By Allen Baker, KG4JJH

The Black Widow—A Portable 15 Meter Beam

Looking for a portable 15-meter antenna for camping or Field Day? Four fishing poles, 50 feet of wire, a few pieces of wood, some PVC and a painter's pole make a stinging portable performer.

The Lure

There are a lot of excellent antenna designs available to the amateur, but few can combine light weight and portability with the significant gain and front-to-back ratio (F/B) of the Moxon Rectangle. All the materials necessary for building this portable antenna (including the mast) are available from your local Wal-Mart, Home Depot and RadioShack for under $125.

The Moxon Rectangle

The Moxon Rectangle is a two-element beam with considerable gain, high F/B ratio, and a direct match to 50 Ω coax. [The Moxon-type antenna is named for its originator, L. A. Moxon, G6XN.—*Ed.*] The antenna is a derivative of the Moxon Square and it has been further optimized by L. B. Cebik, W4RNL.[1] Figure 1 shows the basic dimensions of the antenna.

I used the program *MoxGen*[2] to generate a model at 21.070 MHz for use with PSK and then fine-tuned it with *EZNEC*.[3] Since the Black Widow uses insulated wire (and *MoxGen* is based on bare wire), the final dimensions will change due to the insulation's effect on the wire's velocity factor.

I first built the antenna to the wire lengths in the *EZNEC* model: A = 203.25″, B = 31.25″, C = 4.88″ and D = 37.63″, which resulted in an actual resonant frequency of 20.180 MHz. I trimmed the wires to a final length = FM/FD × L, where FM is the measured frequency, FD is the desired frequency and L is the length before trimming. The final dimensions are A = 194.63″, B = 29.88″, C = 4.75″ and D = 36.0″. For an antenna centered in the middle of the 15-meter band: A = 193.75″, B = 29.75″, C = 4.63″ and D = 35.88″.

Construction

Figure 2 presents an overview of antenna assembly. All of the necessary materials are listed in Table 1 along with sources for each. The antenna can be

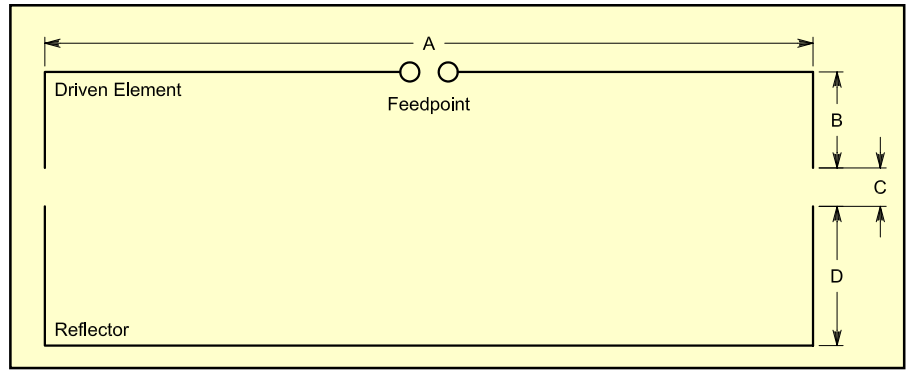


Figure 1—The basic dimensions of the Moxon Rectangle.

[1]Notes appear on page 00.

Table 1
Materials List for the Black Widow Antenna

Item	Qty	Description	Source	Price Each ($)
1	4 each	Crappie Master Fishing Pole, RCM-10LW, 3 sections, 10 ft	Wal-Mart	6.96
2	1 roll	20 AWG insulated stranded wire, 75 ft	RadioShack 278-1219	2.99
3	1 each	Terminal strip, 8-position	RadioShack 274-678	2.49
4	1 each	Connector, SO-239	RadioShack 278-201	1.99
5	1 pkg	Soldering ring, #6	RadioShack 64-3030A	1.69
6	1 each	Epoxy, quick set	Home Depot	2.97
7	4 each	Screw hook, 0.162″ wire diameter	Home Depot	0.42
8	1 each	Wood, poplar, ½″ × 6″ × 36″	Home Depot	5.25
9	2 pkg	Three piece extension pole, Linzer RP503	Home Depot	3.79
10	1 each	Painter Pole, Mr. LongArm Model 2324	Home Depot	39.97
11	1 each	PVC coupling, 1½″	Home Depot	0.47
12	1 each	CPVC pipe, ½″ × 10 ft	Home Depot	2.98
13	1 each	CPVC drop ear 90° elbow, ½″	Home Depot	0.68
14	1 each	CPVC 90° elbow, ½″	Home Depot	0.19
15	10 each	Sheet metal screw, self-drilling, #6 × ½″	Home Depot	0.17
16	230 ft	Nylon twine, #36	Home Depot	3.79
17	3 each	Clothesline tightener, Lehigh 7097	Wal-Mart	2.96
18	50 ft	Nylon rope, 3/16″	Wal-Mart	1.97
19	1 each	2″ × 4″ × 8′, pine	Home Depot	3.00
20	2 each	L-bracket, 3″ × 3″ × ¾″	Home Depot	3.00
21	5.5 ft	RG-8X coaxial cable	RadioShack 278-1313 or equiv	0.32 per ft

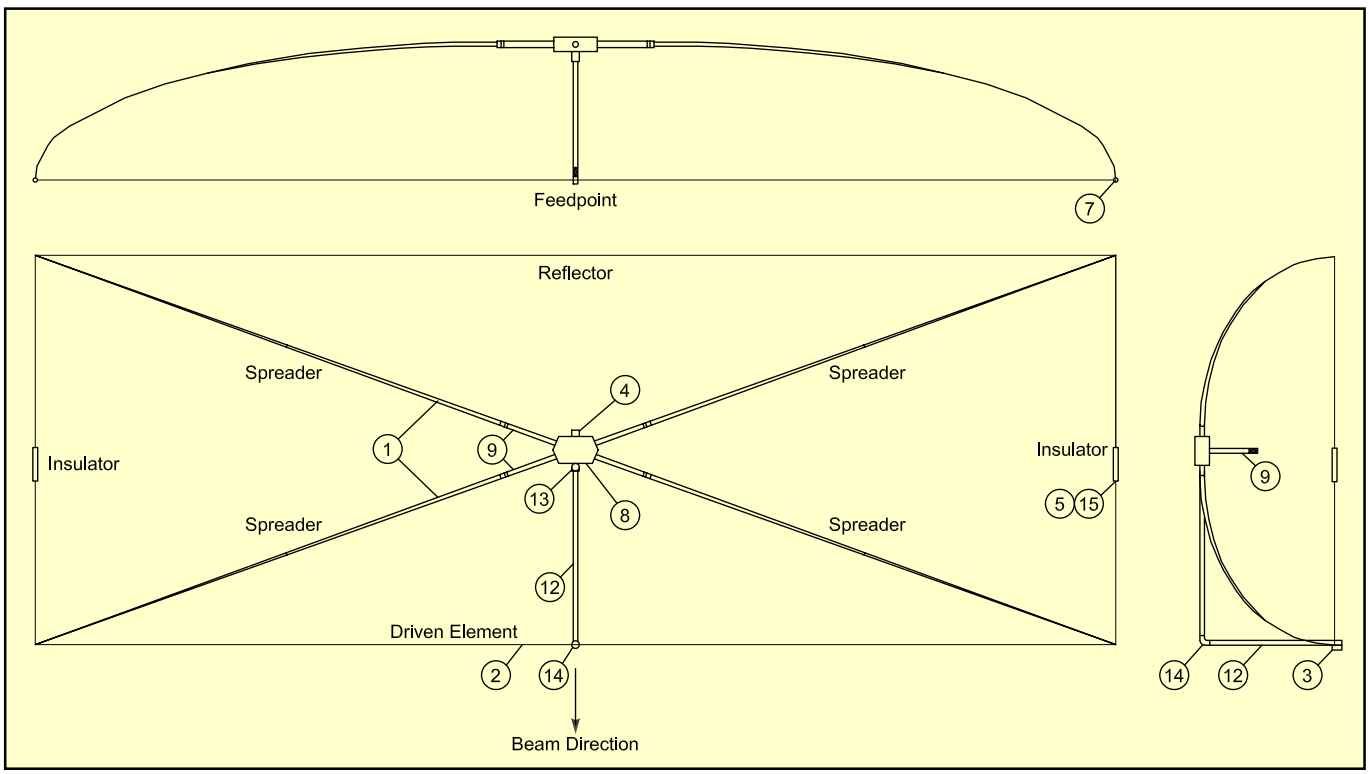
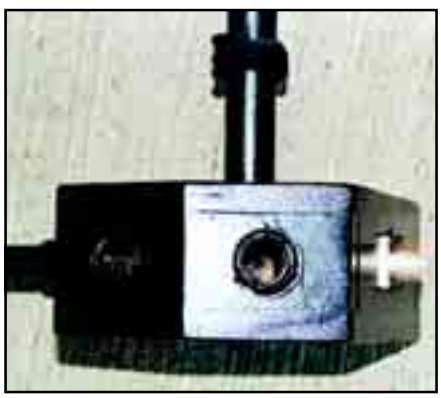


Figure 2—Overview of the antenna and its components. Circled numbers refer to materials in Table 1.



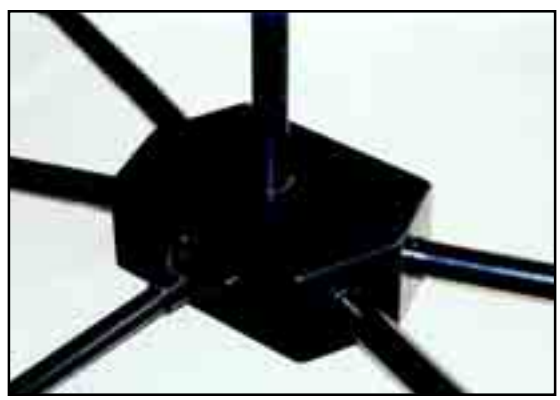


Figure 3—The center hub (left). Note the glued-in (epoxy) threaded sockets for the spreaders. The completed hub (right) shows the mounting stub extending upward and the feed line support extending to the lower left.

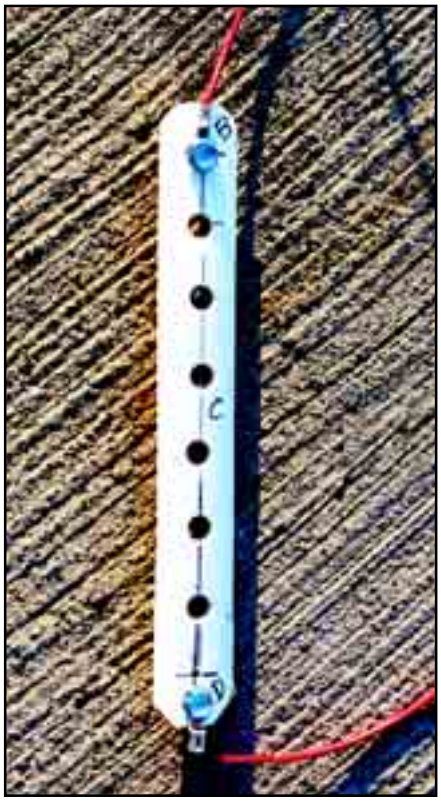


Figure 4—One of the two insulators for the wire elements.

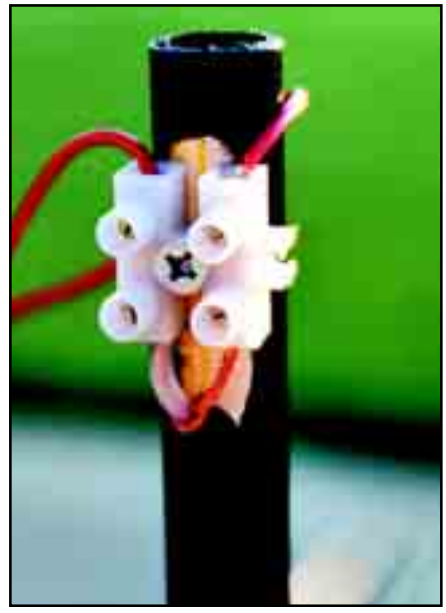


Figure 5—The mounted terminal strip on the feeder arm.

Figure 6—A view of the antenna mast support bracket.

fashioned from the explanations contained here; however, detailed construction drawings for the antenna and the mast components are available at **www.arrl.org/files/qst-binaries/blackwidow.zip**.

Spreaders

Modify each of the four fishing poles as follows. Unscrew the handle cap, roughen two inches of the inside surface with sandpaper, and epoxy a 12″ wooden extension pole (threaded on both ends) into the fishing pole handle. The original pole is too flexible and does not exert enough tension to keep the wires tight, so a portion of the small end must be removed. Extend the pole to its full length, and trim the small end so that the total length from handle to tip (including the wooden pole) is 106.5″. Use a hacksaw or band saw to keep the fiberglass from cracking. Epoxy a screw hook into the end of the pole. (Note: If the screw hook diameter is too large to fit into the end of the pole, cut another 0.5″ to 1″ off of the pole until it fits. Make all four poles the same length.) Spray paint the bare wood with Krylon *Ultra-Flat* black spray paint, and when dry apply two coats of clear lacquer.

Center Hub

The center hub is made from 0.5″ thick poplar wood to minimize weight. Cut the pieces on a table saw and glue them together with yellow wood glue. Cut two of the plastic extension-pole handle sockets in half so that two threaded sockets are produced from each. Drill 1″ diameter holes in the hub, and epoxy the sockets into each hole. I chose to permanently attach the mast mount (which is a wooden extension pole threaded on one end) by drilling a 0.875″ hole through the top and bottom and securing it with epoxy. Extend the nonthreaded end through the hub and trim off the excess after the glue sets.

Drill a 0.625″ hole for mounting the SO-239 connector on one side of the hub. Drill and mount the CPVC drop ear elbow on the opposite side, and drill a 0.3125″ hole through the drop ear elbow into the hub. Sand and paint the hub the same as the fishing pole handles. Figure 3 shows a completed hub.

Insulators

The ends of the antenna elements (within dimension C of Figure 1) are supported by a pair of insulators that maintain a fixed distance between the wire ends. The insulators are made from 6″ × 0.75″ pieces of scrap CPVC pipe cut in half lengthwise. Six 0.3125″ holes are drilled into the PVC insulators to reduce weight. Drill a small hole for a #6 thread-cutting screw to attach the element ends to the insulators. Include the diameter of the solder rings when spacing the holes in the insulators. A view of each of the insulators can be seen in Figure 4.

Wire

Cut wires to the following dimensions (including 0.4″ for each loop of wire around a screw hook):

Two each, ½ Driven Element = ½ A + B + 1 Loop

= 97.315″ + 29.875″ + 0.4″ = 127.59″ or 127.625″

One each, Reflector Element = A + 2D + 2 Loops

= 194.625″ + 72″ + 0.8″ = 267.425″ or 267.5″

Mark the corners (Figure 1, dimension intersections A-B and A-D) on the wires using a permanent marker. Strip ½″ insulation from the wire ends at the feed point for the driven element. Attach solder rings at the ends that will attach to the insulators.

Feed Point and Feed Line Support

Coax is carried to the feed point of the driven element from an SO-239 connec-

tor on the hub, through the hub, and through an "L" made of CPVC pipe. The horizontal pipe length is 31.5″, and the vertical length is 24″. These lengths were determined with the antenna wires installed and the terminal block floating from its vertical support. To account for construction differences, cut the pipe pieces slightly long and trim them in small increments.

Connect the coax to the SO-239 connector first, then feed the coax through the hub, the drop ear elbow, the horizontal pipe, the 90° elbow, the vertical pipe, and out of a hole drilled in the pipe just above where the terminal block will be mounted.

Cut two terminals free from the strip. Clamp the driven element's feed point wire ends into each side of the terminal block. Then loop the wire around the open hooks at the corners using the permanent marker lines as an aid. Attach the wires to the insulators. Dry fit all pipe pieces until the terminal strip can be mounted to the lower end of the vertical pipe such that the driven element is straight and parallel to the reflector. Attach the two-terminal block with a small sheet metal screw. Figure 5 shows the mounted terminal strip.

Strip the coax and attach its shield and center conductor to the terminal strip. When complete, check all wire dimensions with a measuring tape and make adjustments as necessary within an accuracy of $^1/_8$″. Remark the position of the screw-eye mounting loops, if necessary. Align and glue the CPVC parts. (If you prefer not to glue the CPVC, leave enough slack in the coax to allow removal of the pipe and terminal block assembly, and attach the pipes and couplings with screws.) Paint the feed line support to match the hub.

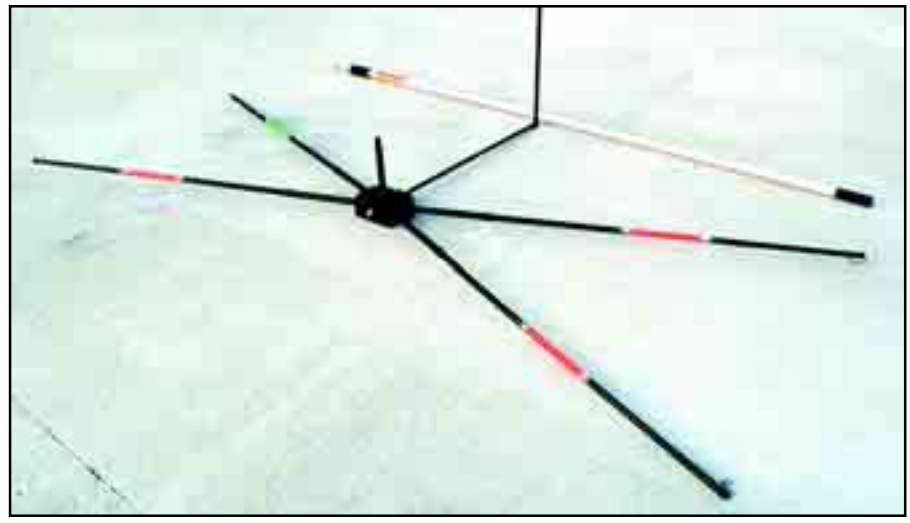
Mast and Support

The painter pole can be supported in a variety of ways but should be guyed at three points. I fashioned my support from 2 × 4s to fit my trailer hitch and used the pickup truck tie points and a ground stake as guying anchors. The bed of the truck also serves as a convenient platform to raise and lower the mast. A PVC coupling, with holes drilled for twine guy lines slips over the pole. Be sure to drill and install a small screw into both ends of the plastic handle socket that connects the painter pole to the hub. This pins the antenna and prevents it from turning on the mast.

The finished Black Widow weighs less than 5 pounds and is stable at a height of 15 feet in windy conditions. On a calm day it could be extended to the full 23

Figure 7—The erected antenna. In the air, the antenna resembles a black spider with its legs hanging down.

(A)



(B)

Figure 8— (A) Broken down into its major components—spreaders, hub, feed line support and wire elements, the Black Widow is ready for transport. The partially assembled antenna (B).

feet, improving the gain and lowering the angle of radiation. Figure 6 is a view of the antenna support bracket and Figure 7 shows the erected antenna.

Setup

Figure 8A shows the Black Widow ready for assembly. Remove the rubber stoppers from the ends of the fishing poles and extend them to their full length. Screw all four fishing poles into the hub. With the assembly upside down on the ground, attach the driven element wires to the feed point and wind the wires one loop around the screw hooks at the marks on the wire. As you progress, the fishing poles will begin to flex upward. Place the PVC pipe coupling with attached guy wires (nylon twine) over the top of the painter pole. Pick up the antenna, flip it over and screw the painter pole onto the mast. Secure the antenna by inserting a screw into the socket on both ends.

Connect a feed line to the SO-239 and secure it to the mast with Velcro or electrical tape. To help suppress RF currents on the outside of the coax shield, wind five turns of coax in a 6 inch coil near the antenna.

Place the antenna and painter pole mast into a suitable support. To prevent the painter pole from bending, raise the middle section first and adjust the guy wires as needed. Lower the middle section and raise and tighten the top section. Now raise the middle section again and tighten. Clothesline tighteners were used on all guy wires to allow adjustment without having to re-tie the twine.

Results

The antenna was designed for PSK use at 21.070 MHz, but tests conducted with an MFJ antenna analyzer at heights of 15 and 23 feet reveal a fairly flat response of 1.2:1 to 1.3:1 across the entire 15-meter band. The *EZNEC* models predicted the antenna to have a gain of 9 dBi at the 15 foot level and 10.45 dBi at the 23 foot level. Likewise, the predicted SWR is 1.11:1 at 21.1 MHz.

Upon completion, I wanted to see if the Black Widow would perform as I had hoped. Tropical storm Isadore had just passed through our area, so it was clear but very windy. With an eye out for the wind, I mounted the antenna on the painter pole at a height of only 15 feet.

A good test for any antenna is to see how well it performs at QRP power levels. With 5 W from my FT-817, my first PSK contact was a station in San Diego, who gave me a signal report of 579. Not bad, considering that distance from my QTH in Tennessee is 1900 miles. Next, I swung the beam toward Europe and contacted a station in the UK who gave me an RST of 589 and an uninterrupted QSO for about 15 minutes. Wow, I was getting excited—that's over 4000 miles!

With the assistance of my brother (NG4T), further SSB/CW tests were conducted using his TS-2000 at power levels up to 100 W with great results. The Black Widow is easy to build, transport and set up. Figure 8A shows the antenna ready for transport and Figure 8B shows it partially assembled. It will outperform many portable 15 meter antennas. Good luck and have fun!

Notes

[1]**www.cebik.com/moxpage.html**.
[2]**www.qsl.net/ac6la/moxgen.html**.
[3]**www.eznec.com**.

Allen Baker, KG4JJH, received his license in September 2000, after a lifelong dream of becoming a ham. He holds a BS in Industrial Engineering from Tennessee Technological University and worked as an instrument and controls engineer with the Department of Energy in Oak Ridge, Tennessee. Allen is active on the digital modes (10 through 40 meters) and loves to experiment with antenna designs. He can be reached at 211 Brochardt Blvd, Knoxville, TN 37922; **awbaker@charter.net**.