The CB-whip HAM "J" Antenna

by N6JSX June, 2012

Here is my very successful 2m/440 dual-band single-feed 'J' mobile antenna made with a 102" CB whip. I've been using this J for more than 25yrs on my mobiles. Over the years through trial-n-error I've modified my basic design making the J more effective and very durable.

In general a VHF/UHF "J" :

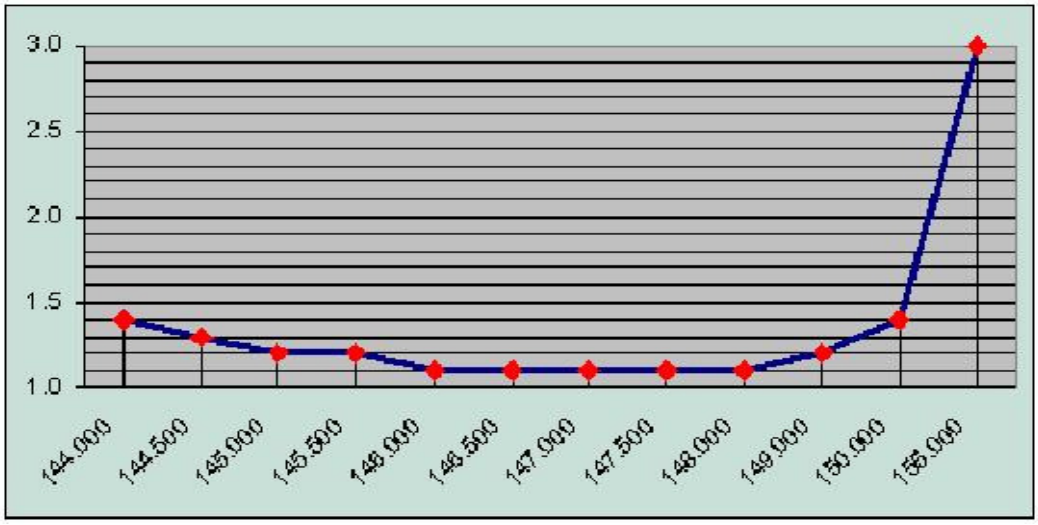
- has a low, **almost flat angle of radiation**, for maximum distance,
- **no ground-plane or radials required,**
- relatively easy to make and durable!

The "J" is the BEST antenna for flat-lander's giving them the longest transmitted signal distance possible. This is due to the exceptional low main lobe, nearly flat, angle of radiation of about 1-3° degrees. The more common antennas have much higher radiation angles that may be good for mountain top repeaters but will significantly shorten flat-land distances. The 5/8λ has ~3-6° degree radiation angle with the highest angle of ~4-9° is from a ¼λ. These ¼λ & 5/8λ antennas **require** a good counterpoise for optimal omini-directional performance.

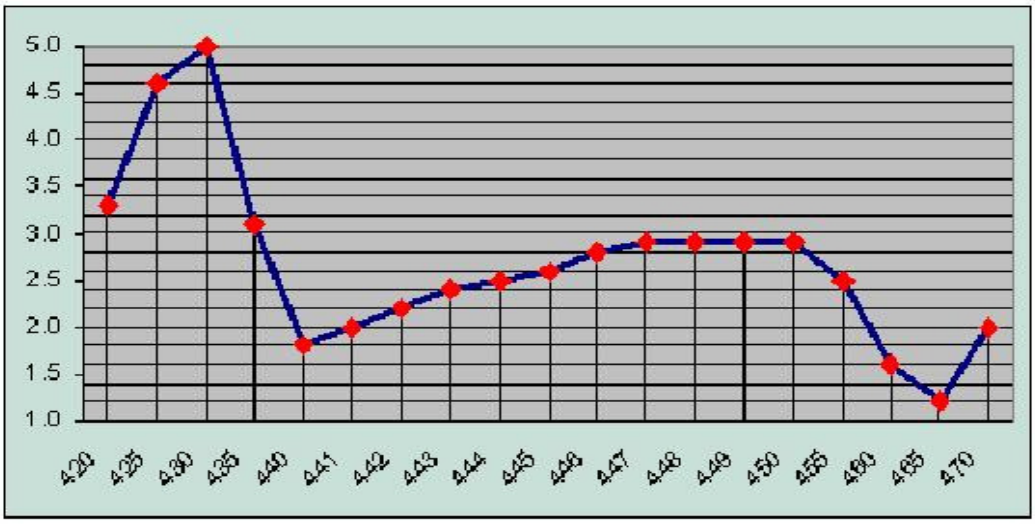
The "J" has approximately 3dBg of gain over a ¼λ ground plane. Technically, the "J" antenna is an end-fed ½λ antenna using a ¼λ matching stub. In years past it was referred to as an "end-fed Zepp". The matching section acts as a matching transformer, the ½λ radiator sees the ¼λ matching section as an image of a false ground. In best terms, the "J" is a balanced ¼λ wave matching stub feeding an unbalanced ½λ wave load. The long element is ¾λ with a ¼λ matching element creating a tuned ½λ active radiator that needs no counterpoise (ground plane/radials).

This design is a dual-band single-feed J; the long element is 2.5λ at 445MHz (63.1”) with a 2m matching element (19.25”), and placing the taps for the best 2m VSWR, (see graph plot). The 440 band is usable, but just barely, as most VSWR protected rigs will fold-back the RF-output to half power or less at >3.0:1 (see graph plot). Over the years I’ve tried many changes to improve the 440 VSWR ‘**while retaining optimal 2m performance’,** nothing seems to improve 440 OPs. Plot data came from MFJ-269 Analyzer

144 - 155 VSWR plot



420 - 470 VSWR plot

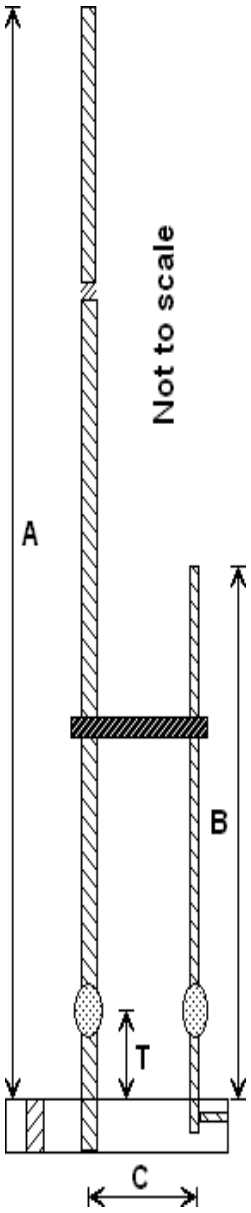


Mobile "J" parts:

102" Stainless-Steel CB whip w/ 3/8”-24 bolt, Radio Shack R/S21-903
SO-239 connector
Terminal Lug, Thomas&Betts **L70-B2** or BTC0208-B2
#10 speed nuts (Lowes)
aluminum block 4”x 0.75”x 0.75”
#8-32 x ½” SS Allen insert (Lowes)
plastic spacer 2.5”x 5/8”x 3/8” (Lowes)
aluminum (SO-239) mounting plate 2”x2/5”x1/8”
RG-8X coax
Liquid Tape [electrical, black, Perfomix™ (eBay)
Penetrox™ (AES)
Stuff™ (AES)
RB14-6, ring crimp-lug (Lowes)

CB-whip J:

Dimensions:
A = 63.1” (2.5λ 445MHz)
B = 19.25” (1/4λ 146.000MHz)
C = 2.0”
T = 2.75” (1.0:1 VSWR 146.000MHz)

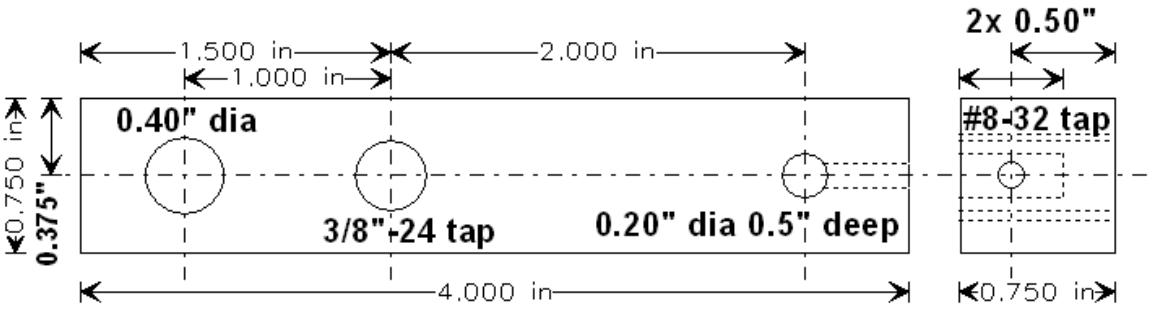


A 2m J long element is typically 57.5” but I found improved 440 band performance using 63.1” that equates too 2.5λ at 445.000 MHz and still obtain very good 2m performance.

I cut the 102” CB-whip to 63.1” (using the edge of a bench grinding wheel to notch the whip, then snap-off). I ground a 45° cone to this SS whip tip. Using the remaining 102” top piece, I measured 19.25” from the larger diameter (bottom end), then grind a notch and snap-off making the matching element. Then I cleaned up the matching element by grinding the larger diameter element end flat (so it completely seats into the base block element blind hole) and putting another 45° cone on the tip.

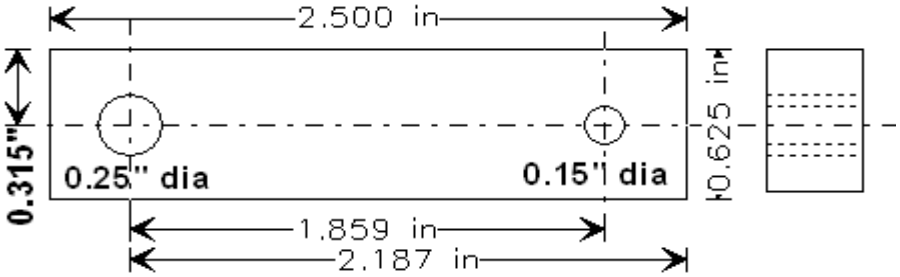
Mobile J base block:

Mobile J base block is an aluminum ¾” SQ x 4” bar.



Cut and drill to the drawing. Drill-&-tap the 3/8”-24 hole for the new main whip bolt. The 0.20” hole is only drilled ½” deep for the matching element. On the end of the block drill-&-tap #8-32 for a ½” Allen insert to be the mechanical anchor trapping the matching element to the base block. The 0.40 dia. hole can be of any size and is for mobile mounting (see above pictures).

Spacer: plastic insulator that keeps the elements equidistant during mobile speed wind loading and renders mutual mechanical support for the matching element to the heavier-longer main element:



Speed nuts trap the spacer.

The insulating spacer is made from plastic decking planks. First, slice a ½" piece from the plank, place this piece upon a paper plate with a cup of water into a microwave oven, then heat until the water is boiling. Use either a thermometer (or the back of your hand) to ascertain if the plastic piece is warm vs. nominal room temperature. If it is warm to the touch the material is RF conductive and should not be used as an antenna/RF insulator. Try a different type of plastic planking. If the piece is near room temperature it is good for antenna/RF use.

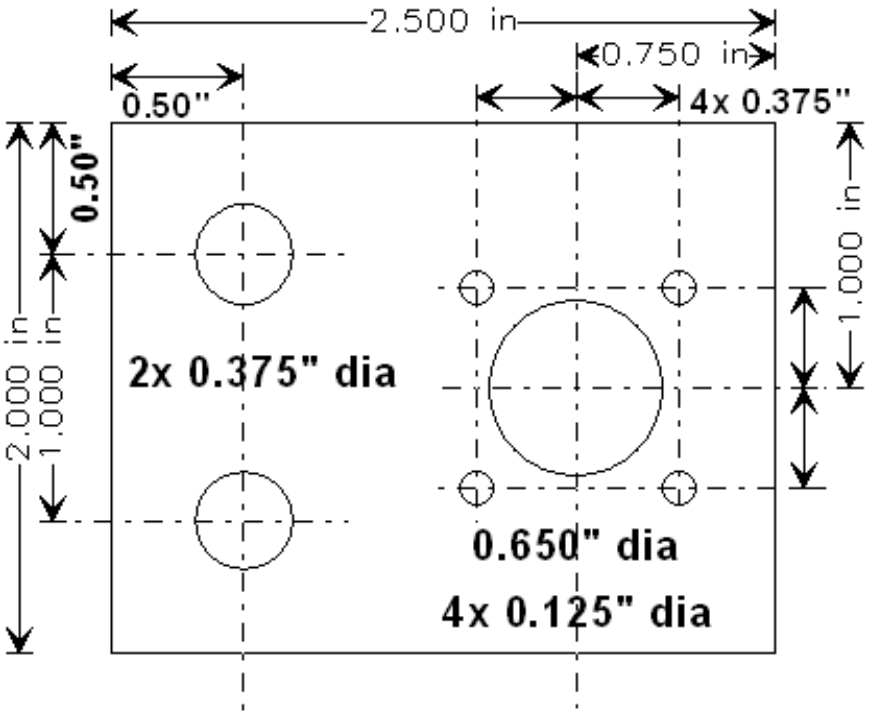
Slice off 3/8" (0.625") strips using a table saw, then cut to length and drill to the drawing dimensions. I used a metal de-burring tool to remove the rough plastic edges from the "new" spacer. The main element hole is over-sized to allow loose sliding. The small hole is drilled to the diameter of the matching element.

My old design was to thread-tap the matching element for shoulder nuts to trap the spacer to the element, but that was way way too much work and very hard on the bit. My improved method is to use #10 speed nuts. One is inverted and slipped down the match element until it cannot slide any further. I use another speed nut (in the proper direction) to sandwich the spacer to the element. By nature of speed nuts they cannot back off the element. So far the speed nuts have survived +85mph road winds - works great!

Old thread-tap method

New Speed Nut method

1/8” aluminum VHF connector plate:



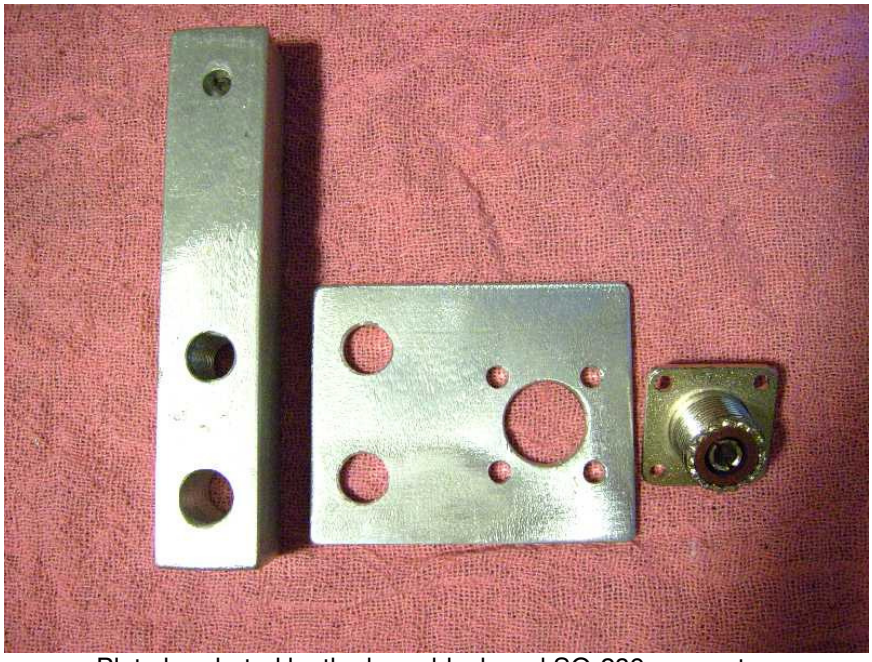
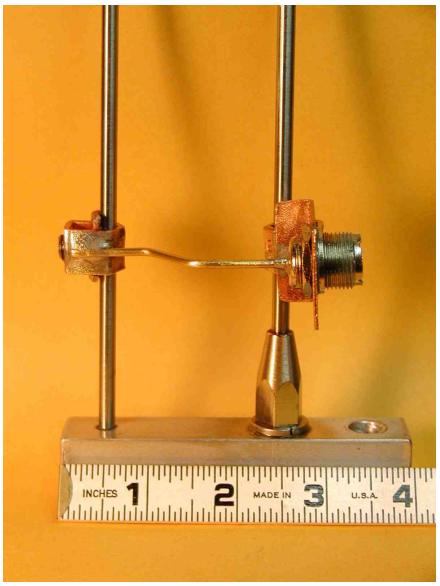


Plate bracketed by the base block and SO-239 connector.

I used an appropriately sized bolts/nuts (prefer Ny-lock nuts) to affix the VHF/SO-239 to the plate. On one of the four bolts I added a crimp ring-lug to solder the RG-8X coax braid.

Coax Taps:

My old coax tap method was in using brass brazing rod, copper SO-239 plate, and modified electrical terminal lugs (see picture). But the flexing of the J whip elements, vehicle vibrations, McDonalds over hangs, and low hanging branches caused the brass rod-to-lug solder joint to break, too often. This tap method may look pretty but had poor durability with flexible elements!



A far better and more durable method is to directly solder coax-to-lug.

Using coax-to-lug method greatly enhances antenna durability. Notice lug modification - the eye-hole part of the lug tab was removed. **The coax center conductor is connected to the short matching element**.

Front view of J coax lug taps

Rear view of coax taps & SO-239 connections

However, using coax creates a moisture/weather integrity problem. To keep the coax wires from oxidizing & corroding, I used 'black' Liquid Tape by Perfomix™ (see picture). I applied two thick coats over two days. BEWARE of using in enclosed spaces - toxic fumes!

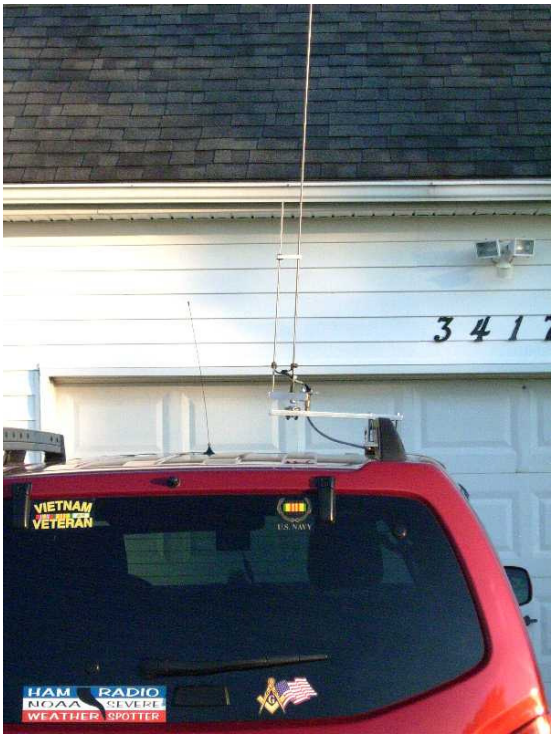
Liquid tape liberally applied

Note: the one tie wrap snugly affixing the coax to the bottom of the main element adding support to the coax and reducing any wind flexing. This coax tap method may not look pretty but has been highly effective for over 25yrs of travels from California to Wisconsin to Ohio and many points in between in all weather conditions.

Tuning:
Before you set any bolts/nuts or apply liquid tape the J needs to be tuned for optimal performance. I highly recommend using a significant amount of conductive WX grease to **ALL and EACH metal-to metal joint surface and screw threads**. Antenna metal joints/clamps/threads will eventually corrode to the point of locking threads into the metal especially with aluminum/copper and stainless-steel hardware. High volume hardware store Stainless-Steal hardware does rust. I recommend using **Penetrox**™ it inhibits metal-to-metal corrosion and oxidation.

Pictured below is my VHF/UHF tuning stand - a (wooden) red ladder, MFJ-269 with 10' of RG-8X coax, and the CB-J being tuned. **Set tap dimension is set the lug screw center at 2.75" from the top of the base block as a starting point.** The MFJ-269 is showing 1.0:1 VSWR at 51Ω on 146.020MHz.

When doing the final mounting of the J onto the vehicle I use a **non-conductive** moisture inhibitor (white grease) inside the PL-259-to-SO-239, called **Stuff**™. It fills all the voids within the connection inhibiting moisture or condensation from forming inside the connector – very good stuff to use!



My new CB-J 2m/440 antenna mounted to my Pathfinder.

Writer BIO: Dale Kubichek, BS/MS-EET, GROL/RADAR, N6JSX - Amateur Extra; first licensed in 1972. Served 10yrs USN, Vietnam Vet, FTG1 Gun/Missile systems & electronics instructor. Electronics Test/MFG/QA Engineer & Program Manager, in; *aerospace* - Hughes, Northrop, Rockwell, HawkerBeechcraft; *commercial* - Magellan, Mitsubishi, Emerson-Copeland; *heavy construction* - TEREX, Manitowoc Cranes, Navistar, Magnetek; *communications* – Hughes, STM, RockwellCollins. *Currently*, a USAF SPO Sr. Engineer on UAV SIMs. *Interests* are in designing/testing antennas, RDF hunting/training, SAT OPs; published numerous articles in 73 Magazine, eHAM.net, WI Badger Smoke Signals, HamUniverse.com. Owner of:
http://groups.yahoo.com/group/HAM-SATs ,
http://groups.yahoo.com/group/RDF-USA , and many more.