“No Counterpoise” antenna: 2 element vertical phased array

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Introduction:

The “no counterpoise” antenna of Jeff Imel is an end fed, broadbanded (multi-band) antenna that can cover a very wide frequency range. It is simply made from twin core cable such as speaker wire, and constructed in such a way that half of its length is twin wire and half of its length is single wire.

For a “no counterpoise” antenna for coverage of 40m through 10m, a total length of 50ft (25ft for each section) provides good performance and easy tuning when fed via a balun (4:1 seems to offer best results) and tuner. To cover the range 20m through 6m, the length is halved (i.e. 25ft total with 12.5ft per section) and for 80m through 10m the length is simply doubled. Like any other antenna, the longer ones would generally be mounted in either a horizontal, inverted L or sloping configuration, and the shorter ones (i.e. 25 ft) are easy to mount vertically with the aid of a fishing pole. Being end fed, the “no counterpoise” antenna can also easily be dangled from a window or strung up a tree, without the hassle of having to cater for a centre feed point.

The idea behind using a pair of these antennas as a phased array came about as I was looking for a simple solution to the problem of making a phased array multi-banded. Conventional vertical antennas either incorporate traps, coupled resonators or other means of tuning to enable them to cover more than one band and provide a good match to 50 Ohm coax. Base fed vertical half waves present an extremely high impedance that requires and L/C network to match to the feedline, and can also result in high losses on twin feed due to the extremely high SWR presented if no L:/C network is present at the base. And ¼ wave verticals require a radial system that can also be problematic. None of these antennas is suitable for a simple multiband phased array due to having to tune each antenna individually at its base in order to overcome the problem of excessively high SWR on the feeders/phasing lines.

It has been found that the “no counterpoise” antenna presents an easy to match impedance across a very broad range of frequencies, with the resistive and reactive components never rising above a few hundred Ohms. Therefore, if feeding these with twin feed line then the line losses resulting from high SWR will remain very small, especially when the line length is short as in a typical /p type operation. I therefore decided to see how a pair of vertical “no counterpoise” antennas would cut it when used in a phased array.

Pre-build computer modelling

Computer modelling with EZNEC indicated that performance with two 25ft “no counterpoise” antennas would be good for the range 20m through 6m when spaced at 3 metres apart, with an excellent bi-directional endfire pattern when fed 180 degrees out of phase and an excellent broadside pattern when fed in phase on the higher frequencies, approaching omni-directional on 20m. Broadside directivity can be improved on the lower frequencies (20m) by increasing the distance between the elements, but this results in additional lobe formation on the higher frequencies.

For the computer modelling, I simulated the array as two vertical “no counterpoise” antennas with an individual source at the base of each, and fed either in phase or 180 degrees out of phase.

Building the phased array

Before building the phased array I had to think carefully about how to feed them. As the feedpoint impedances can reach several hundred Ohms I felt it was important to avoid the use of coax as the phasing lines in order to minimise losses. I therefore decided to use more speaker wire as twin feed phasing lines to the base of each antenna.

Another important point is to decouple the twin feed phasing lines from the “no counterpoise” antennas. The “no counterpoise” antennas are somewhat unbalanced antennas, as they are essential off-centre fed dipoles with the short side folded up against the long side (or they could be described as being Zepp-like). The twin lead phasing lines need to be balanced to ensure there is no undesirable RF. If the twin lead phasing lines are set up as nothing more than an extension of the bottom half of the “no counterpoise” antenna, then the radiation pattern on the antenna is badly upset, and the phasing lines produce a bad vertical lobe in the radiation pattern.

To decouple the twin lead phasing lines from the antenna I decided to construct a simple 1:1 balun at the base of each by winding 8 turns around an FT114-43 toroid. The balanced twin lead phasing lines are then coupled to the unbalanced tuner via a 4:1 current balun and a short length of coax. The balun on each end of the phasing lines serves to help force the phasing lines to be balanced. So in essence – unbalanced antenna > balanced phasing line > unbalanced coax to tuner. Both phasing lines are attached to the 4:1 balun at the tuner end, and the phase of the array changed from in phase to 180 degrees out of phase by simply reversing the connections for one of the phasing lines.

Below is a rough sketch of the “no counterpoise” two element phased array.

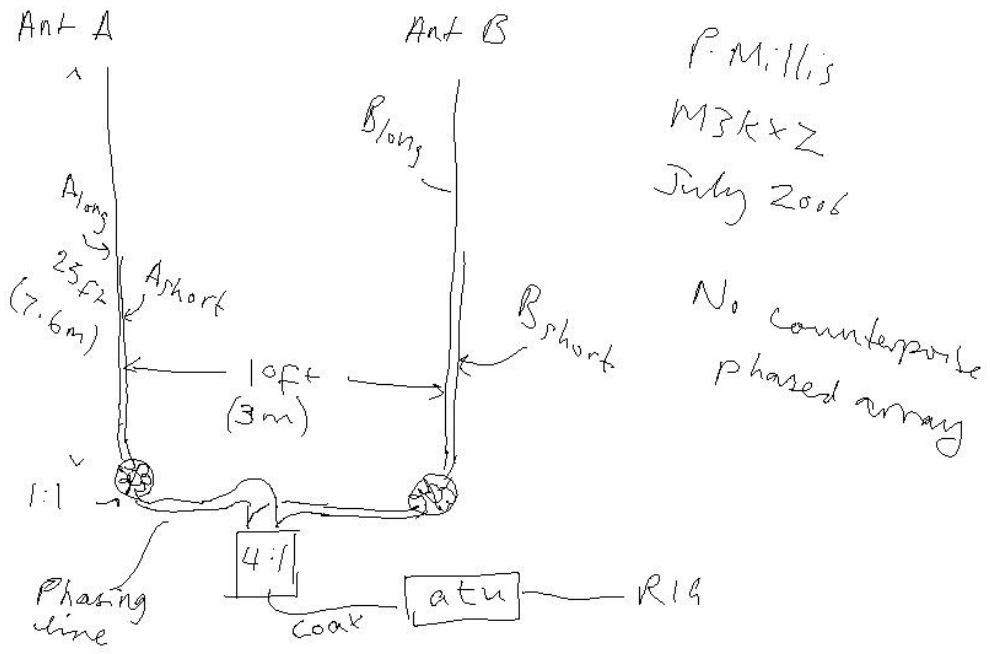

Fig 1 – "no counterpoise" antenna two element phased array for 20m through 6m. The 1:1 baluns consist of 8 turns of the phasing line (twin core speaker wire) on an FT114-43 toroid. This helps force the balance on the phasing lines between antenna base and the 4:1 balun at the atu. When the antennas are fed such that A_{long} and B_{long} are bother connected to one terminal on the 4:1 balun, and A_{short} and B_{short} are both connected to the other terminal then the antennas are being fed "in phase". If the connections to one antenna are reversed such that A_{long} and B_{short} are connected to one terminal, and B_{long} and A_{short} are connected to the other, then the antennas are being fed 180 degrees out of phase.

Below are a couple of photographs showing the phased array set up. Each "no counterpoise" antenna is mounted on a fishing pole by securing the top and then winding it helically around the pole. The antennas are terminated in bullet connectors with the mating connectors being on the phasing lines. The antenna-phasing line baluns are wound on FT114-43 toroids and secured with cable ties on the antenna end of each phasing line, and then secured to the base of the fishing pole with Velcro strip wrapped around the pole. Also shown is the termination to the 4:1 balun and the complete array set up.

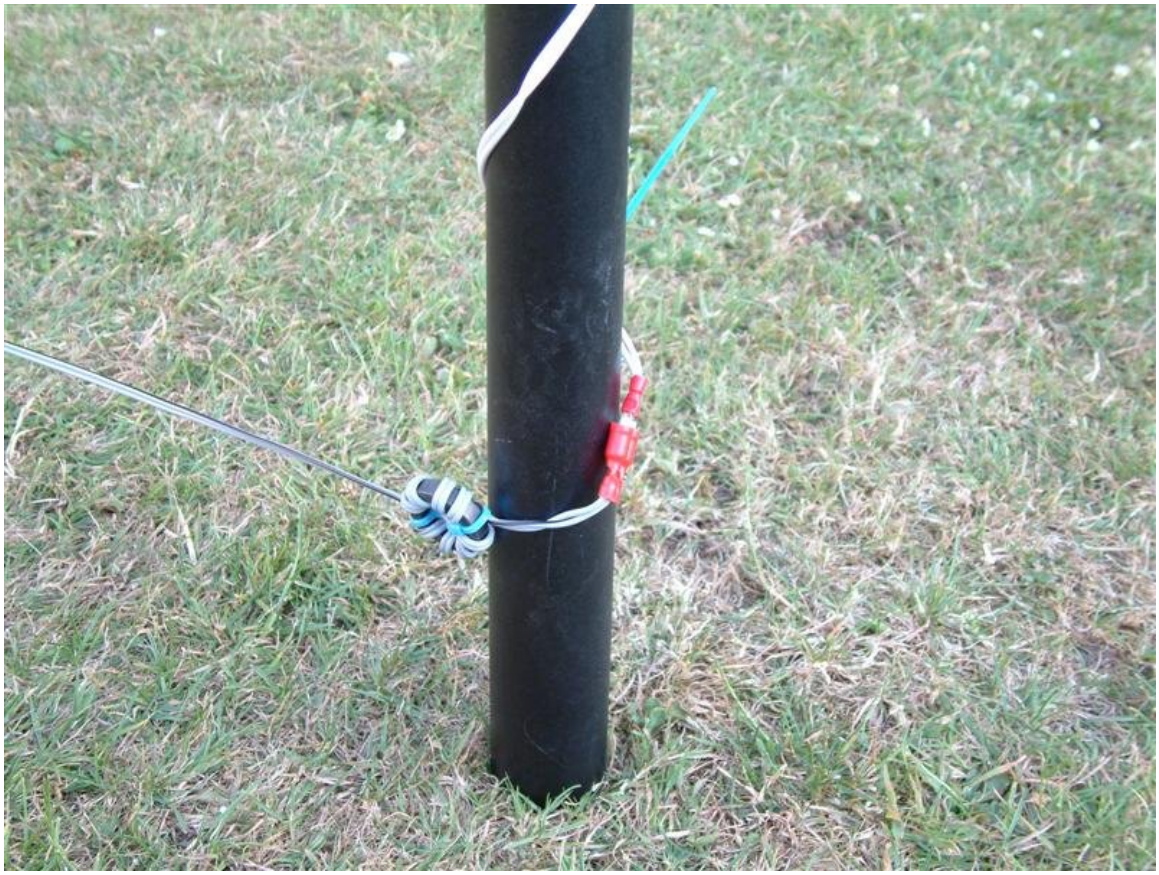

Fig 2 – 1:1 balun at base of one “no counterpoise” antenna. Phasing line is twin lead speaker wire which, over the short distance of 3m, should have very little loss at HF frequencies compared with similar length of coax.

Fig 3 – connection of phasing lines to the 4:1 balun. Phasing is changed between in phase and 180 degrees out of phase simply by reversing the connections of one of the phasing lines. The phasing lines are kept gently taut so that they remain a few inches above the ground, although no deterioration in performance was obersed when they were allowed to sit on the ground.

Fig 4 – the “no counterpoise” two elements phased array at Chez M3KXZ. Note the small dog by the furthest antenna – she likes to keep up with whatever is going on. Note also, that each “no counterpoise” antenna is wound helically around the fishing pole for ease of set up and neatness. Such gentle winding should have minimal impact on antenna performance.

Performance of the “no counterpoise” two element phased array

My initial trial of this phased array has been very promising. This is what I found with the two antennas set up East-West.....

- tuning was easy on all bands 20 thru 6 with the Elecraft T1 atu
- with the antennas "in phase" (i.e. connections same to each one so the long part of each was effectively connected together and the short part of each was connected together) I had S5 to S8 of noise on 20 thru 12.
- with the antennas fed 180 degrees out of phase (i.e. connections to one were reversed) the noise went down to S0 to S1 so it seems the noise source was broadside to the antennas.
- the QSO I had was on 12m with a Spanish station. With the antennas fed in phase, the station was S8 in S5 to S8 of noise, with the antennas out of phase the station was S9 in S0 to S1 of noise. Massive improvement.
- the station was running 100W and was S9 with me, I was running 2.5W and was S5 with him - so it seemed to be doing the trick.

I then went into my "shack" and tuned to the same frequency (24.962 MHz) using my 10m tall vertical which is fed against wire garden fence as counterpoise and tuned with an SG237 - I couldn't hear the Spanish station at all. The only thing I could hear was S9 noise.

Further testing will now take place, with the intention of getting the set up on the beach early next week.

Conclusions

The “no counterpoise” phased array is a very simple multiband vertical phased array that requires minimum number of components. Set up time is in the order of minutes, the antennas are lightweight, the baluns are small, the phasing lines are light and the cost is minimal. This is potentially a good set up for someone who wants some direction to their operating!

The principle is similar to that of the W8JK array, only by combing it with the design of the “no counterpoise” antenna is becomes multibanded and easy to feed with the feedpoint at ground level.

Further information

Please email me if you would like a copy of the EZNEC files and any further information. I will be putting details up on www.outsideshack.com shortly, but my website is still very embryonic!

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