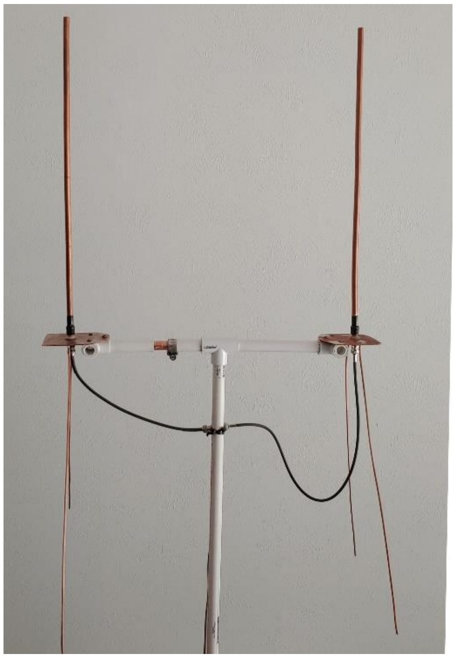
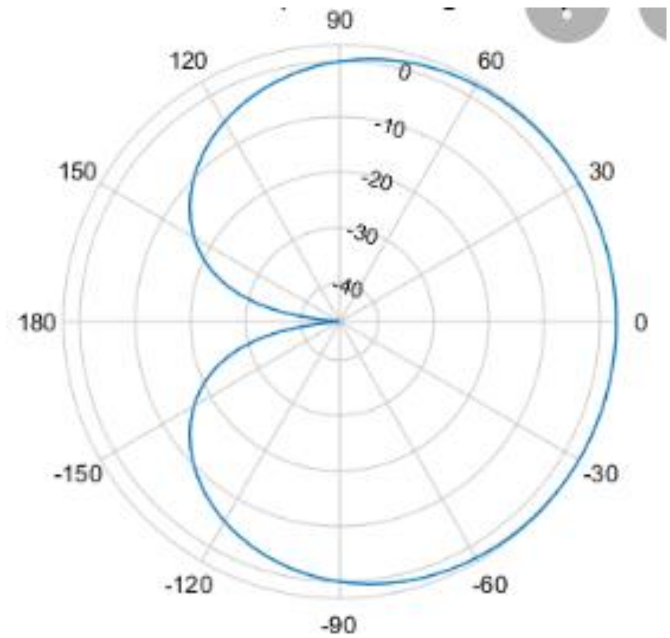
Phased Antenna Radiation Pattern
For Direction Finding





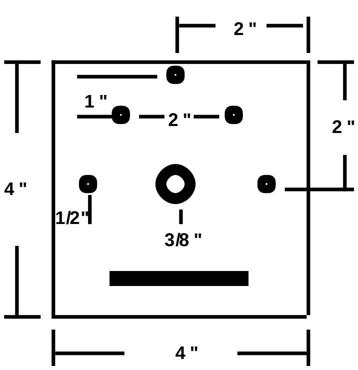
Cardioid Radiation Pattern

Antenna's that provide a cardioid radiation pattern are an excellent for direction finding. The antennas gain is used to determine the general direction of a signal source and antennas null is used to pen-point the actual location. The antenna minimum response is extremely sharp and very effective when you are close to the signal source.

The antenna is basically two 1/4λ antennas separated by 1/4λ and connected by a 90 ^{o} phasing harness.

<u>Antenna Construction</u>

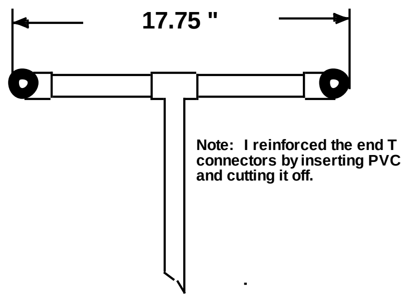
Start by constructing the antennas PBC base plate. Two 4"x 4" double-sided circuit boards are prepared in accordance with the template shown below.



PCB Template

The screw and radial mounting holes are 1/8 "and the antenna connector is 3/8 ".

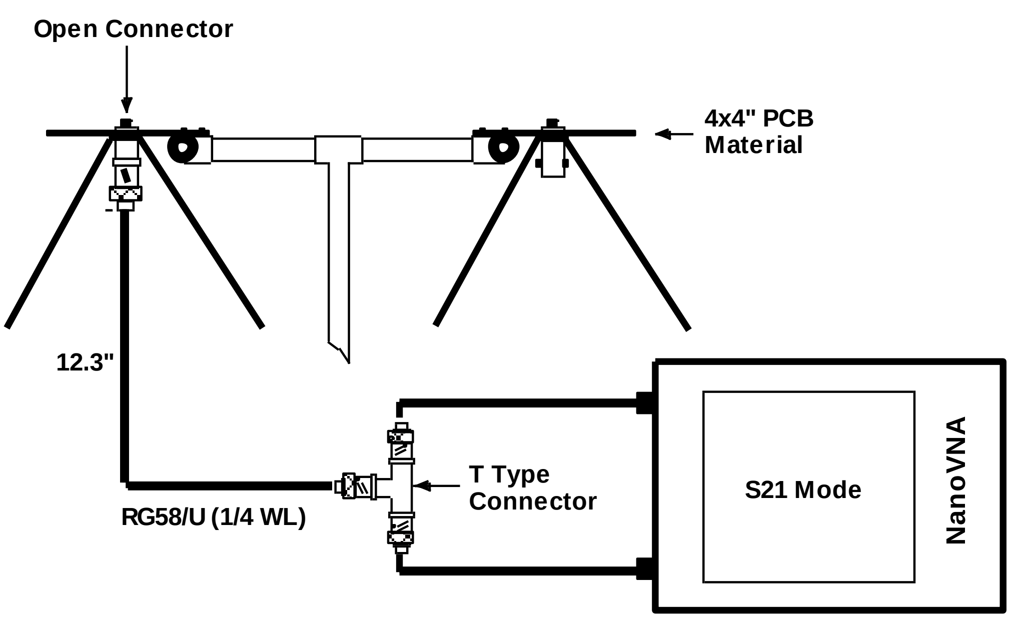
Using ½" plumbing PVC, construct the antenna boom.



Install the BNC connectors on the PCB antenna mounting plates. Place the mounting over the T connector and mark the back center hole, the drill a 3/32 pilot and the plate with a self-tapping screw. Then drill the pilot holes for other two mountings. Caution: Make sure the antenna connector center pins are separated by 19.25".

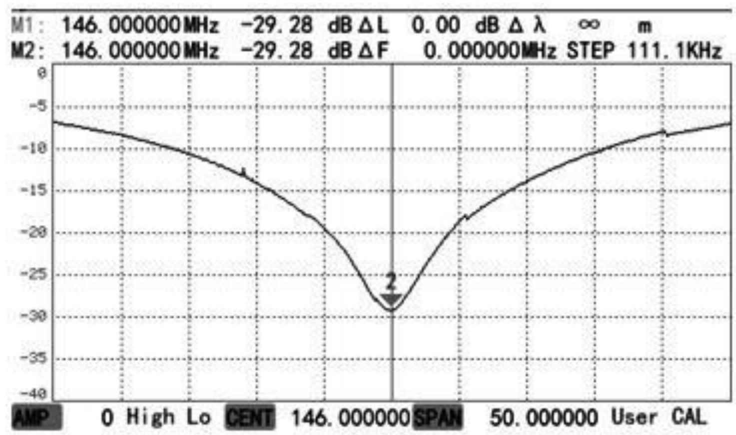
Now solder the antenna ground plane radial elements to the PCB. Insert the radials so they can be soldered to top and bottom of the board. I've used #8 bare copper wire for most of the antennas I have previously built, but 1/8 "Bare brass brazing rod can be used if you prefer elements that are stiff.

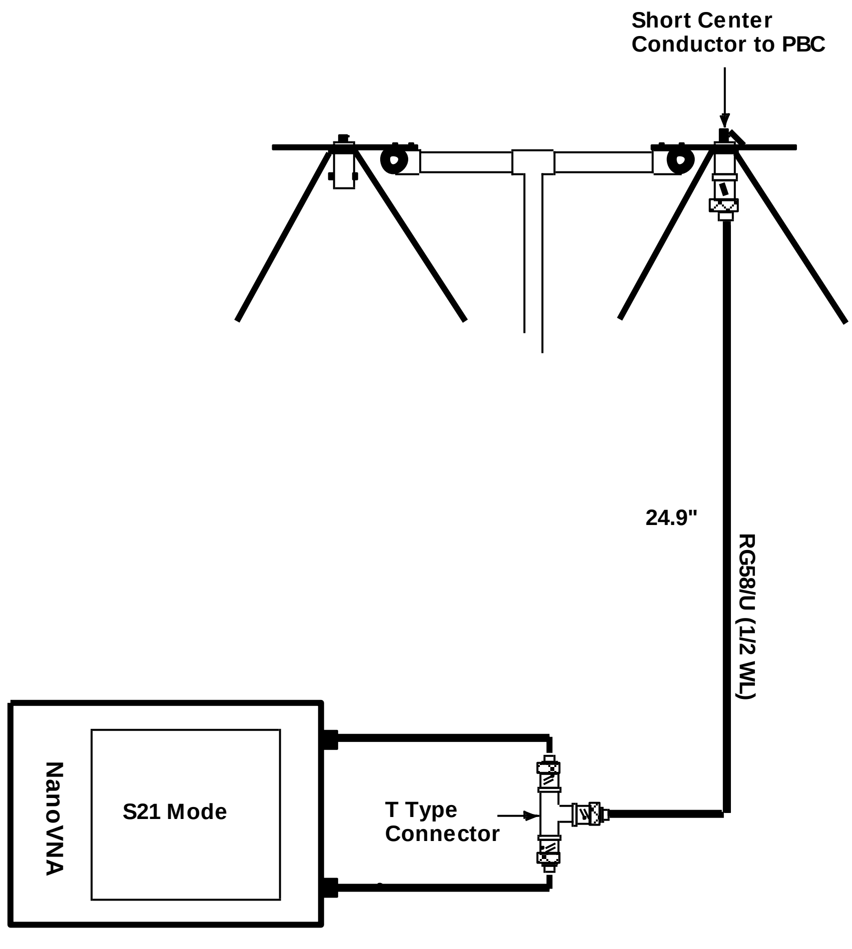
The 90^{o} phasing harness is your next task. This harness determines the null depth, so it's very important that it constructed correctly. The cable should have very good shielding, not something you purchased from Radio shake. Double shielded cable is preferred. **Caution** - You cannot use the cable lengths I measured. Your connectors and cable velocity factor may not be the same value. So you must measure the 1/4 and 1/2 wavelengths using the test setup below.



1/4 Wavelength Test Setup

With the VNA mode set for the S21 measurement mode, set the center frequency for 146.00 MHz and the span for 50 MHz. The length of the cable is modified until dip occurs at 146.00 MHz.

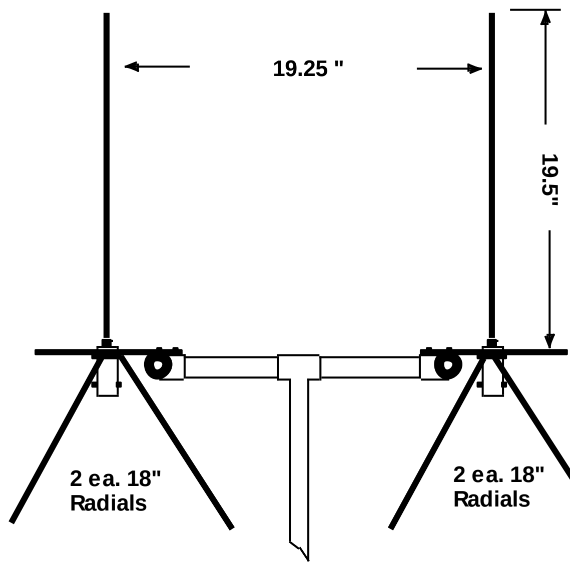




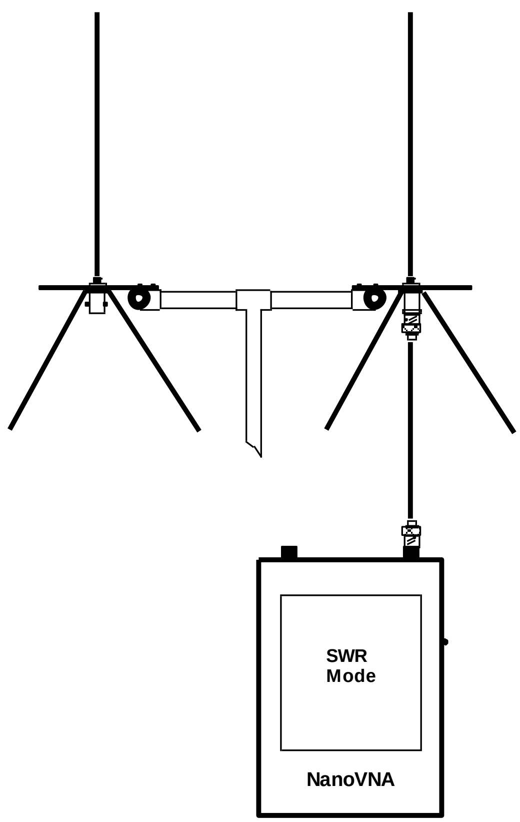
1/2 Wavelength Measurement Setup

With the antenna connector shorted, adjust the cable length until the VNA trace dip occurs at the 146.00 MHz frequency as shown in the screen plot above.

Remove the short from the antenna connector pin and solder driven elements to the connectors. I usually cut these elements slightly longer and trim them to the correct frequency.

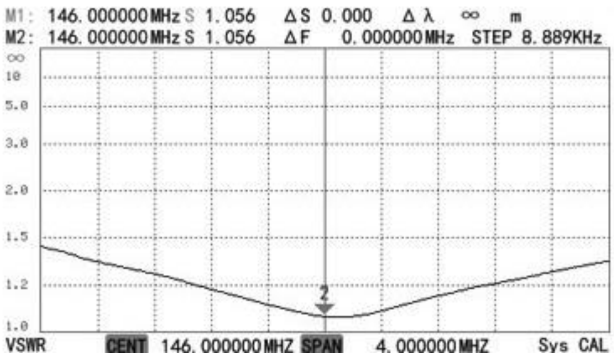


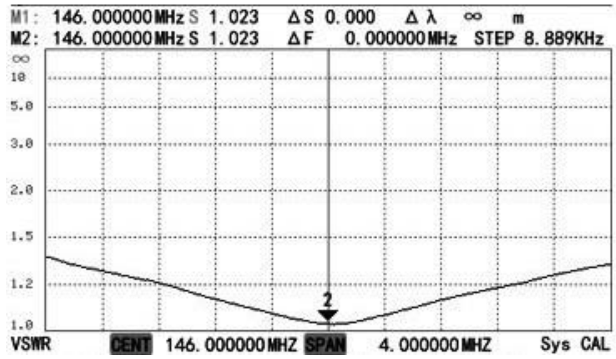
With the driven elements installed, it's time to adjust the 1/4 wavelength antennas for the best SWR at the 146.00 MHz frequency.



Use this test setup to adjust both antennas, theirs's a minimal of interaction between the antennas. Make sure you normalize the cable used between the VNA.

The VNA screen plots below shows the test results of the two antennas.



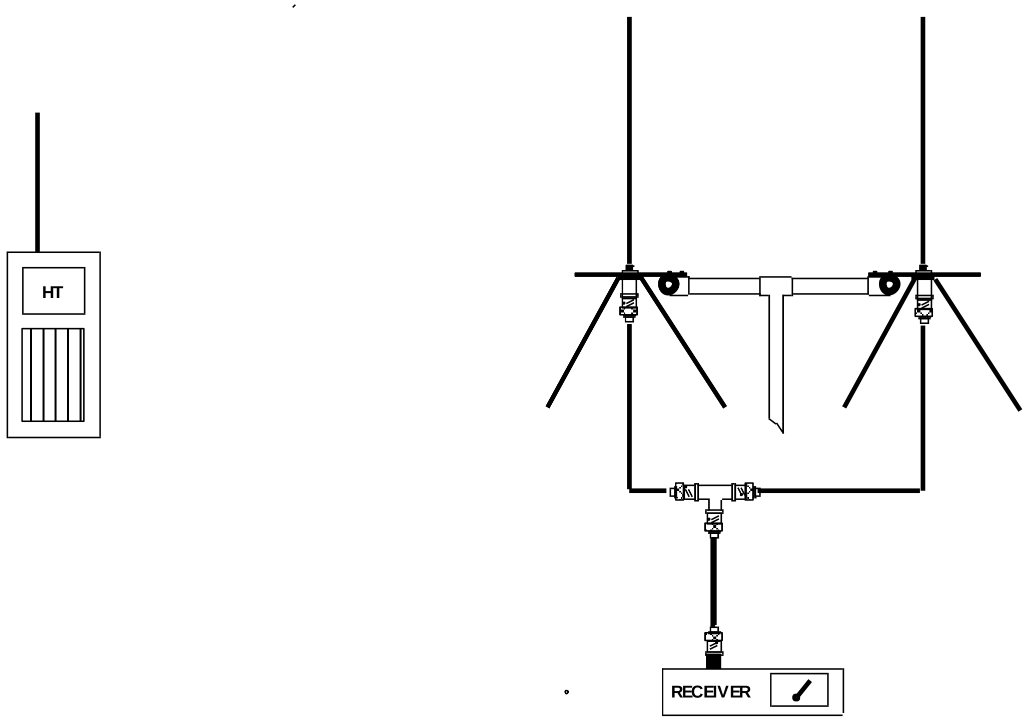


Antenna 1 VSWR = 1.056:1 @ 146 MHz

Antenna 2 VSWR = 1.023:1 @ 146 MHz

90^{o} Harness Assembly

Connect the harness to the antennas, 1/4 WL is the end that equals to the pattern null. If the spacing between the two is exactly 1/4 λ and phasing harness is accurate, the null will be straight off the boom end. This seldom occurs, so you need test were the exact null direction does occur.



In an open area, use a HT to transmit a low power signal. Rotate the antenna and monitor the receivers meter to determine the exact location of null.

Summary

Although a VNA was used to test this antenna, any instrument that's capable of S11 and S21 measurements can be used. This antenna is not a new design, I've used it for many years for finding hidden transmitters. Radio broadcast stations have used this antenna phasing method to prevent interference to other stations on the same frequency.

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