The DBJ-1: A VHF-UHF Dual-Band J-Pole

Searching for an inexpensive, high-performance dual-band base antenna for VHF and UHF? Build a simple antenna that uses a single feed line for less than $10.

Two-meter antennas are small compared to those for the lower frequency bands, and the availability of repeaters on this band greatly extends the range of lightweight low power handhelds and mobile stations. One of the most popular VHF and UHF base station antennas is the J-Pole.

The J-Pole has no ground radials and it is easy to construct using inexpensive materials. For its simplicity and small size, it offers excellent performance. Its radiation pattern is close to that of an “ideal” dipole because it is end fed; this results in virtually no disruption to the radiation pattern by the feed line.

The Conventional J-Pole

I was introduced to the twinlead version of the J-Pole in 1990 by my long-time friend, Dennis Monticelli, AE6C, and I was intrigued by its simplicity and high performance. One can scale this design to one-third size and also use it on UHF. With UHF repeaters becoming more popular in metropolitan areas, I accepted the challenge to incorporate both bands into one antenna with no degradation in performance. A common feed line would also eliminate the need for a duplexer. This article describes how to convert the traditional single band ribbon J-Pole design to dual-band operation. The antenna is enclosed in UV-resistant PVC pipe and can thus withstand the elements with only the antenna connector exposed. I have had this antenna on my roof since 1992 and it has been problem-free in the San Francisco fog.

The basic configuration of the ribbon J-Pole is shown in Figure 1. The dimensions are shown for 2 meters. This design was also discussed by KD6GLF in QST. That antenna presented dual-band resonance, operating well at 2 meters but with a 6-7 dB deficit in the horizontal plane at UHF when compared to a dipole. This is attributable to the antenna operating at its third harmonic, with multiple out-of-phase currents.

I have tested single-band J-Pole configurations constructed from copper pipe, 450 Ω ladder line, and aluminum rod. While all the designs performed well, each had shortcomings. The copper pipe J-Pole matching section would be exposed to the elements.

How the J-Pole Works

The basic J-Pole antenna is a half-wave vertical radiator, much like a dipole. What separates this design from a vertical dipole is the method of feeding the half-wave element. In a conventional dipole or groundplane, the radiation pattern can be disrupted by the feed line and there is usually a tower or some other support that acts as a reflector as it is frequently parallel to the antenna. The J-Pole pattern resembles that of an ideal vertical dipole because of its minimal interaction with the feed line. The performance of this J-Pole is, theoretically at least, equal to a ½ wave radiator over an ideal ground.

The J-Pole also matches the high impedance at the end of a ½ wave radiator to a low feed point impedance suitable for coax feed. This is done with a ¼ wave matching stub, shorted at one end and connected to the ½ wave radiator’s high impedance at its other end. Between the shorted and high impedance ends there is a point that is close to 50 Ω. This is where the feed line is attached.

Creating the Dual-Band DBJ-1

So how can one add UHF to the conventional 2-meter J-Pole? First of all, a half-wave 2 meter antenna does resonate at UHF. Resonating is one thing, but working well is another. The DBJ-1 not only resonates, but also performs as a ½ wave radiator on both bands. An interesting fact to note is that ½ wave center-fed dipole-type antennas will resonate at odd harmonics (3rd, 5th, 7th, etc). This is why a 40 meter center-fed ½ wave dipole can be used on 15 meters. Similarly, a 150 MHz antenna can be used at 450 MHz. However, the performance of the antenna at the third harmonic is poor when it is used in a vertical configuration. At UHF (450 MHz) the ½ wave radiator becomes ⅛ wavelengths long. Unfortunately, at UHF, the middle ⅛ wavelength is out of phase with the top and bottom segments and the resulting partial cancellation results in approximately 2 dB less gain in the horizontal plane compared to a J-Pole operating at its fundamental frequency. Maximum radiation is also directed away from the horizon. Thus, although the J-Pole can be made to work at its third harmonic, its performance is poor, often 6-8 dB below that of a groundplane.

Figure 3—The 2 meter J-Pole modified for both VHF and UHF operation. These measurements are approximate (see text).

From February 2003 QST © ARRL
Table 1
Measured Relative Performance of the Dual-Band Antenna at 146 MHz

<table>
<thead>
<tr>
<th></th>
<th>VHF ¼ Wave Mobile</th>
<th>VHF Flex Antenna</th>
<th>Standard VHF J-Pole</th>
<th>DBJ-1 J-Pole</th>
</tr>
</thead>
<tbody>
<tr>
<td>Received Signal Strength</td>
<td>–24.7 dBm</td>
<td>–30.5 dBm</td>
<td>–24.3 dBm</td>
<td>–23.5 dBm</td>
</tr>
<tr>
<td>Difference from Reference</td>
<td>0 dB</td>
<td>–5.8 dB</td>
<td>+0.4 dB</td>
<td>+1.2 dB</td>
</tr>
</tbody>
</table>

Table 2
Measured Relative Performance of the Dual-Band Antenna at 445 MHz

<table>
<thead>
<tr>
<th></th>
<th>VHF ¼ Wave Mobile</th>
<th>VHF Flex Antenna</th>
<th>Standard VHF J-Pole</th>
<th>DBJ-1 J-Pole</th>
</tr>
</thead>
<tbody>
<tr>
<td>Received Signal Strength</td>
<td>–38.8 dBm</td>
<td>–45.3 dBm</td>
<td>–45 dBm</td>
<td>–38.8 dBm</td>
</tr>
<tr>
<td>Difference from Reference</td>
<td>0 dB</td>
<td>–6.5 dB</td>
<td>–6.2 dB</td>
<td>0 dB</td>
</tr>
</tbody>
</table>

cable is used for the stub, it is likely that the top of the antenna will require some glue or foam to hold the antenna in place because of the additional cable weight. —Ed. | The 300 Ω twin lead is sufficiently rigid so as not to bend once it is inside the pipe. Install an SO-239 connector in the bottom end cap. Once the antenna is trimmed to the desired operating frequency, glue both end caps and seal around the SO-239 connector. Presto! For a few dollars, you’ll have a dynamite antenna that should last for years.

The antenna should be supported only by the lower 12 inches of the housing to avoid interaction between the matching stub and any nearby metal, such as an antenna or tower. The results from the antenna are excellent considering its simplicity.

Measured Results

Brian Woodson, KE6SVX, helped me make measurements in a large parking lot, approximating a fairly good antenna range, using the Advantest R3361C spectrum analyzer shown in Figure 4.

The transmitter was a Yaesu FT-5200 located about 50 yards from the analyzer. The reference antenna consisted of mobile ¼ wave Motorola ground plane antennas mounted on an NMO connector on the top of my vehicle. The flex antenna (“rubber duck”) was mounted at the end of 3 feet of coax held at the same elevation as the groundplane without radials. The J-Pole measurements were made with no groundplane and the base held at the same height as the mobile ground plane. Table 1 gives performance measurements at 146 MHz, while Table 2 gives those same measurements at 445 MHz.

As can be seen in the UHF results, the DBJ-1 outperforms the standard 2 meter J-Pole by about 6 dB (when used at UHF), a significant difference. The standard 2 meter J-Pole performance is equivalent to a flex antenna at UHF. Also note that there is no significant difference in performance at 2 meters between the DBJ-1 and a standard J-Pole. The flex antenna is about 6 dB below the ¼ wave mobile antenna at both VHF and UHF. This agrees well with the previous literature.

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The completed antenna can be seen mounted to the author’s roof in Figure 5.

If you do not have the equipment to construct or tune this antenna at both VHF and UHF, the completed antenna is available from the author, tuned to your desired frequency. The cost is $20. E-mail him for details.

Ed Fong was first licensed in 1968 as WN6IQN. His Extra Class came with WB6IQN. He obtained the BSEE and MSEE degrees from the University of California at Berkeley and his PhD from the University of San Francisco. A Senior Member of the IEEE, he has seven patents and two-dozen published papers in the area of communications and integrated circuit design. Presently, he is employed by the University of California at Berkeley teaching graduate classes in RF design and is a Senior Member of the Technical Staff at Foveon Corporation in Santa Clara, California. You can contact the author at 1163 Quince Ave, Sunnyvale, CA 94087; edison_fong@hotmail.com.
◊ In “The DBJ-1: A VHF-UHF Dual-Band J-Pole” [Feb 2003, p 40], replace “VHF” with “UHF” in the headings of Table 2, columns 1 and 2. Column 3 remains “VHF,” as it refers to the use of a 2 meter VHF J-Pole on its third harmonic. Also, the area immediately to the left of the RG-174 stub should not be shaded. The decoupling stub is in series with two separate pieces of twin-lead.

◊ In “The DBJ-1: A VHF-UHF Dual-Band J-Pole” (Feb 2003, pp 38-40), the length of the RG-174 matching stub should be shortened a bit to get the antenna closer to a 1:1 SWR. Using the formula for line length versus frequency and wavelength,

\[ L = \frac{(VF \times 984 \times N)}{f} \]

where

- \( L \) = length (in feet),
- \( VF \) = velocity factor,
- \( N \) = number of wavelengths and
- \( f \) = frequency in MHz