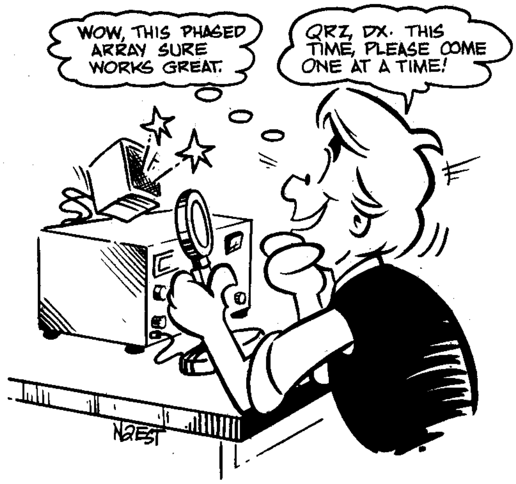
40 Meters with a Phased Delta Loop



Large 40-meter Yagis can set you back a week's salary and take a month to install. A bidirectional, 2-element Delta Loop array provides a better way to snare some DX at modest cost.

By Edward Peter Swynar,* VE3CUI

A station in the U.K. was heard to say, "Forty DX separates the men from the boys." In line with this, it is fortunate for the home-construction crowd that 7 MHz is an area where the mind must often rule over matter! In pursuit of 40-meter DX, some amateurs have embraced the costly "consumer approach." Others have resigned themselves to the likes of the simple and relatively ineffective inverted-V antenna — coupled to the omnipresent kilowatt amplifier. There *is* a better way!

With moderate property dimensions, some trees (perhaps), wire, coaxial cable and a bit of patience, it is possible to build an excellent gain type of array. It can be switched to either of two directions. It is inexpensive and effective for working long-haul DX. I will refer to it as the "2-element, 90-degree-phased Delta Loop."

The Case for Phased Loops

Literature abounds regarding the cardiodal pattern of 2-element 90-degree-phased vertical antennas with 0.25-wavelength spacing. A gain of 3 dB is available over a single 0.25-wavelength vertical element.[1] But, since such an element has a *minus* gain of 1.8 dB over a dipole, one can realize a 1.2-dB gain over a dipole when using two verticals that are phased. The major advantage of the vertical 2-element array is, therefore, the low radiation angle and the directivity (at the expense of many buried copper radials).

With 90°-phased dipoles there is, relatively speaking, more gain and less wire. Again, each dipole element by itself has no gain (using dBd as a reference). Also, this type of array must be fairly high above ground to be an effective DX antenna on 40 meters.

Now, consider the phased Delta Loop arrangement of Fig. 1. By virtue of the feed points on each element, the array is vertically polarized and produces a low angle of radiation, as with the phased vertical system. Furthermore, each loop (by itself) offers a 2-dB gain over a dipole (3.8 dB over a single 0.25-wavelength vertical). Imagine the benefits of two such gain-style loops, positioned properly and driven in combination to enhance the already-existing gain of a single loop element.

Construction

Your specific situation will dictate the precise shape of your loop. Nevertheless, the length of the wire for each element should be taken from the standard loop equation — L(ft) = 1005/f(MHz).[2] I like to add approximately 2 feet of additional wire to facilitate final adjustment for lowest

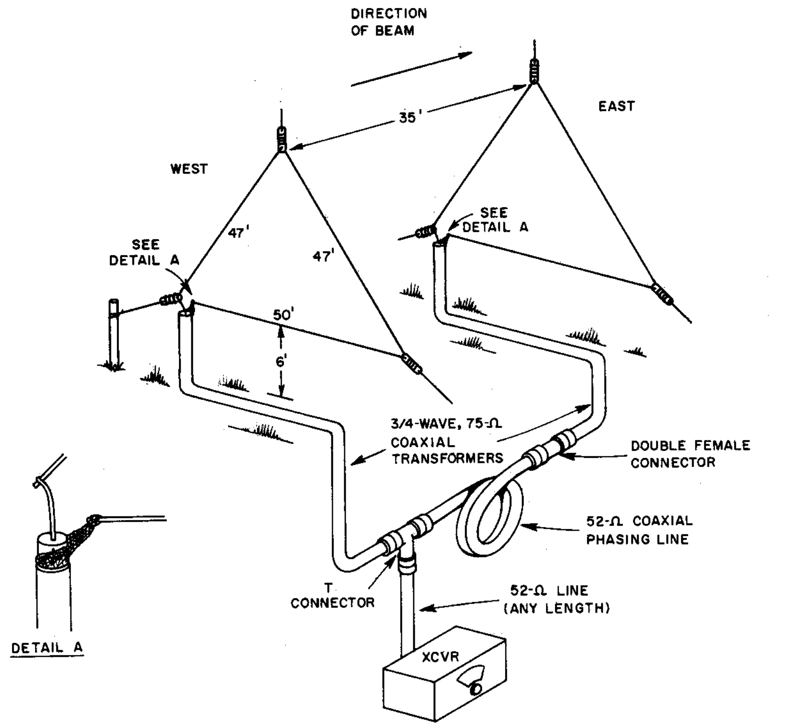


Fig. 1 — Illustration of the final arrangement chosen at VE3CUI for the phased 2-element Delta Loop array. Corner feed, apex up (as shown) yields vertical polarization and a low radiation angle.

[1]Notes appear on page 21.

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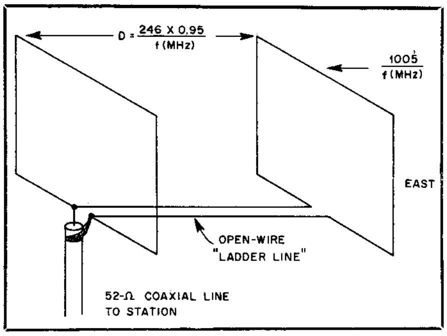

Fig. 2 — Arrangement for the unidirectional loop array that was used first at VE3CUI.

SWR. The element spacing (based on free-space conditions) is obtained from L(ft) = 246/f(MHz).

I first used the feed method seen in Fig. 2. This system has the advantage that use of costly coaxial line is restricted to a single run of 52-ohm cable from the antenna to the ham shack. Also, the balanced phasing line helps to preserve the symmetry of the array. I'm sure this could be improved further by inserting a 1:1 balun transformer at the feed point. The disadvantage of this method is seen when trying to reverse the directivity of the antenna: I must go outside the shack, remove the coaxial feeder from one loop and connect it to the other loop. This is no fun whatsoever when the band is open to two directions at once during a cold January morning!

My present feed system is that of Fig. 1. It is an odd-multiple expansion of the conventional ¼-wave matching transformer, the type used for matching to single loops that are fed with 50-ohm line. I tripled the length of the 75-ohm line section to ¾ wavelength. This was a convenience because of the distance between the shack and the most distant loop. Two equal lengths of 75-ohm coaxial cable are used as transformers (one per loop). The line length is determined by

$$L\ (\text{feet}) = 0.66\left[\frac{246}{f(\text{MHz})}\right] \times 3 \quad \text{(Eq. 1)}$$

when the coaxial cable has solid dielectric rather than foam material. In this case, the velocity factor of the line is 0.66. This factor will be different if you do not use solid-dielectric polyethylene line.

Adjustment

The loops should be adjusted separately for resonance. Attach a 3/4-wavelength transformer to one loop, then connect the free end of the transformer to a random length of 52-ohm line (through an SWR indicator). Attach the remaining end of the 52-ohm cable to your transmitter. While using the least power possible to obtain an SWR-meter indication, adjust the loop length for a 1:1 SWR. *[Safety first! Do not touch a "hot" antenna. Take the rig to the antenna site, or have a friend switch it on and off for you during the tests. — Ed.]*

On completion of this procedure, repeat it with the remaining loop. I do not recommend that you "stagger-tune" the loops in the hope of obtaining increased bandwidth; one loop should be the electrical twin of the other one. I have found, also, that both loops should be the same shape and height above ground, and as perfectly spaced apart as possible. This suggestion may seem extreme, but best results will be had later on if some pains are taken during installation and adjustment.

With the loops installed in their final positions, it is time to add the 52-ohm coaxial phasing section. The length is determined by Eq. 1, but do not multiply by 3, as in the equation, since the line will be an electrical quarter wavelength rather than 0.75 wavelength. This phasing line can be rolled up and taped so that it won't occupy a lot of space in the ham station. This phasing line should be placed in series with the feeder that connects to the loop element that will serve as the *forward* radiator, since it will be the element that will require the 90° lag. The remaining end of the phasing section is connected (by means of a coaxial T connector) to the end of the feeder that goes to the other loop element. The third port of the T connector is used to mate the feed system to the transmitter and receiver via a short run of 52-ohm coaxial cable. Switching of the directivity is done manually in the shack by transposing the ends of the T connector that go to the feed system. Faster switching can be had by using a coaxial relay or manual switching method. For my needs, it was easy to grow used to reversing the two PL-259 plugs by hand.

The layout of my 50- × 80-foot lot is such that the directivity of the array is NNE or SSW. This has been good for DX from Europe and the South Pacific. One loop is held aloft by means of a tall tree. The other loop is supported by my 48-foot tower, and it is spaced 10 feet away from the tower.

The SWR curves differ between "beaming east" and "beaming west." See Fig. 3. I feel that the problem is caused by the aluminum siding on the house, which is close to one of the loops. Despite this annoyance, the system is flat across the part of the band that interests me — the DX segment.

Results

The bulk of my DXing is done at a power level of 500-W dc input. The exception was my first QSO with the antenna, during which I was using 50 W: I received an RST 559 report from 3B8CF on Mauritius Island, despite the pileup bedlam.

The front-to-back ratio of the array appears to be roughly three S units (18 dB) over long DX paths. Over short paths (interstate or interprovince), do not expect

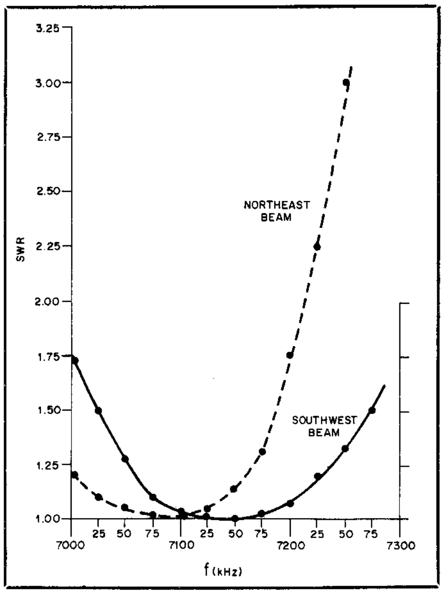

Fig. 3 — SWR curves developed at VE3CUI for the 2-element loop array. Note that the curves show a disparity. This may be the result of one loop being in proximity to the aluminum-sided house.

much by way of F/B ratio. Close-in contacts will be more satisfactory with a high-angle radiator, such as a single loop from this array, or a dipole, can provide.

The phased loops certainly "hear" the signals better than other antennas I have used. Also, I seem to receive longer band openings than with other types of antennas I have used. I have been gratified a number of times by comments such as, "Best signal from North America, OM." I have not made performance comparisons against a reference dipole, but I received the substantially stronger signal report during a four-way DX QSO that included two local hams. One was using an inverted V, and the other had a single Delta Loop. One fellow had a report of "inaudible" (inverted V at 40 feet), and the ham with the Delta Loop was barely discernible in the noise. My report was 5 × 8.

Conclusion

Despite the low antenna height and cramped space, the 2-element phased loop array is a superlative budget-saving performer. I hope some of you will investigate the DX potential of this simple antenna. Certainly, you will experience the same kinds of pleasures I have while chasing DX on 40 meters!

Notes

[1]Gain figures are unproven and are theoretical.
[2]m = ft × 0.3048.

E. P. Swynar, 31, was licensed in 1971. His first ham station was homemade from circuits in the ARRL literature. He has had two antenna articles published in CQ. His major interests in radio are homemade gear and homemade antennas. He has a BA in history and economics, and works as a supervisor in the quality control section of General Motors of Canada, Limited.