parasitic stray effects make small increases in the electrical length of the antenna, slightly lowering the antenna operating frequencies. The loads are necessarily large to achieve high Q, low loss performance. Wide air gaps between turns of the load windings and the use of thin walled

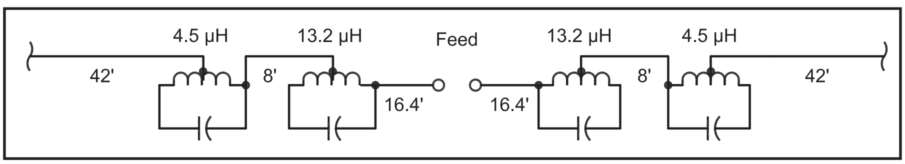


Figure 2 — Schematic for six band W8NX Special using dominant element principle dipole.

[1]A. Buxton, "Dominant-Element-Principle Loaded Dipoles," *QEX*, Mar/Apr 2004, pp 20-30.

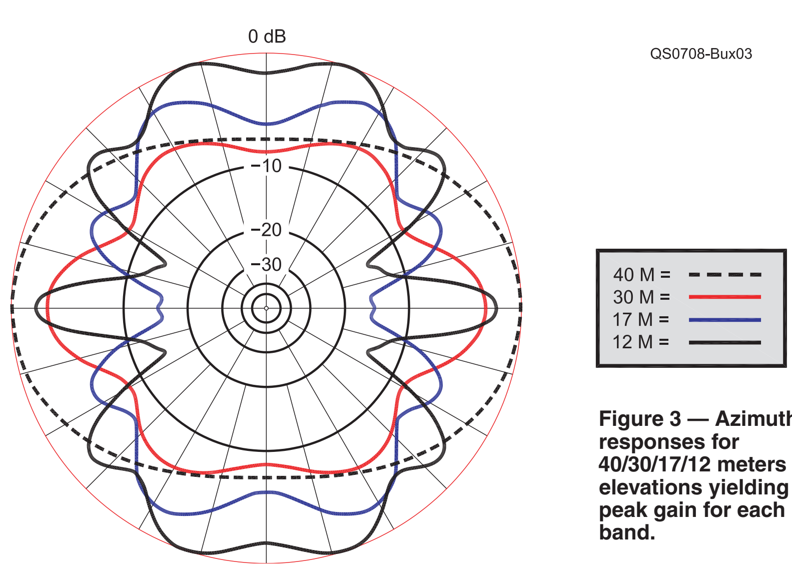


Figure 3 — Azimuthal responses for 40/30/17/12 meters at elevations yielding peak gain for each band.

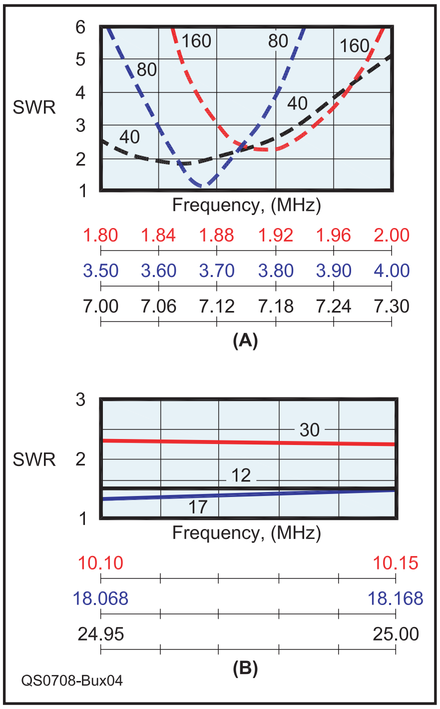


Figure 4 — At A, SWR curves for 160/80/40 meters. At B, SWR curves for 10/17/12 meters.

PVC coil forms minimize dielectric losses in the load elements. The use of RG-8U coax cable with large diameter stranded wire center conductors minimizes skin effect I^2R losses.

The Q of each 160/80 meter load is 260, and the Q of the 40/30 meter loads is 325. Load losses on 80 through 12 meters are less than 0.5 dB, but on 160 meters the loss approaches 3 dB. On 160 meters the radiation resistance of the antenna is low because of the relatively short length of the antenna, reducing the overall radiation efficiency to about 50%.

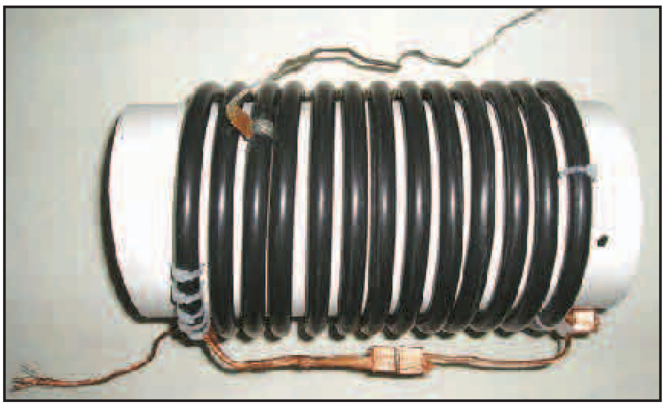
The radiation patterns have a single pair of broadside lobes on 160, 80 and 40 meters. Figure 3 compares the azimuthal patterns for 40 through 12 meters, at the peak elevation angles for each band. The patterns on the higher frequencies display numerous lobes, characteristic of long wire types of antennas. The peak gain on 40 meters is 3 dB above an ordinary dipole. As is the case with an ordinary dipole this has only two lobes. The gain on 12 meters is about the same as on 40 meters but the pattern has 10 lobes.

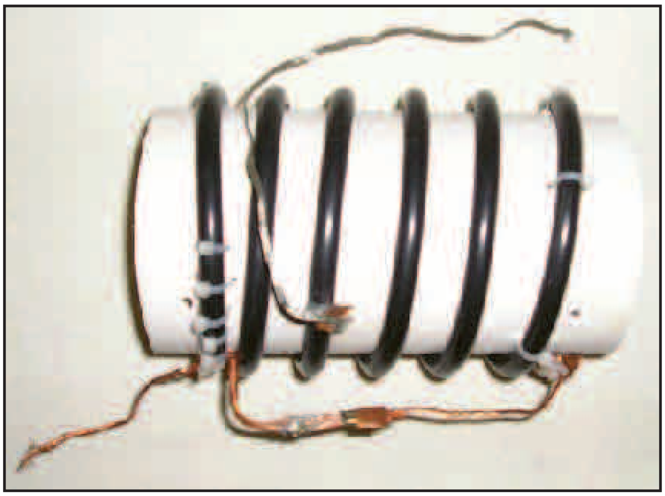
The measured SWR curves for the 160, 80 and 40 meter bands are shown in Figure 4A; those for the 30, 17 and 12 meter bands are shown in Figure 4B. The SWR curves are those measured at the rig end of an 80 foot long, 75 Ω RG-59 feed line. The curves pretty much speak for themselves.

Those of you interested in getting as much effective working bandwidth as possible on 160 meters can employ the trick of extending the feed line length when operating on 160 to that of a quarter-wave impedance inverter. The length of the extension must bring the total length of the RG-59 feed line to about 100 feet. This maximizes the effectiveness of the antenna tuner, reducing the required size of the tuner capacitors. The tuner now has an easier matching job of keeping your rig or linear amplifier happy. However, you have increased your feed line losses and even though your rig is happy over a broader bandwidth you have somewhat degraded the radiation efficiency of your antenna system. If you carry this trick to extreme measures under high power linear amplifier operation, you could conceivably incur current or voltage breakdown in your antenna feed line. The safe upper limit on 160 meters for SWR for RG-59 feed line is about 6:1 at maximum legal power operation corresponding to a maximum usable bandwidth of 130 kHz.

Remember your rig or linear amplifier never sees this SWR — the antenna tuner shields it from this level of mismatch. Your

Figure 5 — At left, construction techniques for 160/80 meter load element. At right, construction techniques for 40/30 meter load element.





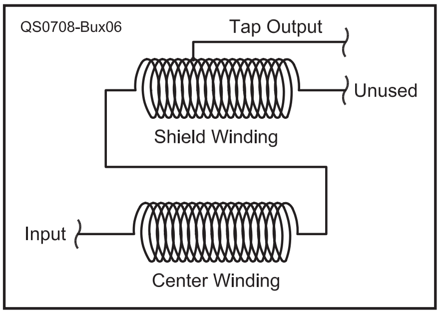


Figure 6 — RG-8U load element schematic.

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Load	Form Dia Inches OD	Form Length Inches	F0 MHz	Dim A Feet	Dim B Feet	Number Turns	Spacing Between Turns Inches
160/80	4.188	9.125	2.38	2.78	12.88	13	0.14
40/30	4.188	7.75	6.62	2.57	4.61	6	0.65

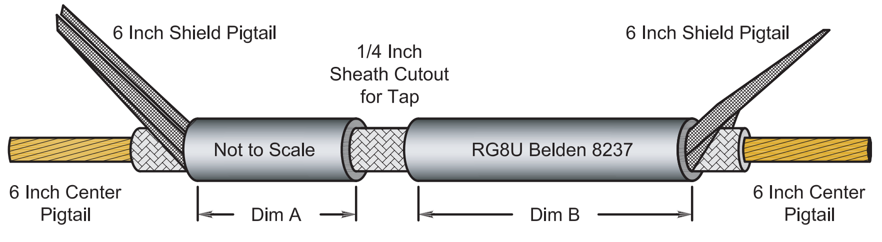

Figure 7 — Details of the load element coax.

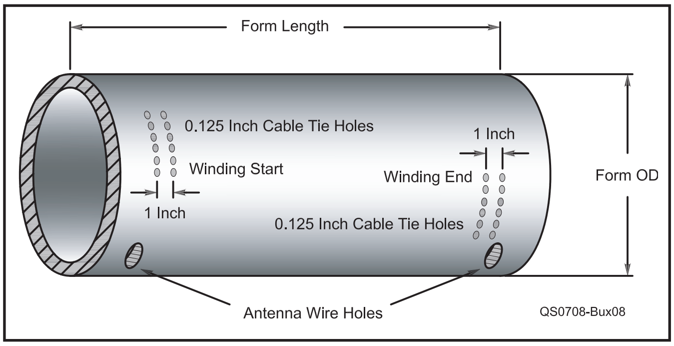

Figure 8 — Details of coil form.

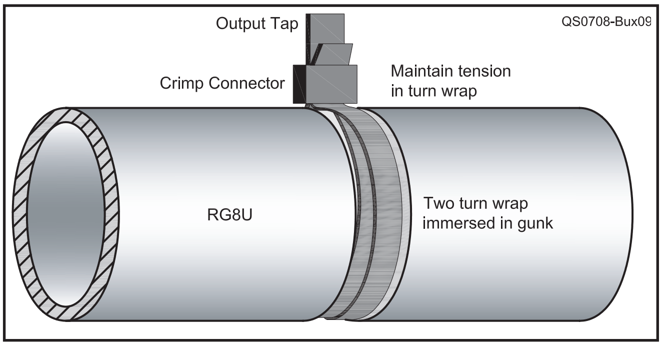

Figure 9 — Output tap detail.

antenna tuner does not reduce the SWR on the feed line. While some amateurs frown upon using this trick, it does give considerably more effective working bandwidth for 160 meter operation.

Construction

The toughest part of constructing this antenna is making the load elements. Figure 5A shows the 160/80 and 40/30 meter load elements. The load element schematic is in Figure 6. Note how the pigtail at the output end of the center winding is fed backward to the pigtail of the input end of the shield winding. The loads are made of RG-8U coaxial cable (Belden 8237) wound on a form made of 4.188 inch outside diameter PVC drain pipe.

Figure 7 shows details of the coax used for the loads. Figure 8 shows the load forms, the critical ones being the lengths and diameters of the forms and the 1 inch edge margins of the windings on the forms. Dimensions A and B fix the output tap location, with the RG-8U laid out flat and straight on a table. The tap is a 15 inch length of silvered braided shield wire cannibalized from RG-58 coax cable. The tap requires two turns tightly wrapped around the RG-8U wire at the ¼ inch break cut in the PVC sheath. Cover this break with anti corrosion gunk (Burndy Products, Penetrox A will do) to prevent resistance developing at the tap.

Care is required in making the output tap to hold the two turn wrap around the RG-8U permanently in tension using a crimp connector. Figure 9 shows the details of the 15 inch output tap of the loads. Unfortunately, soldering at the tap would weaken the electrical properties of the RG-8U coax cable so a mechanical-only connection is necessary.

The input terminal of any load is the near end (nearest the feed line) of the center conductor winding of the coax cable. The far end of the center conductor is fed back to the near end of the shield winding. The output of the load is taken at the tap on the outer shield winding. The output tap acts as an auto transformer, giving the needed L/C ratio for the load. You should fine tune the loads to within 1% of the specified frequency. I used a dip meter and an accurately calibrated receiver for fine tuning the loads.

Air gap spacing between the turns of each load reduces dielectric load losses and permits fine tuning of the load resonant frequency. Expanding the air gap increases the load resonant frequency; reducing the gap lowers the frequency. Do not hesitate to increase the gap between turns as much as necessary to achieve the resonant frequency of the load, even though you may distort the appearance of the load. After completion of the fine tuning, the location of the turns must be stabilized by cable ties, as shown in Figure 5. More cable ties are actually required than are shown, especially around the first and last turns of the load winding. Stabilizing the interior turns is not as critical, as they have less effect on the load's resonant frequency than the outermost first and last turns.

Although making the loads for this antenna may seem like a challenging task, your efforts will be well rewarded. There is nothing as satisfying in ham radio as the successful completion of a good, hands-on homebrew project.

I wish to thank my friend and colleague, Mel Vye, W8MV, whose help and constructive comments are greatly appreciated. I also wish to thank Jeremy (KB8QVF) and Angie Holland for their help with the photography of the antenna and the load elements.

Al Buxton, W8NX, has been a radio amateur since he was first licensed as W7GLC in 1937. A registered professional engineer, Al holds BSEE and MSEE degrees from Tulane University. His career spans industry and academia: 26 years in the defense industry with Goodyear Aerospace, six years with Tulane University and 11 years with the University of Akron. He's an Associate Professor Emeritus of Akron University. In industry, Al worked on the development of computers, automatic controls, radar, aircraft guidance, and navigation and space antennas. You can reach Al at 2225 Woodpark Rd, Akron, OH 44333 or **buxtonw8nx@aol.com**.