# A New Spin on the Big Wheel

*A popular 2 meter antenna returns in an improved, easier to reproduce form.*

**L. B. Cebik, W4RNL, and Bob Cerreto, WA1FXT**

In his "Antenna Options" column in the Jan/Feb 2008 issue of *QEX*, L.B. Cebik discusses some different options for omnidirectional horizontally polarized antennas. Here he and Bob Cerreto provide the details on how to build and use two versions of an update to the Big Wheel antenna from the '60s.

Most attempts to develop a horizontally polarized omnidirectional (HPOD) 2 meter antenna have sought to minimize the antenna's size. Shapes such as circles (halos), squares and rectangles usually result in the need for either hypercritical dimensions or difficult matching conditions — or both. By turning to more conventional full size structures using three dipoles, we can reduce the number of critical parameters and ease the process of replicating the antennas in a home workshop. In fact, we shall describe two versions of the same basic antenna. One is a triangle of three dipoles that folds into a flat package, suitable for easy transport to a hilltop. The other is a circle of three dipoles that requires somewhat less space but needs greater precision in construction. Both antennas share a common feed system and display broadband characteristics that ease the builder's task.

## The Basic Three Dipole Design

A 1961 *QST* article described a horizontally polarized 2 meter antenna called the big wheel.[1] The authors described it as three full wavelength (λ) loops with a parallel connection at the central hub and feed point. Unfortunately, their description proved to be off target. In fact, the antenna is a continuous loop with three high-impedance feed points, as shown by the current curves on the left in Figure 1. (All wire models of the same antenna show the same results, but are less clear to read when converted to graphics showing current distribution.) The legs constituted transmission lines (with variable spacing in the original) that transformed the high impedance at the rim to a low impedance at the hub. By judicious sizing of the circle and the legs, the authors managed a very good omnidirectional antenna.

Unfortunately, many amateurs had difficulty replicating the design because the antenna's dimensions are critical at every point. Small changes in the leg (transmission line) spacing or even differences in the tubing curvature at the rim could throw off the impedance values at the hub.

The big wheel is difficult to model because numerical electromagnetic code (NEC) based antenna modeling tools implementation of transmission line models are not fully accurate when applied to a low current position along the antenna's geometry. The antenna proved equally difficult to build due to the sensitivity of the structure to small dimensional changes. Therefore, we decided to re-explore a territory that the big-wheel authors had set aside: the use of three dipoles to form the same HPOD patterns. The center and right outlines in Figure 1 show the triangular and circular forms that emerged. Note that the current magnitude curves place the feed points of the dipoles at high current, relatively low impedance positions, removing the big wheel's matching challenge.

Both forms are very broadband in virtually every operating parameter once the builder gets the dimensions correct. The triangle, with a wider separation between the dipole end tips, is less critical with respect to dimensions, but requires more space. The circular version, with tighter coupling between dipole tips, requires more careful construction, but results in a more compact structure. In fact, for the same performance, the circular three dipole antenna is smaller than the original big wheel.

The far-field performance of the three dipole HPODs and the big wheel are virtually identical. Therefore, the data in Figure 2 applies equally to all three designs. At a height of 20 feet above average ground, the three elements in all of the designs provide

1961 Big Wheel    Three Dipole Triangle    Three Dipole Circle

High Impedance Feedpoints    Low Impedance Feedpoints    Low Impedance Feedpoints
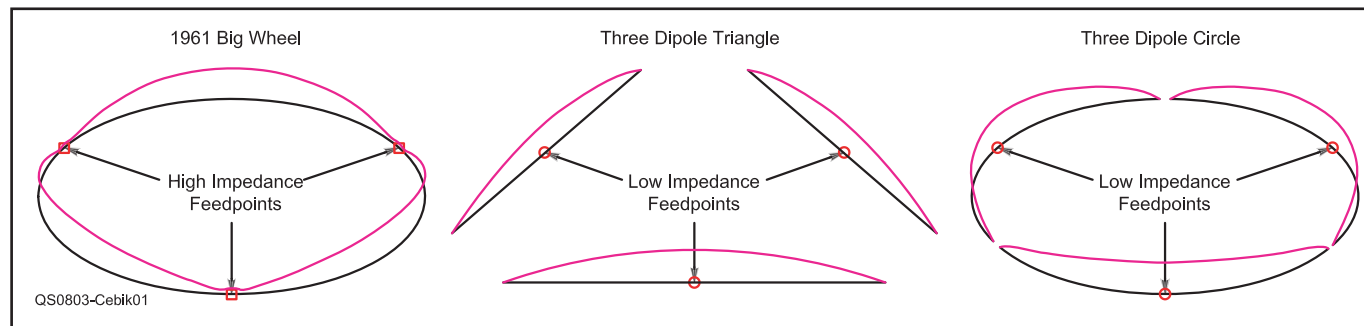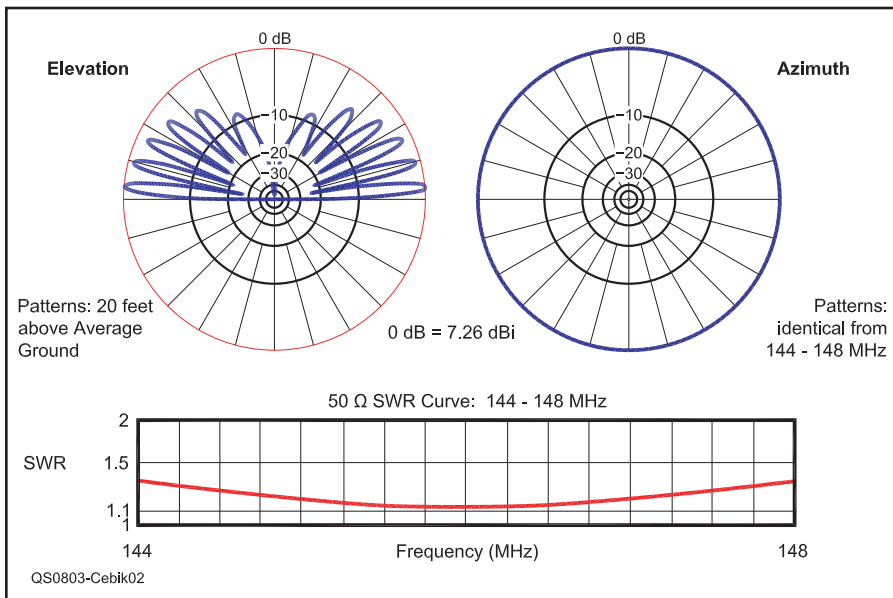
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**Figure 1 — Relative current magnitudes on three different three element HPOD antennas.**

Figure 2 — Representative elevation and azimuth patterns and 50 Ω SWR curve for a three dipole HPOD antenna using either a triangular or a circular shape at 20 feet above average ground. The patterns of the conventional big wheel are virtually identical in shape and strength.
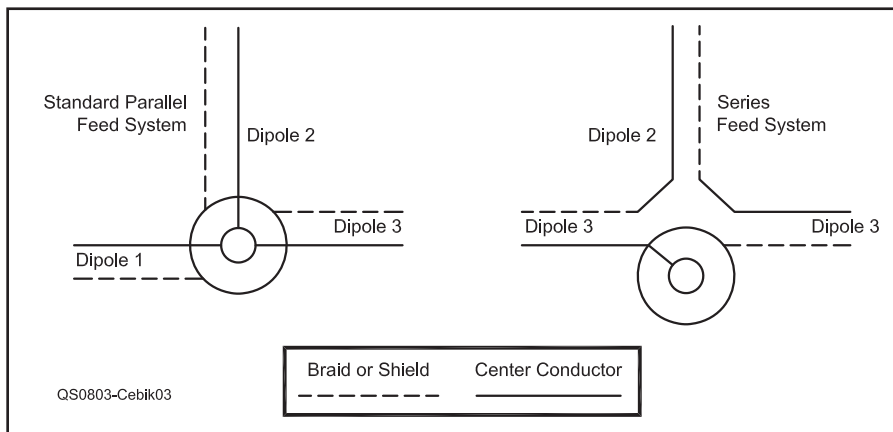


Figure 3 — Alternative methods of feeding the three dipole arrays: the prototypes employ the series feeding system for ease of matching to a 50 Ω main feed line.

an average gain in the lowest lobe of about 7.2 dBi. The azimuth pattern is as close to circular as is possible with fewer than four elements. The gain variation for the worst case was less than 0.3 dB. Although a physical antenna is unlikely to obtain the perfection of a model, the differences in gain around the horizontal will still fall below the level that an operator can detect.

The modeled SWR curve applies to both of the three dipole models.[2] Because the dipoles of the final designs present feed point impedance close to 50 Ω, we may use standard coaxial cable of virtually any length to reach the hub without changing the impedance significantly. Matched to a 50 Ω main feed point at the hub junction, the SWR curve is very flat and in the model shown in the graph, the SWR is acceptable (well under 2:1) for at least 8 MHz in the 2 meter range.

Moreover, the circularity of the pattern and the gain are virtually constant across the entire 2 meter band. Even though the antenna is likely to see service only in the first MHz of the band, the broadband characteristics ease the difficulty of successfully building a version at home.

To obtain a 50 Ω main feed point impedance, the three dipole arrays use a somewhat nonstandard arrangement at the hub. As shown on the left in Figure 3, most builders would try to connect the three connecting cables in a parallel arrangement. The resulting impedance would be less than 17 Ω, a somewhat difficult value to handle. As well, any remnant reactance at the hub would constitute a significant portion of the impedance magnitude, creating a matching challenge. However, both of our three dipole designs use the scheme on the right, a series connec-

tion of the lines with the source. The resulting hub impedance is close to 150 Ω, and any stray reactances become very small portions of the impedance magnitude. Therefore, a simple λ/4 matching section can handle the impedance transformation to the 50 Ω region.

150 Ω is a borderline value. If the actual impedance of a physical antenna is below this value, then a 75 Ω line (such as RG-59) provides the best match. If the value is a bit higher than 150 Ω, then a 93 Ω cable (such as RG-62) is the better choice. For the lower half of the 2 meter band, λ/4 is about 20 inches. Multiply this length times the velocity factor of the line actually used to obtain the physical length of the matching line. If you are not satisfied with the frequency of the SWR minimum value, you can lower it by lengthening or shortening the matching line.

Based on the basic design information, W4RNL built a triangular version of the array, suitable for both home and hilltop service. WA1FXT took on the task of bending aluminum to form a circular prototype that is both smaller and perhaps more aesthetically pleasing. The differences give the builder options that may fit one or another set of shop skills and tools. Therefore, let's examine both antennas.

## A Three Dipole Triangle

A very capable horizontally polarized omnidirectional antenna consists of three dipoles fed in phase. Each dipole is broadside to a direction 120° from the adjacent dipoles. The goal is to find dimensions that will achieve this goal plus provide a workable feed point impedance at each dipole. The prototype constructed to test the basic model of this arrangement used ½ inch diameter aluminum tubing as a light but sturdy material. Each dipole used a 2 inch length of 0.375 inch diameter fiberglass rod as a center insulator. The dipole halves are held in place with #6 stainless steel sheet metal screws. The gap should be as small as is feasible, ⅛ to ¼ inch. These same screws will fasten the ends of the coax cable to the element, with a stainless steel washer to prevent electrolysis between the aluminum element and the copper wires. For ease of disassembly in portable operation, the prototype used lugs under the screws.

The key is to find the correct dimensions so that each dipole presents a 50 Ω impedance at its feed point to match the connecting cable impedance. Table 1 lists some dimensions for both 0.5 and 0.375 inch aluminum tubing, perhaps the two most likely materials for this project. For the triangle, we used 146 MHz as the design frequency because the performance and the SWR do not sig-
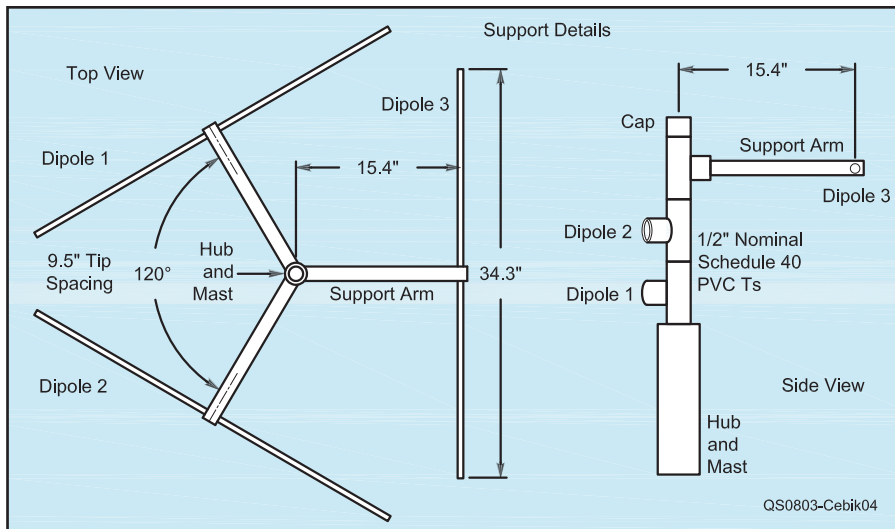
**Figure 4 — Some details of the support structure used for the three dipole 2 meter triangle.**

**Table 1**

**Dimensions for a Three Dipole 2 Meter Triangle (inches)**

| Design Frequency (MHz) | Element Diameter | Radius to Feed Point | Dipole Length | Tip-to-tip Spacing |
|---|---|---|---|---|
| 146 | 0.5 | 15.4 | 34.3 | 9.5 |
| 146 | 0.375 | 15.3 | 34.7 | 9.15 |
| 144.5 | 0.5 | 15.6 | 34.7 | 9.6 |
| 144.5 | 0.375 | 15.5 | 35.1 | 9.25 |



**Figure 5 — The triangle HPOD disassembled for transport.**

nificantly change across the band. This center-design frequency also provided a good view of the antenna's broadband properties. However, the table also lists dimensions that are usable if the builder wishes to place the performance center of the antenna at 144.5 MHz. The prototype used the half-inch-diameter material and the 146 MHz dimensions for that material.

Note the length of the dipole. It is about 3.3 inches shorter than an independent dipole composed of the same material. The resonant impedance (50 Ω) is lower than the usual value for a standard dipole of about 70 Ω. The three dipoles in the triangle do interact by virtue of both the proximity of their feed points and the closeness of their tips. The dimensions of the triangle are therefore quite

critical to successful operation of the array as designed. However, in the triangular form, they are not finicky, and cutting errors of ⅛ to ¼ inch will not materially affect performance.

In fact, the relatively relaxed conditions for the triangle prompted the particular design that emerged. The prototype may be useful for field or hilltop service, since the support structure and the elements and their cable come apart and store in a flat package for transport. Figure 4 provides a few of the support structure details. The arms are ½ inch nominal Schedule 40 PVC, with T fittings at the hub. Each fitting has a cemented stub pointing upward. For field service, do not cement the upper part of the stub to the next T. Instead, let it twist. Once you have aligned the elements as specified below, drill

holes through the T fitting and the stub and install 2.5 inch hitch-pin clips to hold the antenna in alignment during use. A convenient way to accomplish this without a protractor is to predrill only the T fitting of each movable arm. Then, assemble the hub and install the elements and align the arms so that each of the three spaces between dipole ends is as equal as possible. Finally, drill through the outer T fitting holes through the stub. Install the hitch-pin clips.

To fold the structure for transport, first remove the clips, and then twist the arms into parallel alignment. Remove the elements and cables as a unit. Figure 5 shows the two piece transport package for the antenna. Assembly is simply the reverse of disassembly. In field service, each assembly will require a new set of cable ties, while disassembly will require a small knife or cutter. (Please carry away cut cable ties from the operating site.)

For field use, the elements pass through tight ½ inch diameter holes in the outer ends of the arms (carefully measured to establish the feed-point radius). Each element slides into the armhole until the cable connections touch the edge of the hole. Under most conditions, the element will not need further pinioning to remain in place. However, a small cable tie on the other side of the arm will increase holding power. For a more permanent installation, the builder can cement the hubs in final alignment and install any desired kind of brace at the armhole to position the elements more permanently. Caution — each element should be marked to ensure that the connecting cable center conductor is in the same position on each arm. Either all three center conductor screws should be touching the armhole or all three should be away from the armhole. Reversing one of the dipoles relative to the other two will produce a highly directional pattern and a feed-point impedance that is well off the target value.

The construction style vertically spaces the element at 2.5 inch intervals. Modeling tests showed that the displacement increased the distortion of the circular azimuth pattern from about 0.1 dB up to about 0.3 dB, a variation that we have not been able to detect in operation.

Figure 6 shows the cabling details of the triangle, beginning with the dipole connection at the end of the support arm. For field use, small cable ties hold the connecting cables neatly on their way to the junction. Since the connecting cable impedance matches the dipole impedance, the cable length is not at all critical. As well, the cable type also makes no significant difference to performance. Calculations show that cables ranging from RG-58 on the lossy end of the scale to lossless hypothetical cables change
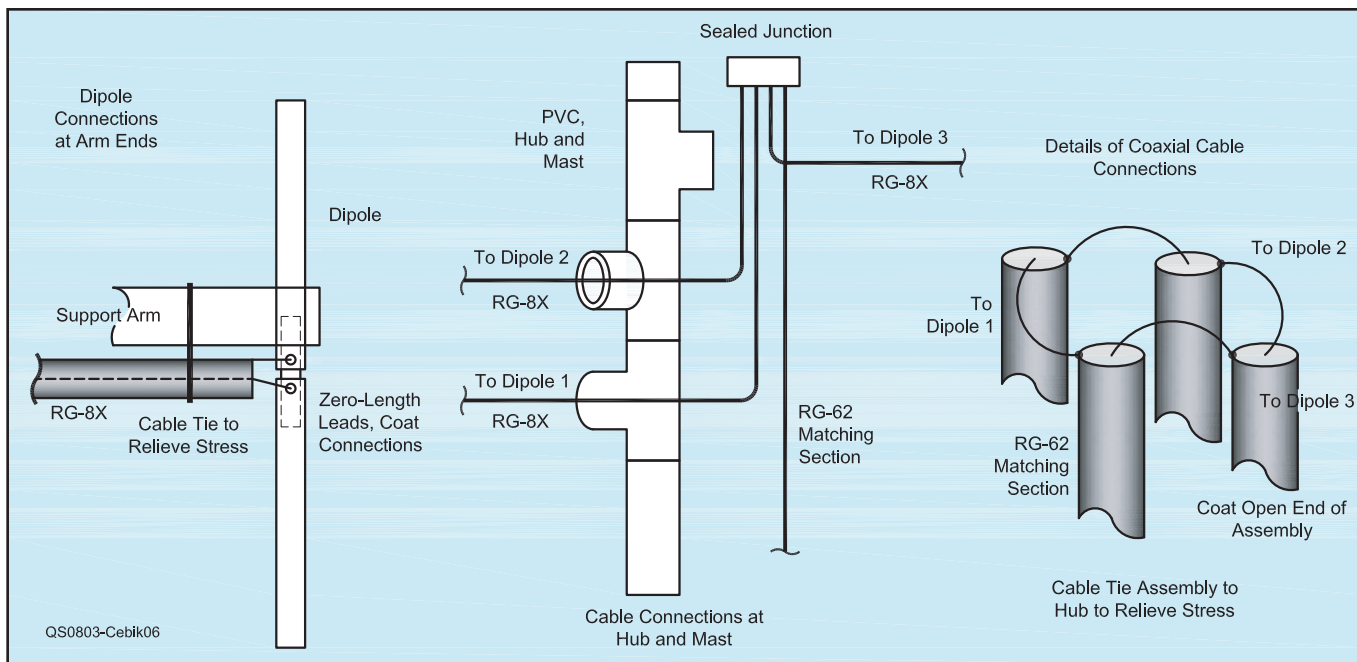
**Figure 6 — Some details of the cable runs and connections used on the three dipole triangle; a similar system is used with the three dipole circle.**

the array gain by about 0.1 dB for reasonable cable runs. The prototype used 20 inch connecting cable lengths to ensure that there are no stresses at the main junction of the cables. Figure 7 shows the entire assembled antenna on its test mast, including the cable ties that keep the coaxial cables neatly arranged and free of stresses. Figure 8 shows the simple connections at the dipole centers, uncoated for portable use and easy disassembly.

Since the antenna uses a series connection to arrive at a junction impedance above 50 Ω, as shown on the right in Figure 6, the antenna requires a λ/4 cable section to transform the impedance to a value that matches the main feed line. The design data showed a net junction impedance of about 150 Ω. Although a section of 75 Ω cable can be pressed into service, it will transform the impedance to a value in the 30 Ω range. A better choice is RG-62 (A or B) with an impedance of 93 Ω

and a measured velocity factor of 0.84. Ideally, a 50 Ω impedance at the source end of the matching section calls for close to 170 Ω at the load end. At the design frequency, the impedance will be about 57 Ω, a very usable figure. With about 17 inches of RG-62 93 Ω cable having a velocity factor of about 0.82, the antenna provided a 50 Ω SWR of 1.3:1 or better from 144 to 145 MHz.

The SWR check is one of two tests for the assembled antenna. The other check requires a second person stationed about 10 λ (about 65 to 70 feet) or more away. One person provides a signal source and the other provides reception with a signal strength reading. It does not matter which person is at the antenna. For the test, simply hand rotate the antenna and test mast, checking for any changes in the signal strength. If the assembly has gone well, the S-meter should not budge.

Although the triangle assembly leans

toward potential hilltop uses for the array, permanent installation requires only a few extra steps. Instead of using hitch-pin clips at the hub, cement the rotatable hubs. As well, cement or otherwise fasten the dipole elements into place at the armholes. For both types of use, seal the cable junction. Several thin coats of *Plasti-Dip* or liquid electrical tape work well and durably. Finally, use a brush to coat the arm ends of the connecting coaxial cables with the same material.

## A Three Dipole Circle

For a permanent installation or for mobile use, you may prefer a circle of three dipoles. The circle has no loose dipole ends and is more compact than the triangle. Indeed, it is



**Figure 7 — An overall view of the HPOD triangle in use, showing the general construction and cable routing.**



**Figure 8 — A close-up of the junction of the support arm, the dipole element, and the connecting cable termination for portable operation. For a permanent installation, insert a stainless steel washer between the hook connector and the element and seal the junction.**

aesthetically more pleasing. However, such pleasure comes at a cost. The construction and adjustment of the elements are somewhat more critical, although completely manageable.

At first glance, the circular HPOD may seem like an intimidating construction project, especially in forming the rim elements. Bending the tubing is not overwhelming if you construct a bending jig and follow some simple suggestions. The dimensions are no more difficult to reproduce than an average woodworking project.

Two pieces of ¾ inch plywood salvaged from a discarded pallet create the bending form and the base. Notice that the diameter of the bending form is less than the dimension shown for the model. The smaller diameter is necessary to account for the tendency the tubing to spring back after it is bent. A form diameter of 28 to 29 inches will result in a final rim diameter of about 31 inches.

Figure 9 shows the general outline of the bending jig. There are two rows of holes in the base circling the form. The inner side of the inner row is used when bending the tubing around the form. The outer side of the outer row is used to make the final bends and set the rim to a final diameter of about 31 inches. Use ¼ inch diameter bolts for the holding pins. If you use nails or screws, they will bend and reduce the accuracy of your rim. When you drill the holes for the inner row, use a small piece of tubing as a gauge to set the distance of the pins at exactly ½ inch away from the form. When you drill the holes for the outer row, use a wooden gauge to set their distance from the rim.

You will need about 120 inches of ½ inch aluminum tubing for the rim. The longer that the tubing is, the easier it will be to bend. We used two 72 inch sections. Try to use 6061T alloy tubing and not the variety found in average Home Center. The alloy used for Home Center tubing is too soft and does not form well.

While cold bending is possible, we do not recommend it because cold bending requires considerably more bending force and seems to cause more "spring back" than hot bending. Wet the form down before you bend. This will lessen the chance for flaming the form. The form was well scorched after bending but retained its shape without flaming. Be sure to wear the appropriate safety equipment such as gloves and eye protection.

Close one end of the tube with a ⅜ inch bolt taped in place and fill the tube with fine sand, such as children's play sand. As you fill the tube, tap the tube down to eliminate any air pockets. When the tube is filled, close the remaining end. Secure one end of the sand filled tube against the wood bending form with a pin, and start bending
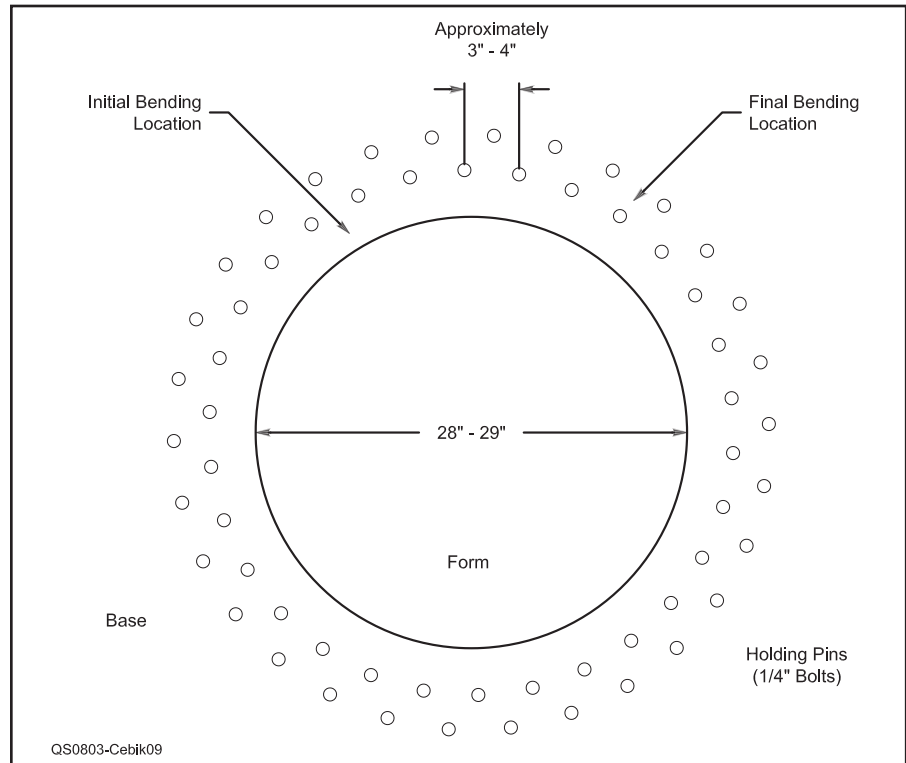


Figure 9 — General outline of the bending jig used to form the dipoles for the circular HPOD.
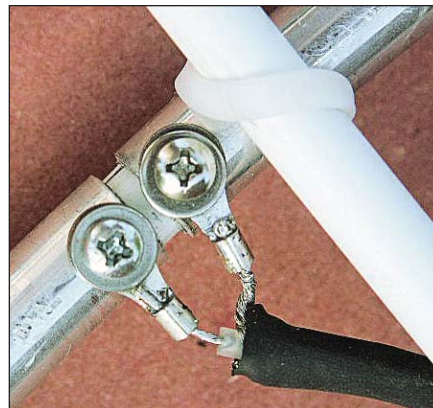


Figure 10 — A close-up of the method used to connect the element to the support arm with cable ties in the circular antenna.

around the form from one end of the tubing to the other. Heat the tubing with a torch as you bend. You will know that you have heated the tubing to the correct temperature when you feel the tubing start to "give" with moderate pressure on the tube.

As you are bending around the form, pin the tubing against the form with ¼ inch bolts every 3 inches. As you approach the end of the tube, the bend will become difficult. If you have any trouble getting the end against the form, secure a wood block to the base with wood screws and drive a wooden wedge between the block and the tube forcing it against the form. When you

reach the end of the tube (or form), stop and let the tube cool to room temperature before removing the pins and tubing.

After you have bent enough tubing for the rim, remove the form from the base and place the pins in the outer row of holes. Secure one end of the rim to a pin using a cable tie. Form the rim by bending the tubing around the pins using cable ties as needed to hold the rim in shape. Do not tie the rim too tightly. You must be able to slide the rim for final assembly. When you reach the end of the first section of tubing, measure and cut the remaining tubing to provide the additional length to complete the rim. If necessary, the ends can be spliced with a telescoping piece of ⅜ inch tubing bent to the same radius. Coat this splice with Penetrox anti-oxidant and secure it with #6 stainless steel sheet metal screws.

After the complete rim is formed, measure and mark the locations of the dipole ends and feed points. Position the rim so that one of the dipole ends is between two pins and secure the rim to these pins. Cut the tubing and rejoin the ends with a 3 inch by ⅜ inch fiberglass rod. Repeat this procedure for each dipole end. Then, measure, cut, and rejoin the feed points in the same manner. Do not permanently secure any of the joints until after testing and adjustments have been completed.

The next task is to fabricate the support structure and hub for the rim. Start by drilling three ⅜ inch holes in a 1¼ inch PVC
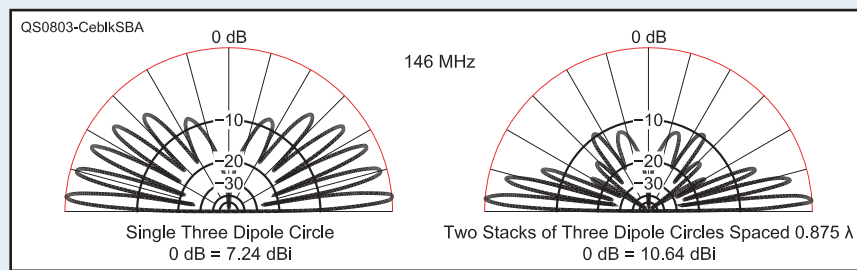
# Stacking Three Dipole Arrays

To obtain additional omnidirectional gain, stacking three dipole arrays is about the only feasible option. Modeling and other tests suggest that the optimal spacing between three dipole arrays is about 0.875 λ, although spacing values between 0.75 λ and 1.0 λ will yield excellent results. Figure A compares the patterns for a single three dipole circle and a stack of two circles using optimal spacing, with the lower antenna 20 feet above average ground. As the maximum gain values show, stacking the arrays adds more than 3 dB gain to the system, while the patterns themselves show the source of the gain in terms of the reduced strength of many of the upper-angle radiation lobes.

A wavelength on 2 meters is just over 80 inches, so stacking is certainly feasible in most circumstances. Even on hilltops, an additional 7 feet of mast necessary to support the second array will withstand at least light breezes without requiring additional bracing. For a home situation (without deed restrictions or subdivision covenants), stacking is advisable. The key lies in feeding the two arrays to maintain in-phase conditions at both feed points.

The left side of Figure B shows a standard method of feeding two 50 Ω arrays in phase. Two ¼-λ sections of 75 Ω cable transform the individual array impedances to 100 Ω. In parallel at the junction, the net impedance is just about 50 Ω. Because each array has a λ/4 section of cable already installed, the added length of 75 Ω lines, adjusted for the velocity factor of the line used, will allow a separation of just about 0.8 λ, close to the optimum value, without having to use the next odd-multiple of λ/4 lines (that is, a pair of 3λ/4 lines).



Figure A — A comparison of elevation patterns for three dipole circles used singly and in an optimally spaced stack of two. The lower antenna is 20 feet above average ground.
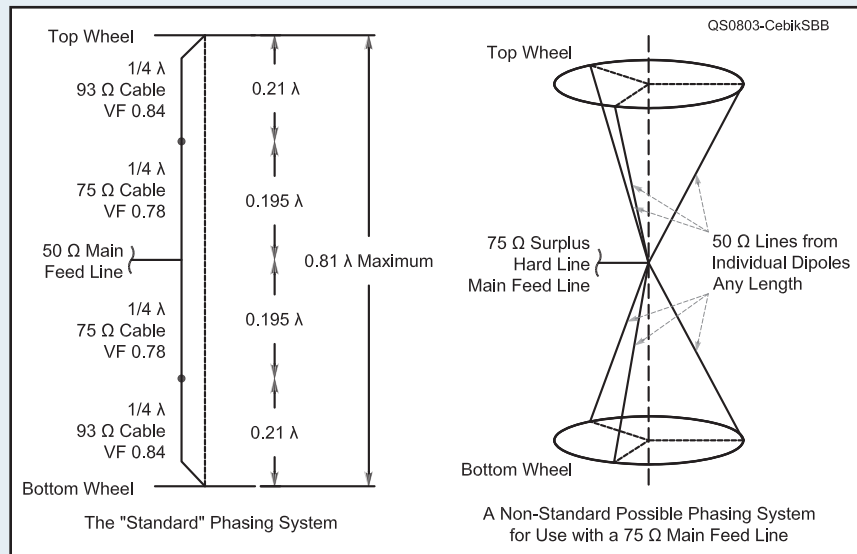


Figure B — Some alternatives for feeding a stack of two three-dipole arrays in phase.

One of the benefits of designing the three dipole arrays for a 50 Ω impedance that matches the impedance of the connecting lines appears on the right side of Figure B. The length of the connecting lines from each dipole is not critical, so long as they are all identical for each array. Therefore, we may bring the lines to a central position in the stack. At about 150 Ω per junction, the parallel value becomes about 75 Ω. This value is ideal for the use of low loss surplus hard line that one might obtain from cable installers.

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coupling at 120° intervals about 1 inch from the end of the coupling. Drill 5⁄16 inch holes adjacent to these holes. Insert 18 inch × 3⁄8 inch fiberglass rods into each 3⁄8 inch hole in the hub and, using cable ties, fasten the remaining end to the rim near the feed point of the respective dipole. Figure 10 shows one method of attaching the dipole centers to the support arms. The rods will be cemented into place after final adjustments are complete. Close the top of the hub with a 2 inch × 1¼ inch piece of PVC pipe and a slip-on end cap. The pipe can be cemented but do not cement the end cap. Figure 11 shows the hub details with the connecting lines in place.

Finally, cut three 21 inch lengths of 50 Ω coax. The prototype used RG-58C. Using

# 6 ring lugs and stainless steel sheet metal screws, attach one end of the coax to each feed point of the dipoles. Make sure that the inner conductor and outer braids are installed in the same sense relative to each other. For example, If you installed the center conductor of one coax to the left of the feed point, all center conductors should be installed on the left of the feed point.

Slip the remaining end of the coax through the 5⁄16 inch hole in the hub and connect the remaining ends in a series arrangement. Refer to Figure 6 for details. A small piece of polycarbonate sheet or fiberglass perforated board placed under the series connections adds support for the cables and reduces the chance for breakage. Keep in mind that the length of the coax connect-

ing lines is not critical, but they all must be the same length. Keep the end connections as short as possible. Fasten the coax to the fiberglass support arms with a high quality electrical tape or UV resistant cable ties. The matching line will connect at the center of the hub and drop away from the antenna at a 90° angle down the mast. You can run the matching cable and main feed line in the mast. The prototype runs the main cable outside the mast for easier maintenance.

To test the new wheel, select your testing area carefully. The antenna should be at a height of 10 feet and 10 feet away from surrounding objects. Although you may use a simpler antenna analyzer, such as the MFJ-259, to test the antenna, the circular antenna had the benefit of an Array

Figure 11 — The hub, support rods and the main junction of connecting cables and the λ/4 matching section before final sealing.



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Figure 12 — Measured SWR of the circular three dipole horizontally polarized omnidirectional antenna.

## Table 2

### Modeled and Final Dimensions for a Three Dipole 2 Meter Circle (inches)

| Design Frequency (MHz) | Element Diameter | Radius to Feed Point | Circumference | Dipole Length | Tip-to-Tip Gap |
|---|---|---|---|---|---|
| Modeled | | | | | |
| 146 | 0.5 | 15.5 | 97.4 | 31.4 | 1.0625 (1¹⁄₁₆) |
| 146 | 0.375 | 16.0 | 100.5 | 32.4 | 1.125 (1¹⁄₈) |
| 144.5 | 0.5 | 15.7 | 98.4 | 31.75 | 1.0625 (1¹⁄₁₆) |
| 144.5 | 0.375 | 16.2 | 101.6 | 32.75 | 1.125 (1¹⁄₈) |
| Final | | | | | |
| 144.5 | 0.5 | 15.8 | 99.375 | 32.0 | 1.0625 (1¹⁄₁₆) |

## Table 3

### List of Materials and Local Sources for Circular Wheel

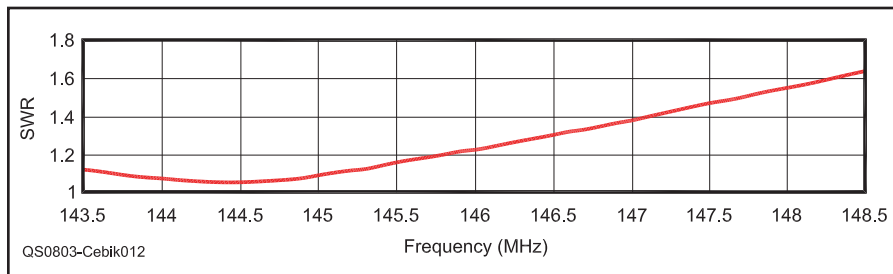| Material | Suggested Source |
|---|---|
| Two pieces 36 × 36 × ¾ inch plywood | Old pallets or Home Center |
| 144 inches ⅜ inch aluminum tubing | Texas Towers or **online metals.com** |
| 12 inches ⅜ inch aluminum tubing | Texas Towers or **online metals.com** |
| 6 feet ⅜ inch fiberglass rod | Home Center, farm and garden supply, Max Gain Systems |
| 1¼ inch PVC coupler, pipe, end cap | Home Center, hardware stores |
| No. 6 stainless steel hardware | Home Center, hardware stores |
| 1¾ inch ¼-20 bolts | Home Center, hardware stores |

Solutions AIM-4170, which has proven highly accurate to its upper frequency limit of 170 MHz.[3] The device also provides accurate resistance and reactance readings, including the sign of the reactance.

Initial tests on the wheel using a series connection among the three connecting lines to the dipoles, produced an impedance at some distance from the target value shown by the models. Adjusting all the gaps between the dipole ends to 1¹⁄₁₆ inches resulted in readings of about 120 +*j*31 Ω. Table 2, in the bottom line, shows the final dimensions used by this prototype. The series connection impedance allowed the use of a section of 75 Ω coax to transform to the final 50 Ω line impedance. The measured velocity factor for the matching line coax was 0.81 and its characteristic impedance was 75.0 Ω. A line length of 20 to 21inches brought the impedance to the target, as shown by the measured SWR curve in Figure 12.

The circle is somewhat more sensitive to small changes than the triangle, due to the close spacing of the ends. There are two tactics for changing the series impedance at the hub. First, change the end spacing between the dipoles in ¹⁄₁₆ inch increments. Second, try changing the length of the matching line by ½ inch increments. (The method of connecting the dipole to the connecting cables may alter the exact impedance of each dipole relative to the modeled value.) And lastly, change the length of each dipole in ¹⁄₁₆ inch increments

If you experience common mode currents on the matching line and the 50 Ω main feed line, you may add a split ferrite block about 18 inches below the junction of the matching section with the main line. Alternatively, and with equal effectiveness, wrap the cable around the pole for several gentle turns.

The final test is for an omnidirectional pattern. A receiver with an S-meter or a reliable field-strength meter is useful. Spinning the wheel slowly produced gain variations of less than 0.2 dB at any frequency within the first MHz of the band. Although requiring somewhat more careful construction than

the triangular version of the array, the results are more nearly ideal.

## Conclusion

Over the years, the use of three dipoles to form an omnidirectional horizontally polarized radiation pattern for 2 meters has experienced unwarranted neglect. The designs and prototypes described in these notes should restore these arrays to their rightful places as viable alternatives to many of the other possible HPOD designs. Except for using reasonable care both in cutting and adjusting the elements, the three dipole array — in either triangular or circular form — provides both a high performance antenna of its type and the potential for a satisfying antenna building experience.

**Notes**
[1]R. Mellen, W1IJD, and C. Milner, W1FVY, "The Big Wheel on Two," *QST*, Sep 1961, pp 42-45.
[2]*EZNEC* models of a big wheel simulation and of various versions of the three dipole triangle and circle are available at **www.arrl.org/files/qst-binaries/**.
[3]J. Hallas, W1ZR, "Product Review — Three Antenna System Measurement Devices," *QST*, Aug 2007, pp 67-73.

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*with a major dc power systems supplier. Back in Connecticut, Bob was first licensed in 1965 as WN1FXT. Since then, the ham radio world for Bob has been filled with many homebrew projects. He feels most comfortable in his radio lab and woodworking shop with fellow hams and grandchildren. Since he moved to Ohio in 1984, his backyard has become a three-acre antenna breadboard. No single antenna seems to stay in the air for too long before it is replaced by something new. Visitors to WA1FXT often find themselves part of a new homebrew project. Bob's wife, KC8BOM, serves as a catalyst for his ham radio ventures and is an accomplished builder too. Bob is looking forward to retirement when he has to make that difficult choice every morning: "Which project do I work on today?"*

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*Since his retirement as a professor at the University of Tennessee, L. B. Cebik, W4RNL, has written extensively for radio amateurs about antennas and related topics in many venues, including his own Web site,* **www.cebik.com**. *Licensed since 1954, LB has served ARRL in many capacities, including as Educational Advisor and as Technical Advisor. He is a contributing editor to* QEX *and is technical editor for* antenneX. *LB can be reached at 1434 High Mesa Dr, Knoxville, TN 37938-4443 or* **cebik@cebik.com**.