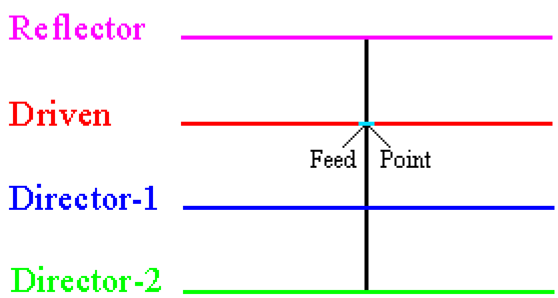
2 Meter Antennas for directional, semi-directional, and omni-directional propagation.

The web site below contains plans for building a simple directional yagi for 2 meters and other frequencies.
http://www.qsl.net/w4sat/antlegn.htm

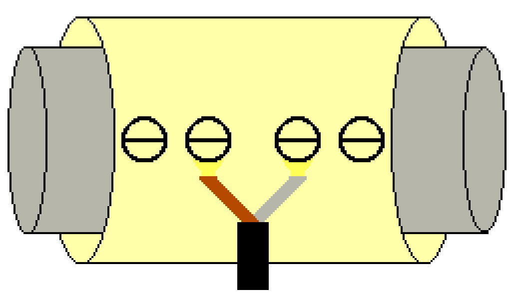
Excerpts below

VHF / UHF Direct Connect Beams

Here are some lengths and spacings for various direct connect beams. The layouts are straight forward and are illustrated below. Your SWR should be less than 1.3:1 with these designs.



The driven element is cut into two halves and insulated from the boom with non-metallic material. Then the two wires of the coax are connected, one to each section of the driven element. You may drill small holes and use sheet metal screws to accomplish this.



The reflector, director 1, and director 2 can be attached directly to the boom by a variety of methods.

2 Meter 4 element beam center frequency 146.52 MHz

2 Meter 4 element beam 1/2" diameter tubing	**Element Length**	**Element spacing from Reflector**

Reflector	38-1/8"	*****
Driven	36"	24-1/4"
Director 1	34-1/2"	49"
Director 2	34-3/8"	71-1/2"

	Freespace	**Over ground 30 feet**
Gain	8.43 dbd	10.34 dbd @ 5 degrees 13.71 dbd @ 10 degrees
F / B	13.32 db	13.60 db at 5 degrees

The web site below contains a free download software tool for designing a directional yagi antenna on 2 meters. Many other helpful topics as well.

http://www.raibeam.com/wa7rai.html

Cheap Yagi Antennas for VHF/UHF

From Clear Lake Amateur Radio Club

by Kent Britain, WA5VJB
edited by John Maca, AB5SS
[***Editors notes:*** *The antennas described in this article were built as the result of several discussions between Kent and a Cuban radio operator. While there are plenty of high performance antenna designs,most of the parts required to build them are not available in Cuba. There just isn't an EPO or RadioShack available in Cuba. Kent accepted this as a challenge to design a really good antenna that could be built with little more than ground wire, coax and a wooden boom. Using the latest antenna design software, he has developed several variations for 144 thru 1296 MHz. Apparently, the designs work very well... Kent entered the 432 MHz version in a recent antenna contest and lost by 0.2 dB to a Midwest ham who had copied his design. Though disappointed in losing, it did prove to Kent that the antennas can be easily replicated with consistent performance.*]

If you're planning to build an EME array, don't use these antennas. But, if you want to put together a Rover station with less than $500 in the antennas or just want a good antenna for the home, read on. These antennas are relatively small, easily constructed from common materials/tools and have surprising performance. The feed method is greatly simplified by directly soldering the coax to the driven element. No baluns or gamma matches are used in this design. This simplified feed uses the structure of the antenna itself for impedance matching. The spacing of the director and reflector elements from the driven element directly affects the feed point impedance of the antenna. So, the design starts with the feed (driven element) and the elements are built around it. Typically, a high gain antenna is designed in the computer, then you try to come up with a matching arrangement for a 31.9 Ohm feed! For the cost about 0.5 dB of gain, these antennas make some design compromises for the feed impedance, use an asymmetrical feed and make trade offs for a very clean pattern. But, they allow simple measurements, have wide bandwidth, the ability to grow with the same element spacing AND... you can build these
antennas for $5!!!!

The booms used for these antennas is 1/2" X 3/4" wood. The elements have been made from silicon bronze welding rod, aluminum rod, hobby tubing and solid ground wire with no change in performance. Since you want to be able to solder to the driven element, silicon bronze welding rod, hobby tubing and #10 or #12 solid copper wire have been

used and work fine. A drop of "Super Glue", epoxy or RTV is used to hold the elements in place. A good coat of Polyurethane should be applied to the wooden boom to protect it from the weather. A polyurethane varnished 902 MHz version has been in the air for a year now with little deterioration in performance.
And now for the antenna designs. These antennas have been carefully designed to have the highest dB's/Dollar ratio of anything around They were designed with YagiMax, tweaked using NEC and the driven elements experimentally determined on the antenna range. The driven element design is the same for all frequencies except for the length (L) and separation (H). See Figure 1 for details on the driven element. All dimensions are in inches.

144 MHz. This antenna is peaked for 144.2 MHz but performance is still good at 146.52 (emergency use only!) Driven element dimensions are L = 38.5" and H = 1.0" Elements are 1/8" diameter.

More detailed specs at http://www.clarc.org/ArticleRepo/uhf2.pdf

---

Easy Square Dipoles (bi-directional)

From Hamuniverse.com

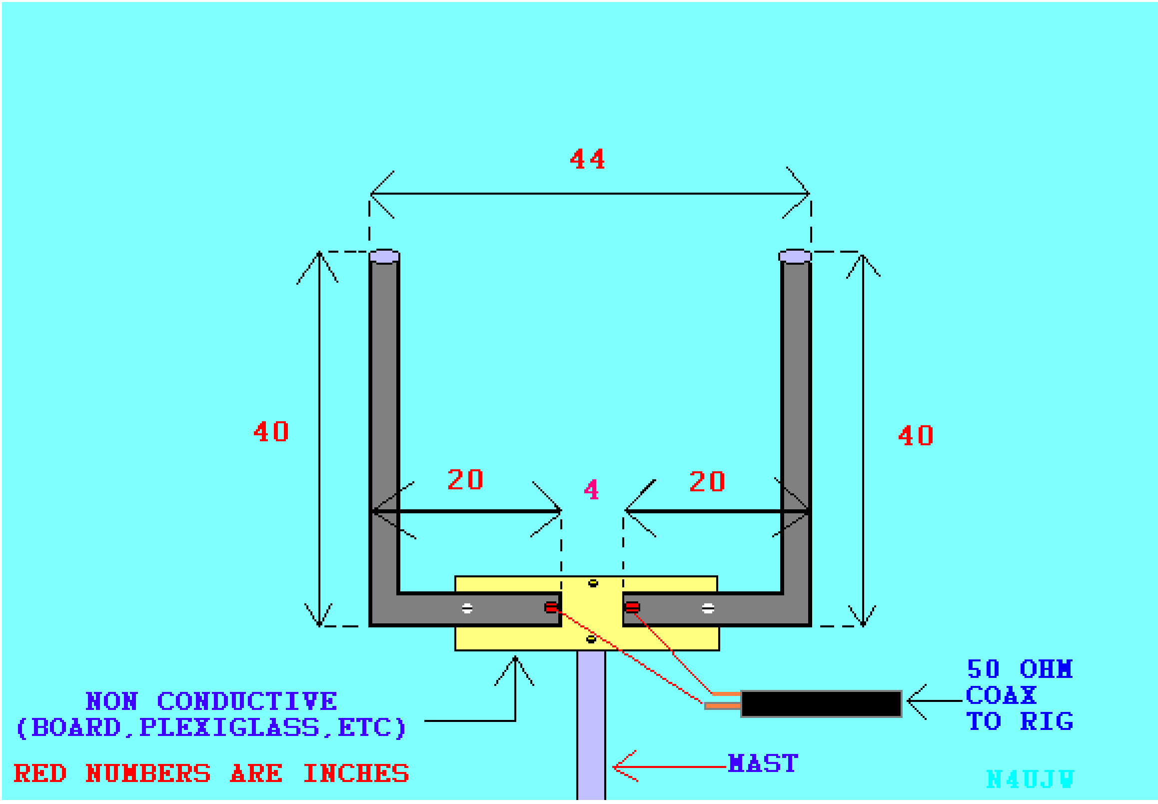
The "Slingshot" Antenna
for 2 Meters

Re-edited by N4UJW from an original article by David Younker
KA8OGD (callsign no longer active)
73 Magazine April 1989

While recently going thru some of my old ham radio magazines, I ran across this inexpensive and easy to build antenna project for 2 meters. I have not seen it on the internet so here it is for you to try!

I personally have not tried this antenna but it should work fine if you follow the very simple directions!

It can be built as is for 2 meters, or you can try it on other bands or frequencies with the formulas provided by me below.



THE SLINGSHOT ANTENNA
NOT DRAWN TO SCALE
Please note in drawing that elements are bent 90 degrees. Make your bends as needed depending on material used for elements. If you use copper tubing, a 90 degree elbow on each should work fine. If you are comfortable with bending, great, if not, get the hardware store to do it for you!

The completed antenna is bi-directional with a rough figure 8 pattern and is composed of 2, 3/4 wavelength sections of electrical conduit bent and cut to the lengths in the drawing and supported as shown on any type of insulating material attached to the mast with whatever arrangement of bolts, nuts, clamps, etc.
You should note that the bottom (horizontal element portion) is 1/4 wavelength long and the top (vertical element section) is 1/2 wavelength long.
The element mounting plate (in yellow in the drawing) can be plexiglass, painted wood or whatever you happen to have that is NON CONDUCTIVE. You can use copper or aluminum for the active 3/4 wave elements, but aluminum would be preferred due to less weight.
Although electrical conduit comes in various sizes, the size was not stated in the original article but I would suggest 1/2 inch or larger in diameter. (The larger, the greater the bandwidth.)

The total length of each element is 60 inches + - and they are attached about 4 inches apart on the mounting plate with enough bolts and nuts as needed.
The coax attachment points are in red on the picture, and I would suggest that you use spade lugs on the ends of the coax to attach it to the bottom end of each element (the ends nearest the bend) with bolts, nuts and lock washers all the way thru the element and plate. There must be a good electrical connection between the coax center conductor and shield braid and each element. Keep the connections lengths from the end of the coax as short as possible. They become part of the radiating element lengths.

It does not matter which conductor from the coax is attached to which element.
SEAL ALL CONNECTIONS AND THE END OF THE COAX!
When attaching the elements to the mounting plate, drill enough holes all the way thru the elements and plate for good mechanical stability and attach with bolts and nuts. The elements and coax connections must not touch the support mast at any point if the mast is made of metal of any kind! You could use a pvc pipe or length of lumber of the required length instead of metal to get the antenna up as high as possible and a half wave or more is preferred!

"This design, untrimmed, up a half wave, presented an SWR of 1.5:1 across the top 2 MHZ of the band (146-148mhz)".......KA8OGD

A note or two more about experimenting with this antenna:
MAXIMUM SIGNAL IS OFF BOTH ENDS (TO THE RIGHT AND LEFT AS DRAWN NOT BROADSIDE. Point the boom at your target!)
ANTENNA SHOULD BE ROTATED IN DIRECTION NEEDED!

The formulas for calculating the lengths for this project seem to be approximately the following.
There is a more complicated formula first and then a simple version....take your choice...they both yield the same result:

11808/freqmhz = 1 wavelength in inches
11808/147.00Mhz = 80.3 inches (using 147.00Mhz)
3/4 wavelength = .75 x 80.3 = 60.2 inches

Simple version formulas:
8856 / freqmhz = 3/4 wavelength section in inches (total element length)
5904 / freqmhz = 1/2 wavelength section in inches
2952 / freqmhz = 1/4 wavelength section in inches

Lets do a calculation for 144.200Mhz ssb using the more complicated version formula:
11808/144.200 = 81.88 inches
3/4 wavelength = .75 x 81.88 = 61.4 inches total element length per side
1/4 wavelength would be = 81.88 / 4 = 20.47inches or 1/3 of 61.4 inches. (The vertical section takes 2/3rds of the total length of one side of the antenna element)
The 90 degree bend will be at the 1/4 wave point on the total length.

Footnote to construction: It is advisable to add about 5 or 6 turns of coax at the base of the antenna as an air choke to help keep rf off the feedline. Some builder do this....some don't.

According to the article, 15 meters is about as low in frequency as it can be used before it becomes very difficult to keep it up due to size and weight! (one element would be about 34.5 feet long according to my Texas Instruments model TI-7140 handheld calculator and the above formulas!) HI!

MODIFICATIONS, COMMENTS AND UPDATES!
Experimentation performed by LA2PJ of Norway taken from his email: (January 23, 2003)

Tonight I have tried a construction from your webpages,
The Slingshot Antenna. Just soldered two wires to the end of a short length of coax and pinned it to the wall in my shack with small needles to get the correct shape.

The results were amazing! The direction of the wall is in the right direction to a distant repeater here on the west coast of Norway. Using an Alinco handheld with approx 1W, I was able to work through the repeater with full quieting. The distance is 94 kilometers (approx. 55 miles. The reports indicated that they could not notice the difference when I switched between this indoor antenna and a Diamond X-510 vertical on the roof. The SWR was 1.4:1 at 144MHz rising to 1.7:1 at 146 MHz, indicating that the antenna is a bit long. But then the elements are made of 1mm stranded copper wire. Am thinking of a way to produce the antenna to be used outdoors.

If your offer is still valid, I would like to present this antenna in Norwegian at our web site.

Best 73's
Egil - LA2PJ

(I said yes to his request for adding the project to his site in Norway. Stay tuned here for the link when he gets it up and running for our fellow Norwegian Ham friends to enjoy.)
Editors note: Egil, LA2PJ, is the former Webmaster for the NRRL, the Norway counterpart to our ARRL!

Update from KC2GOA: The two meter slingshot works now that I made some changes. I had to change the spacing between the two elements to 1/2 inch and cut the short lengths to 19 1/4 inches and the long ones down to 39 1/4 inches and I came up with a 1.2 swr at 146.000mhz. 73's KC2GOA.........

[Editors note: The diameter of the elements and the spacing at the center insulator will play an important part in getting the antenna to resonate at your frequency of operation for lowest SWR. Some experimentation may be needed with your particular construction techniques!]

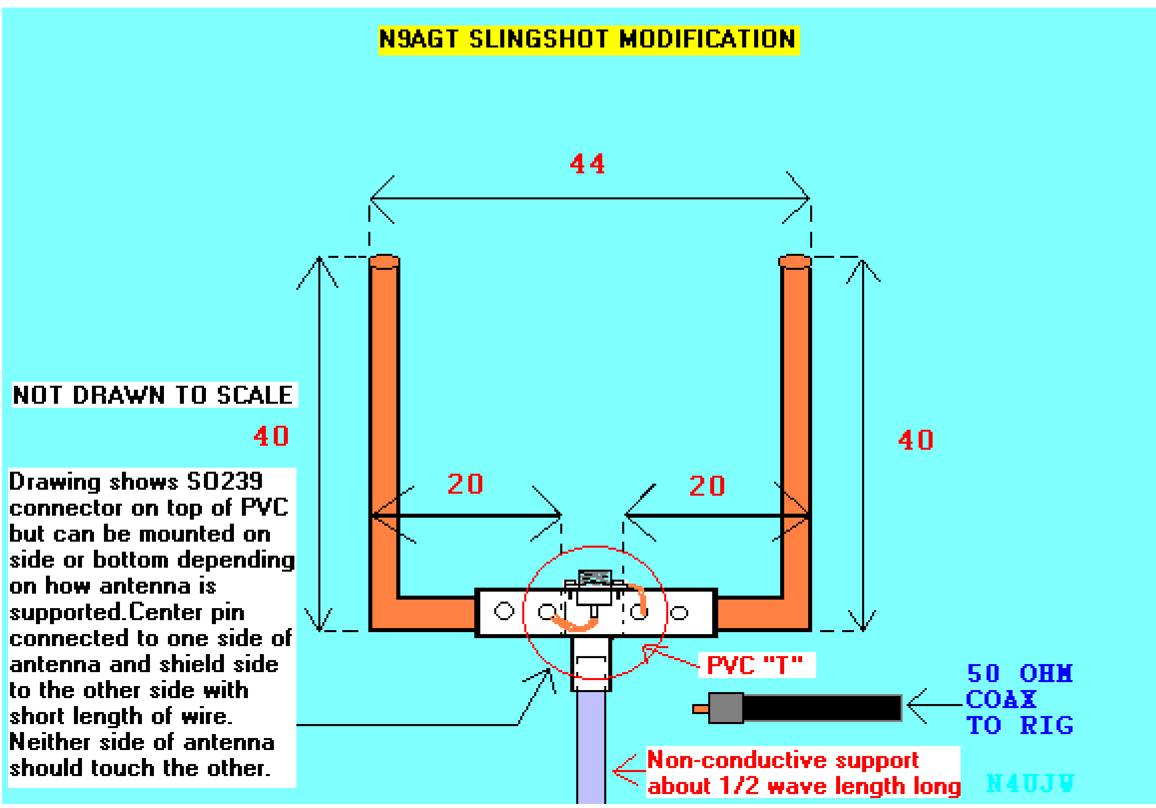
More updates: January 2004
440mhz scaled version by N9YBP CLICK HERE

From the editor: I hope you try this antenna project as is and if you are pleased with the results, please let me know, and if you have tried any modifications to it and they worked a lot better in performance, please email me with them. I will be glad to add them to this project with full credit going to you!

EXPERIMENT! EXPERIMENT! EXPERIMENT!
(See latest experiments with this antenna and input from builders next below.

MORE MODS FEBRUARY, 2005 BY ROY:
I constructed this antenna as per KC2GOA's latest dimensions. However I added an S0 239 connector between the two elements for direct connection with coax with a PL259 connector.
See drawing below: For the antenna itself. I used the ½" copper tubing AS STATED ABOVE, but for connecting the two sides together, I used a 12" piece of ½" PVC which the copper tubing fit snuggly inside of, and attached an SO 239 connector in the middle.

I mounted the 239 connector on the PVC with a self tapping screw into the GAP between the antenna sides. I then bolted thru both PVC and copper tubing with brass machine screws and nuts to secure the tubing to the PVC.



To make the connections to the 239 connector, I bore oversized holes into the PVC so that the screw head and nuts would contact the copper tubing. I bought the brass screws long enough - 1 ¼" - so that I could put two nuts on them; one to hold it to the tubing and the other to act as a lug to connect a short piece of bare #14 copper wire to. I then soldered the other end to the 239 connector. I repeated that for the other side. This makes it a neat and clean antenna. I hung my antenna from the rafters in the attic - **upside down**! I use it as my east/west antenna as I already had built the 'Hentenna' antenna that you have on your website for the north/south coverage! They both work great! If someone wanted to mount this antenna right side up, they would need to put a PVC tee between the sides and point it downward! I used 12" of PVC pipe, but you could use it much longer and add more screws for better support in the vertical position!
73 N9AGT, Roy.

**Editors note: Great work Roy! I'm sure there are other ways to attach the coax to the antenna........
an MFJ ANTENNA ANALYZER would help in tuning the antenna, but use what you have.......
keep experimenting and have fun!.......N4UJW**

440 mhz Slingshot Scaled version
Click Here

---

2 Meter Square Loop

http://www.eham.net/articles/4319

A modified version from the e-ham design above (link) is shown below. Looks to improve tuning.

The 2 meter square loop.
Credit is given to K0FF for most of this design.
We have added modifications that proved useful in the design.
The mods will be presented under modifications in the design instructions. Special thanks to **W6ARQ** and, **KC5BBP** for their input on this Antenna.

2 Meter Square Dipole by K0FF

Here is the parts list and dim. sheet for the 2 meter square dipole, made of copper water pipe.

Parts List
1/2 Inch Copper Water Pipe
Long Sides 9 1/2 inches
Open Ends 3 1/4
2 Short Pieces on each side of "T" 4 7/16
4-90 Degree Elbows
2-Copper Caps
1 Copper Tee
Brass Plate for SO239
Gamma Tube 4 3/4 of 3/8 Copper Tubing
RG8 is 5 1/2 inches long
Copper or Brass Gamma Tube Bracket
SO239

Modification Parts (DO NOT USE STAINLESS STEEL)
6 Brass Nuts-Note Any size
2 Brass Screws at least 1 1/2 long

Instructions The mounting array to be affixed to a standard mobile
mast that presents 3/8 X 24 threads.
Run coaxial cable right to the antenna and connect it to the built in SO-239.
There are two adjustments on the Antenna to match the coax Imp.
Adjust the Gamma Match Tube for Lowest SWR, then the tunable stubs move in or out for lower swr.
Do not use Stainless Steel Screws, Soldering them to the end caps is almost impossible.

The 2 meter square loop is a folded Dipole around itself.
The shape is 11" X 11".

Solder the antenna parts together using 90 degree elbows at the corner open ends and mind the gap.
All measurements are critical. The brass plate to hold them form an "L" 1-3/4" tall with a 1/2" lip.
A 5/8" hole is provided 1-1/4 inch from the bend, and attached using stainless steel or brass hardware.
Two small holes are drilled in the lip and mounted to the copper TEE with #6 self taping screws.

Solder the 5 1/2 inch piece of RG8 to the SO-239.
When using the RG8 discard the outer shield and use only the Dielectric. Slip the RG8 inside the 4-3/4 Gamma Tube.
The Gamma bracket should be at least 1 1/2" long brass or copper.
Secure with stainless steel screws right before the 90 degree elbow.
Either side doesn't matter.
The Gap between the Open Ends is 2-3/8".
Adjustments to the gap in or out can be made with the modification of installing the brass screws on the end caps.

The Antenna is more or less Omni Directional and horizontally polarized.
It presents a high takeoff angle and is intended for use in the 144.200mhz area.
The Antenna can handle 100 Watts and has proved useful in working some satellites such as AO-27.
The Antenna provides excellent SSB results while mobile and have talked with other stations 200 miles with similarly equipped Antennas.
For further Information on assembly or instruction details Email the following hams below.
Af4ar6077@aol.com
W6arq@charter.net
Kc5bbp lives too far back in the hills of Tennessee to get daylight...much less email!!!!

I have found this Antenna works very well and, is a solid performer.
Best of luck with your Antenna.
EXPERIMENT! EXPERIMENT! EXPERIMENT!
73
Mike Gunter/Af4ar
Murfreesboro,Tn
See the original design on eham.net

DID THIS PAGE LOAD SLOWLY? CHECK THIS OUT

AF4AR/W6ARQ
KC5BBP

MOUNTING PARTS

MOUNT ASSEMBLED

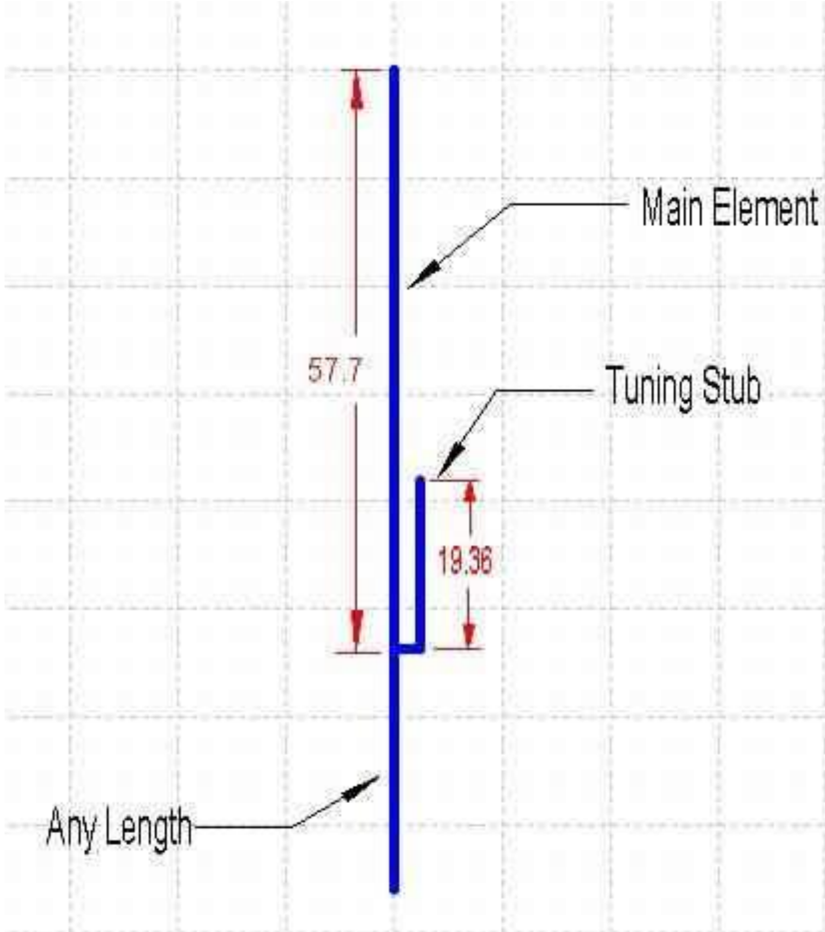
GAMMA MATCH CLOSEUP
BLAST OFF!!
BEWARE OF THE SHOCK WAVE!

Topic: Verticals (Omni-directional)

FromWB8ERJ http://www.wb8erj.com/146jpole.htm

A 146 Mhz. J-Pole Antenna

Here is a 2 meter (146 Mhz) J-Pole antenna that is inexpensive, and easy to build. I use 3/4 inch copper pipe, and the associated fittings necessary.



Additional notes on J-Pole construction:

The above dimensions for the J-pole are in inches. Measurements on overall length, and stub length are from the centerline of the separation pipe (horizontal) to the top of the antenna. The Connect at measurement is 2 1/4 inches from the top of the horizontal member to the point of connection. The distance between the main element of the j-pole centerline and the tuning stub centerline is 2". I cut a length of RG-8X foam coax to a length of 67" for the feedline, and coil up 4 turns (as small as you can get it) just below the horizontal part of the matching section. This will de-couple the feedline from the j-pole antenna, and help provide some lightning protection. Connect the center conductor of the coax to the main element, and the shield to the tuning stub of the j-pole.

In all of the above dimensions, they are to be considered starting points for constructing a j-pole. I temporarily attach the coax using 1 inch hose clamps, and adjust the coax connection first to the lowest SWR. From there, I adjust the length of the main element of the J-pole. Then I start over by re-adjusting the coax connection.

The point where the tuning stub attaches to the main element is the j-pole antenna's ground point. That is why you can make it any length. Its a good idea to provide a ground here. This too will help with lightning protection. (provided your tower is properly grounded!)

Only use rosin-core solder. Don't use "plumbing solder", acid-core solder, or plumbing paste. The acid in these materials breaks down the solder joint when electric current passes through it.

To see a photo of the j-pole antenna that I use, click here. This is the 440 MHz version, black from years of use.

WB8ERJ's Home Page

The COPPER CACTUS Antenna

To: All Amateurs
From: Gary - KG0ZP
RE: The COPPER CACTUS ANTENNA

Dear Fellow Hams:
Here are the numbers for the Copper Cactus J-Pole antenna! I hope you are already familiar with the construction of the standard J-Pole antenna, so I won't go into any unnecessary detail. The antenna may be built as a MonoBander, DuoBander, TriBander, QuadBander or whatever with great success. You can either feed it with separate coax's for each band or a single coax, however, separate coax's make it much easier to tune. There’s no trick to building them, just remember the overall length is for the lowest frequency of operation. In other words, a MonoBander, DualBander and TriBander are all exactly the same length overall 58.09" on 2mtrs. Feed the coax up the center of the pipes. Use T-Fittings at the proper distance below the top of the antenna for the desired frequency. The only problem is that the more bands you try to incorporate into the antenna, the harder it is to get the SWR flat on all bands.

Here are the numbers you are looking for:

Frequency	52MHz	146MHz	223.5MHz	435MHz	912MHz	1265MHZ
Pipe Dia.	1"	3/4"	1/2"	1/2"	3/8"	3/8"
Stub	54.70"	19.36"	12.65"	6.46"	3.02"	2.16"
Overall Length	163.92"	58.09"	37.94"	19.39"	9.07"	6.49"

Separation	5"	2"	1-1/4"	3/4"	1/2"	1/4"
Connect at	6"	2-1/4"	1-1/2"	1"	3/4"	1/2"

For best results, build the highest band first, for e.g. the 435MHz antenna, If you really want it to look neat, use 3/8" copper for the vertical and 1/4" copper for the transformer section (stub). Naturally the finished product will be in the shape of a "J". Now build the next band, for e.g., the 223.5MHz antenna, by adding pipe to the T-connector that is the base (mast mount) of the 435MHz antenna, I use 1/2" for the vertical and 3/8" for the stub of this section. Now build the 146MHz antenna, don't forget the overall length of the antenna is the lowest frequency you will be using. I use 3/4" for the vertical and 1/2 for the stub. The stub must be parallel to the vertical, however you can point the base of each stub in any direction you like. I prefer 3 equal distant points, but you can make them all on the same side if you wish. I feel the three points make it look like a cactus. My measurements on overall length, and stub length are from the centerline of the separation pipe (horizontal) to the top of the antenna. The Separation distance is technically from centerline to centerline, but inside measurements are fine and visually look better. Some of the measurements are less than physically possible, in this case just push the T-Fitting and elbow as close together as you can get them, no need to trim the fittings.
The Connect at measurement is from the top of the horizontal member to the point of connection.

Final Note: If you use 1/2" pipe for all the construction, on the 2-meter stub, add 1/4" to its length, or use pipe-caps and adjust them up or down to get the 1/4" additional length. The antenna should be in perfect tune, SWR less than 1.2 - 1 on all bands, using separate coax for each band. Solder all the joints before installing the coax, any pipe you have left over can be used as the mast.
To install the coax, drill a 1/4" hole in the top of the horizontal part of each T-fitting closest to the vertical, then tilt the drill at an angle, so that the drill bit is sort of heading down the vertical.

PS Until you are familiar with the construction techniques of the J-Pole, I wouldn't attempt any more than three bands the first time out. In fact, A dual-bander, using the above dimensions will be perfect every time.

73s de Gary - KG0ZP
Copper Cactus Single Coax Feed

Single Coax Feed to Multi-Band Copper Cactus Antenna.

There are three connection possibilities to feed the multi-band copper cactus antenna with a single feedline or coax. However, it is imperative that you use the proper coax for the highest band of operation, RG58 just won't cut it and even RG8 in lengths longer than 25 feet is marginal in 440 operation.

For all single coax feeding methods, the antenna will require re-tuning to obtain the lowest SWR for each band. This is accomplished by installing in the pipe cap of the tuning stub on each band of operation a brass machine screw of at least 2 inches in length vertical out of the cap.

The first and simplest connection method, albeit the hardest to tune, requires that you place a shorting wire on all but the lowest band of operation. If you are building your antenna from the N0ZOI (now KG0ZP) plans for "The Copper Cactus Antenna" and for example building a tri-bander for the frequencies of 144, 220 & 440 MHz, the shorting wires should be placed between the normal connect points for the shield and center conductor of each band. The 440 band shorting wire should be placed exactly 1 inch above the top of the horizontal pipe of the 440 tuning stub, the 220 band shorting wire should be placed exactly 1-1/2 inches above the horizontal pipe of the 220 tuning stub and your coax suitable for 440 operation should be connected exactly 2-1/4 inches above the horizontal pipe of the 144 tuning stub with the center of the coax going to the main vertical and the shield to the tuning stub (this is just the reverse of the connections shown on the plans and in the methods below), keeping the center conductor length as short as possible. For best results, tune the antenna from the highest band to the lowest, however, using the shorting method does create quite a bit of interaction.

The second method is easier to tune than the first method, but does require placing 1/4 or 1/2 wavelength matching sections for all the bands of operation. If you are building a dual band antenna, the use of a T-Connector simplifies the project. Please bear in mind that you cannot use a 1/4 wavelength matching section on one band and a 1/2 wavelength matching section on another band, plus each band of operation requires the use of a matching section, including your lowest band of operation. Unfortunately, the connections will be inside the vertical section, a feat not easy to accomplish, but it does make tune-up much faster and easier than the shorting strap method shown above. The center connector of the coax matching sections is affixed to the tuning stub and the shield to the vertical section, keeping the center conductor length lead as short as possible.

The third method requires no antenna re-tuning from the specifications given on the plans and random length pieces of coax may be used. However, a relay switching assembly must be constructed inside a weather tight enclosure or the use of a duplexer for dual-band operation or tri-plexer for tri-band operation can be utilized. As above, the center conductor of the coax goes to the tuning stub and the shield to the vertical.
I will note that I have used random length coax, without *-plexers or relay assemblies, however, this method worked on only three of five duplicate antennas using the same random length pieces of coax on each. Each band showed an SWR of less than 1.025 to 1 until connected together, then two of the antennas showed an SWR of over 3 to 1 and three antennas were less than 1.8 to 1 across all bands without re-tuning. A little re-tuning brought the SWR down to below 1.2 to 1 on two of the antennas, but we could not achieve anything lower than the original 1.8 to 1 on the third. So if you use random length coax and no relays or *-plexers, good luck.

NOTE: The connect distance above the horizontal member on each band is selected for an impedance of around 50 ohms, moving the connect point up or down from this set point can and will increase the impedance as high as 650 ohms within a distance of 1/2 inch either side of the established proper connect point.

TTUL - 73+ de Gary - KG0ZP @ K0PFX.#STL.MO.USA.NA

The Mirrored J-Pole

Mirrored-J:

You asked for it, so here it is!
My popular mirror-image J-Pole Design.

The mirror-image J-Pole is very easy to construct and requires only two T-Fittings plus a length of copper pipe. To visualize the antenna, one must only picture a 3 half-wavelength vertical and a 2 quarter-wavelength vertical positioned a few inches away from and centered on the the tall vertical.

Construction of the mirror-image J-Pole is accomplished by starting with two T-Connectors separated by the distance shown for the band of choice. For two meters the space between the two vertical pipes should be 2 inches.
Two vertical pipes will point upwards and two vertical pipes will point downward from each T-Connector.

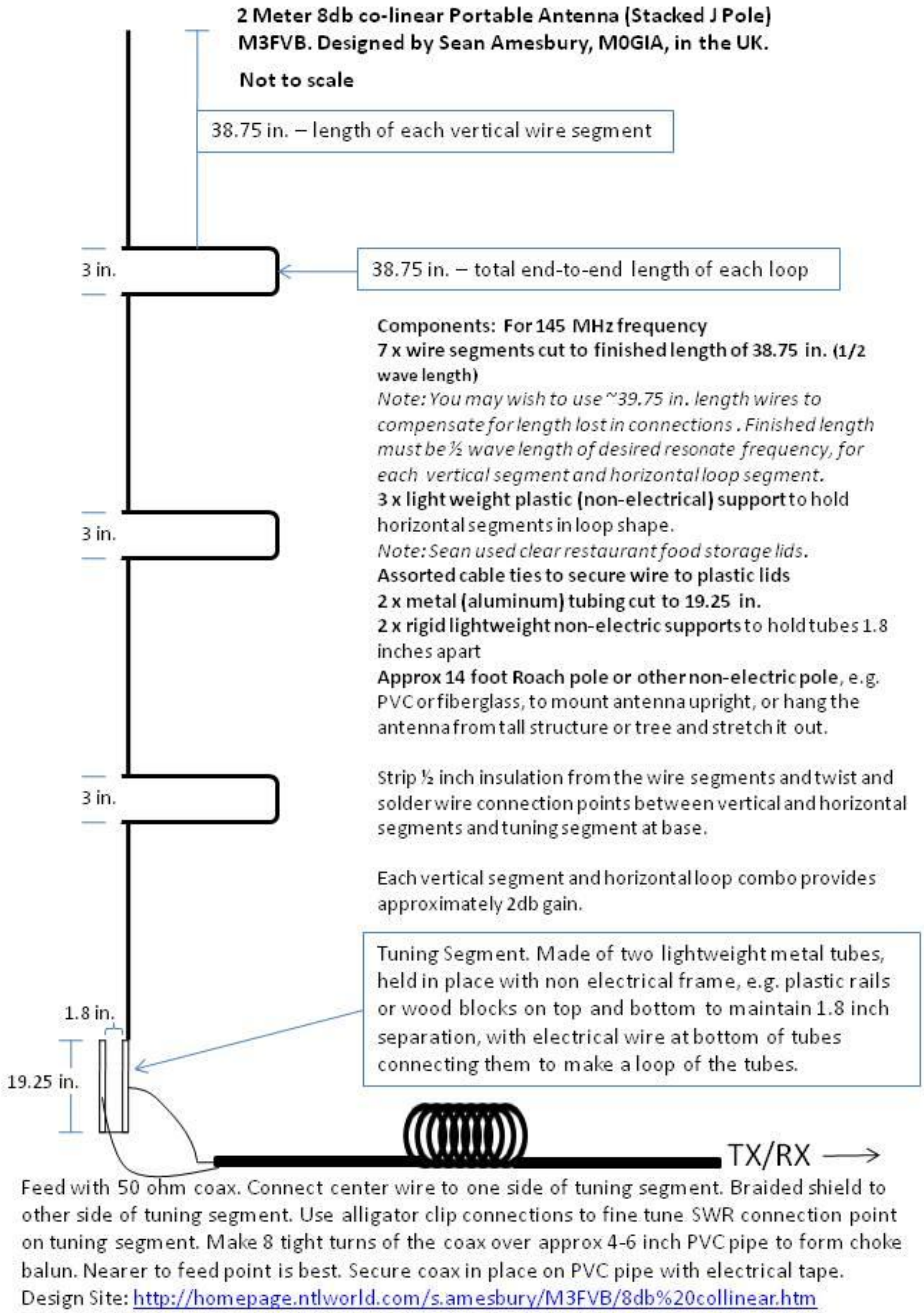
The tall vertical pipes are affixed to one T-Fitting and the short vertical pipes are affixed to the other T-Fitting. The tall vertical pipes are of the length shown as the Overall Length on the plans for the Copper Cactus. For 2-meters this distance is 58 inches to the centerline of the T-Fitting or an overall antenna length of 116 inches.
The short vertical pipes form the tuning stubs and are the length shown as the Stub Length on the plans for the Copper Cactus. For 2-meters this distance is 19-1/3 inches to the centerline of the T-Fitting or an overall stub-length of 38-3/4 inches. The nice thing about the mirrored-J is that mistakes in measurements up to 2 inches on the long vertical and 1/2 inch on the tuning stub, will not affect the performance or SWR of the antenna.

The mirrored-J is mounted on the end of 1-1/2 inch PVC pipe about 5 or 6 feet long. The PVC pipe is mounted horizontally from your tower or roof gable. The tall vertical pipe of the antenna is slid through a comparable size hole drilled into the side of the PVC at the end. A PVC T-Fitting may be sawn in half and used as a saddle to mount the antenna to vertical masts.

The antenna itself sits vertically. The coax is connected as per the instructions on the Copper Cactus plans to the upper vertical and tuning stub. On this particular antenna, the center conductor of the coax should go to the tall vertical and not to the tuning stub as in normal J-Pole construction. As always, keep the center conductor of the coax as short as possible, lengthening only the shield if necessary, using copper wire.

For Safety, the shield of the coax should be grounded to earth ground before entering your shack.

TTUL - 73+ de Gary - KG0ZP @ K0PFX.#STL.MO.USA.NA



A more detailed build instruction set for this 8 db portable co-linear antenna is at:
http://www.hamuniverse.com/2metercollinear.html

Additional Home Brew Site: http://www.ac6v.com/antprojects.htm