VHF/UHF  Dual Band J-Pole

By: Ed Fong WB6IQN

eemail: edison_fong@hotmail.com

ARRL VHF/UHF Antenna Classics
ARRL Vol. 8 Antenna Compendium
ARRL Vol. 3 Antenna Compendium
QST  March 2007
QST  February 2003
The DBJ-2: A Portable VHF-UHF Roll-Up J-pole Antenna for ARES

WB6IQN reviews the theory of the dual band 2 meter / 70 cm J-pole antenna and then makes detailed measurements of a practical, easy to replicate, "roll-up" portable antenna.

Edison Fong, WB6IQN

There have been more than three years since my article on the dual band J-pole (DBJ-1) appeared in the February 2010 issue of QST. I have been asked over 100 times regarding that antenna. Some have reported good results, and a few individuals even built the antenna and confirmed the reported performance. Some have asked about using this antenna for their LAEC Chaser and emergency operations center. When asked why they choose the DBJ-1, the most common answer was value. When budgets are tight and you want a good performance-to-price ratio, the DBJ-1 (Dual Band J-pole) is an excellent choice.

The current Dual Band J-pole costs about $35 per antenna and what you get is a VHF/UHF J-pole antenna with vertical performance on both VHF and UHF bands. It is a small city building about 3/8 of the beam size of the orbital ripple pattern. If you want big, go elsewhere.

I have constructed using PVC pipe, it is UV protected, and it is waterproof. To date I have personally constructed over 400 of these antennas for various groups and individuals, and have had excellent results. One was tendered with an antenna in the Graduate School of Civil Engineering at UC Berkeley.

The most common request from users is for a portable "roll-up" version of this antenna for backpacking or emergency use. To address that request, I would describe the principles of the DBJ-2. It can be extended to a portable roll-up antenna. Since it is the second version of this antenna, I call it the DBJ-2.

Principles of the DBJ-1

The original J-pole (J-pole) is shown in Figure 1. Unlike the popular ground plane antennas, a J-pole has ground plane (or "footprint") radials. The DBJ-1 is easy to construct using inexpensive materials from your local hardware store. For its simplicity and small size, the DBJ-1 offers excellent performance and competes with commercial PCB ground plane antennas.

Radiation patterns are close to that of an ideal vertical dipole because it is end fed, with virtually no distortion of the radiation pattern due to the feed line. A vertical dipole, unless fed closely in phase, will always have some distortion of its patterns because the feedline comes out of the center, even when a balun is used. A vertically polarized, center-fed antenna is also physically more difficult to construct because of the feed line running horizontally from the center.

The J-pole antenna has a half wave vertical configuration. Unlike a vertical dipole, which because of its center feed is usually mounted alongside a tower or some kind of metal supporting structure, the radiation pattern of a centered J-pole mounted on the top of a tower is not distorted.

The J-pole works by creating a low impedance (50 ohm) feed line to the high impedance of the end, a vertical dipole. This is accomplished with a 1/4 matching stub located at 30 degrees and open at the other end. The impedance steps every 90 degrees, from 30 degrees to 90 degrees around the Smith Chart. Below the shortened end the high impedance end of the 1/4 dipole chart, there is a point that is closer to 30 degrees and this is the 90 degree point.

By examining the Smith Chart, you will find a point located at the 30 degree position on the Smith Chart. This point is characterized by its simplicity and high performance. One can divide this design into two equal parts and use one on UHF and VHF. The DBJ-1 covers from 118 MHz to 540 MHz, which makes it one of the larger antennas in this band. I have tried to keep the antenna as simple as possible and add a CD type feed point. I have added the antenna on my VHF since 1995 and it has been perfect in the San Francisco area.

By Edison Fong, WB6IQN

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 inexpensive transceivers on the band greatly expands the range of high performance, low cost dual band antennas for the radio amateur. The most popular VHF and UHF band station antenna 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, thus, there is virtually no disruption to the radiation pattern by the feed line.

The Conventional J-Pole

I was introduced to the conventional version of the J-Pole in 1990 by my long time friend, Dennis Moreland, KA6GC, who was intrigued by its simplicity and high performance. One can divide this design into two equal parts and use one on UHF and VHF. The DBJ-1 covers from 118 MHz to 540 MHz, which makes it one of the larger antennas in this band. I have tried to keep the antenna as simple as possible and add a CD type feed point.

A conventional J-Pole consists of two sections of copper pipe, 400 and 200, and a aluminum end. While the design performs well, each has its drawbacks. For example, the copper pipe J-Pole, which is smaller, is more expensive and requires more support.

Figure 2 shows a photograph of the DBJ-1 antenna. The antenna is composed of a 1/4 wave vertical dipole and a 3/4 wave horizontal dipole. This arrangement allows for a simple feed line and a compact design.

Adding a Second Band to the J-Pole

The conventional J-Pole design is not usable for 10 meters. The DBJ-1 is composed of two sections of copper pipe, 400 and 200, and a aluminum end. While the design performs well, each has its drawbacks. For example, the copper pipe J-Pole, which is smaller, is more expensive and requires more support.

Figure 3 shows a photograph of the DBJ-1 antenna. The antenna is composed of a 1/4 wave vertical dipole and a 3/4 wave horizontal dipole. This arrangement allows for a simple feed line and a compact design.

By Edison Fong, WB6IQN

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.

The Conventional J-Pole

I was introduced to the conventional version of the J-Pole in 1990 by my long time friend, Dennis Moreland, KA6GC, who was intrigued by its simplicity and high performance. One can divide this design into two equal parts and use one on UHF and VHF. The DBJ-1 covers from 118 MHz to 540 MHz, which makes it one of the larger antennas in this band. I have tried to keep the antenna as simple as possible and add a CD type feed point.

A conventional J-Pole consists of two sections of copper pipe, 400 and 200, and a aluminum end. While the design performs well, each has its drawbacks. For example, the copper pipe J-Pole, which is smaller, is more expensive and requires more support.

Figure 2 shows a photograph of the DBJ-1 antenna. The antenna is composed of a 1/4 wave vertical dipole and a 3/4 wave horizontal dipole. This arrangement allows for a simple feed line and a compact design.

Adding a Second Band to the J-Pole

The conventional J-Pole design is not usable for 10 meters. The DBJ-1 is composed of two sections of copper pipe, 400 and 200, and a aluminum end. While the design performs well, each has its drawbacks. For example, the copper pipe J-Pole, which is smaller, is more expensive and requires more support.
Why a J-pole?

- J-pole configuration - no radials
- Ground plane requires radials – high wind load
- Very close to an ideal dipole pattern
• First introduced to the ribbon J by AE6C in 1990
• Antenna excellent - considering simplicity
• Stick it in a PVC 3/4” - very durable
• Will last for years since PVC is UV protected.
• To date – we have delivered over 15,000
• Price to performance - excellent
• It will also resonate at odd harmonics
• Ah ha!!! It will also work at UHF
• Very poor performance because of phase cancellation
• Typically 6-8 dB of loss at 3rd harmonic
• Goal is to design a dual band J-pole but without the loss
• New design must be simple, reproducible, no radials due to wind load.
• No inductors, no capacitors, because they are not easily reproduced.
• I tried all types of configurations, but this one seems to work the best.
• Basically matching is the same at VHF and UHF.
• A 1/4 wave decoupling stub (RG174) is used at UHF
Smith Chart

- 0 ohms
- 0.5j
- -0.5j
- -1j
- -2j
- +1j
- +2j
- infinity
- capacitive
- inductive

Represents 1/2 wavelength once around
0 ohms on left side
infinity at right side
normalized to 1 at center
Cut out a 1/4” notch

Splice and short together

37 1/4”

15 1/4”

1 1/4”

300 ohm twinlead

RG174a coax

Figure 1  The original 2 meter ribbon J-Pole.
Figure 2 Horizontal pattern of fundamental and 3\textsuperscript{rd} harmonic. At the third harmonic most of the energy is launched at 45\degree.
Copper J limited to VHF due to minimum spacing of the parallel pipes. Does not work well for 70cm.
Arrow – VHF/UHF J-pole – does not have decoupling at UHF.
According to Dr. Larry Cebik and myself, there is NO validity to the Slim Jim. Every simulation we have done and physical models both Dr. Cebik and myself have built give the same results as a J-pole.
Figure 3  The 2 meter J-pole modified for both VHF and UHF operation.
Figure 4 The dual band J-pole modified for portable operation. Note that dimensions are slightly longer due to the velocity factor of air.
Notice that the dimensions on the DBJ-2 (roll up) are longer than the DBJ-1 (base station). This is because we have compensated for the velocity factor of the pvc pipe.

The pvc pipe used is very important. We found that Lowe’s item #23990 was the best performance for RF.
Figure 5a  2 meter J-pole at UHF.

Figure 5b  DBJ-1 at UHF.
<table>
<thead>
<tr>
<th>VHF ¼ wave mobile</th>
<th>VHF rubber duck</th>
<th>Standard VHF J-Pole</th>
<th>Dual Band J-Pole</th>
</tr>
</thead>
<tbody>
<tr>
<td>-24.7 db</td>
<td>-30.5 dB</td>
<td>-23.34 dB</td>
<td>-23.47 dB</td>
</tr>
</tbody>
</table>

**Table I** Measured relative performance of the dual band antenna at 146MHz.

<table>
<thead>
<tr>
<th>UHF ¼ wave mobile</th>
<th>UHF rubber duck</th>
<th>Standard VHF J-Pole</th>
<th>Dual Band J-Pole</th>
</tr>
</thead>
<tbody>
<tr>
<td>-38.8 dB</td>
<td>-41.3 dB</td>
<td>-45 dB</td>
<td>-38.9 dB</td>
</tr>
</tbody>
</table>

**Table II** Measured relative performance of the dual band antenna at 445 MHz.
Here I am in my lab using the HP8753D 6 GHz network analyzer.
Stub shows a clear resonant at 445MHz.
Hands touching at shorted end. Graphs changes, but not 445MHz resonant point. This says I can place anything at shorted end without affecting the 445MHz resonant high impedance.
146 MHz marker of the UHF shorted stub.
445 MHz marker of open wire.
DBJ-1 mounted on the side of the roof.
DBJ-2 kit – roll up dual band with BNC, SMA, and reverse SMA. Also 6ft extension cable.
The two element UHF phase conlinear with the voltage and phase given on the right. Dimensions are given for insertion into \( \frac{1}{4} \) inch 200 PSI PVC pipe. US patent 8,947,313
2mt / 220 MHz/ 70 cm - Tri band antenna with helical loop which allows for insertion into a ¾ inch pvc pipe. Total length is 5 ½ feet which is a practical length for ¾ inch 200 psi pvc pipe.
DBJ-1 dual band base antenna - available in HAM (144-148 MHz and 440-450 MHz) or Commercial (152-157 MHz and 460-470 MHz) $25

DBJ-2 dual band roll up antenna - available in HAM (144-148 MHz and 440-450 MHz) or Commercial (152-157 MHz and 460-470 MHz) includes 6ft extension, BNC, SMA and SMA female adapter $25

TBJ-1 triband base antenna 2mt/220 MHz/70 cm -- $60 - includes shipping with 6ft of pvc pipe.

50 ft RG8x coax cable with molded PL259 connectors $25

6ft extensions cables (BNC male to BNC female $5

BNC – female to PL259 (adapter for roll up DBJ-2 to mobile or base) $2