A New QTH, and a New Loop Array at VE1ZAC / VE1ZU

Jeff Smith August 2020

Semi retirement, a new QTH, and a new antenna project. And some catching up to do with ham chums..

A move to semi retirement 2 years ago prompted a VE1ZAC property change from suburban Halifax to a new QTH in Nova Scotia's South Shore region, on a lake with a couple of acres. There is plenty of room now for garden and antenna projects.

The new location is very quiet for RF noise. The property is sloped to the NE and largely open with a sprinkling of useful trees for antenna projects.

The new inventory of antennas:

- The long running OCF 80M dipole with a base mounted high power remote matcher, and a switch and matching network allowing the antenna to be used as a Marconi against a selection of radials. The radials aren't perfect but some are 40 meters long and the antenna performs admirably on 160M. This is a great multi band antenna, and gives a good account on 80 and 160. On 40M it is decent for N-S paths and is a backup for 20M. On 30 M it favours N-S and it can also work on 30M in the Marconi mode when needed.

- A ground plane 30 foot vertical with a base mounted SGC tuner works all bands at low power.

- A DIY 40 foot fold-over tower supports a 2 element Steppir beam. The beam and rotator has been in use for many years at the old QTH and required a rebuild and over haul. Some surplus donated hardline has been pressed into service for the run to the new shack. Part of the hardline is 50 ohms and part is 75 ohms with a Sevick style UNUN at each end. The tower can be folded over at the hinge and the beam lowered in about 10

minutes. Makes maintenance and storm damage prevention easy for a ham who now qualifies as a geezer. This tower was fabricated from donated tower sections.

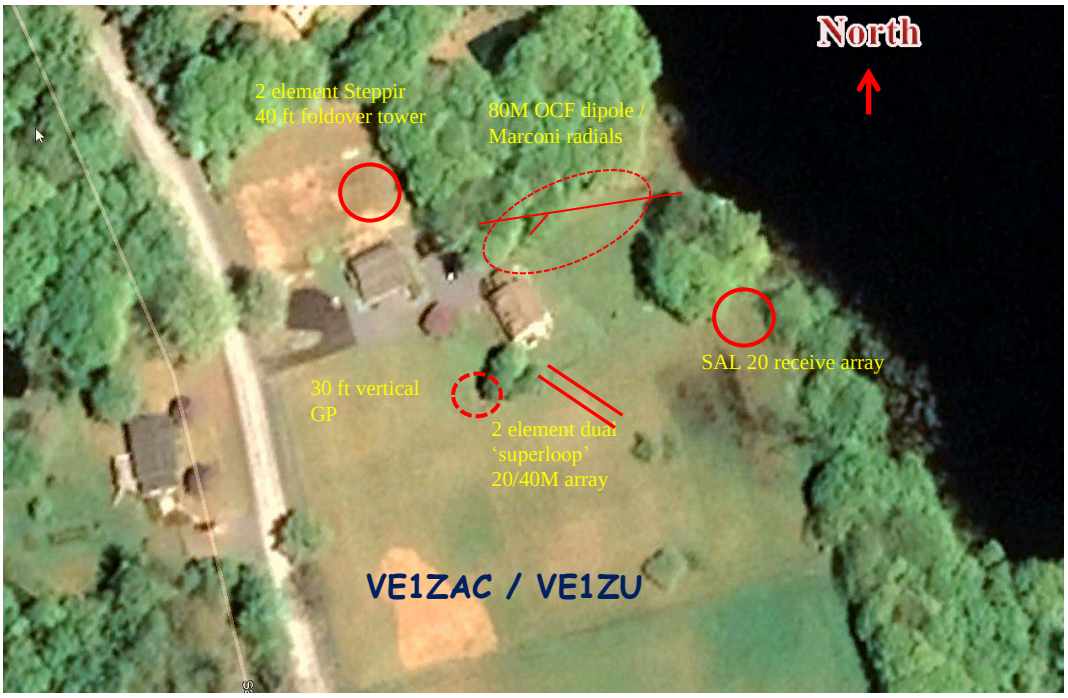
- The SAL20 receive antenna has been setup near the lake. In Halifax, this antenna was essential for low band use. Here it is still helpful, although the noise abatement problem has largely evaporated. It is still a stellar direction finding antenna and really helpful in certain conditions on 80 and 160.

The new shack is located in a walk out basement with a pastoral window view of the lake.

But, 40M is still a problem for contesting (mainly) and some DX work.

Here in the NE of the continent, a reversible antenna aimed SW and NE is a very useful addition to the antenna farm. Without the complexity of rotating, a wire antenna can be pretty decent for contesting and DX.

Here is an aerial view of the property with antenna locations



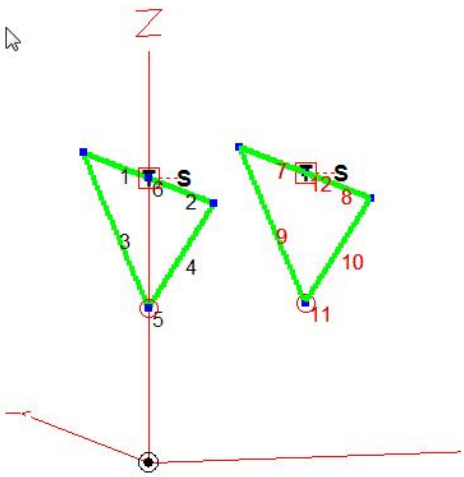
Some convenient trees and a couple of 35 ft radio type masts allowed a wire antenna placement in the right direction, but over sloped ground. A compromise. What to put up?

Over the years one of Jim Thompson's Radio Works "Super Loop" versions has often been employed at VE1ZAC, with decent results on 40M and on 20M. This antenna has also been used in multiple Field Day outings and been rebuilt several times. These had a 4:1 balun at the bottom feedpoint. Jim's "SuperLoop" is an inverted Delta loop with a stub inserted in the middle of the upper element. It allows the antenna to look like a reasonable load on 40M and 20M.

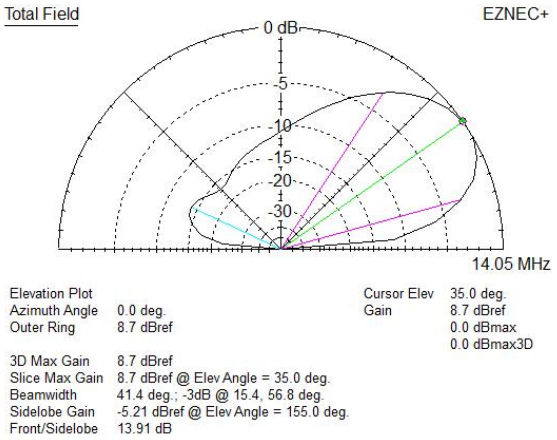
An iteration of this antenna was put up and as expected, it provided decent use in the NE and SW directions on 40M. And it was pretty good on 20M as well.

But, the itch to provide some array gain performance dominated the last radio season.

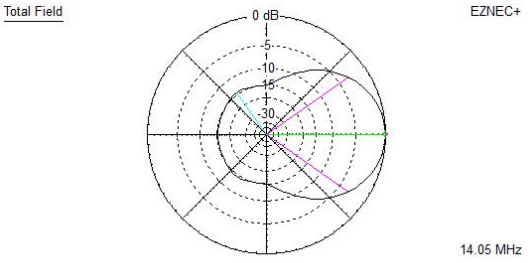
Would it be possible to put up a second loop and drive it as an array ? A lot of hours were spent with EZNEC modelling this potential array. Some of the modelling features included wire elements for the stub and also using the stub feature in EZNEC. The upper height was varied between 30 and 35 feet above ground. Since it was going to be located on the side of a hill, the height of one of the loops was changed to simulate sloped ground. The loops were spaced broadside and 20 feet apart, since one end had 2 convenient trees that could be pressed into service.
The antennas were able to be aimed broadside to the NE and SW path.



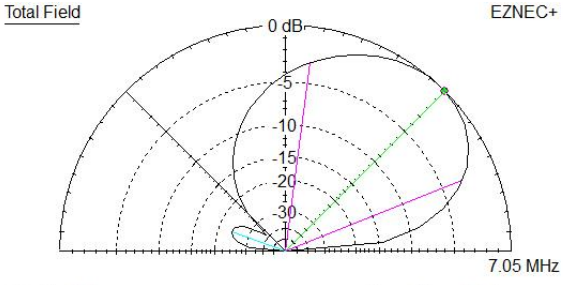
In the model two sources were used and current phased to simulate an array.
Here are representative model outputs for 20M and 40M for two identical loops:



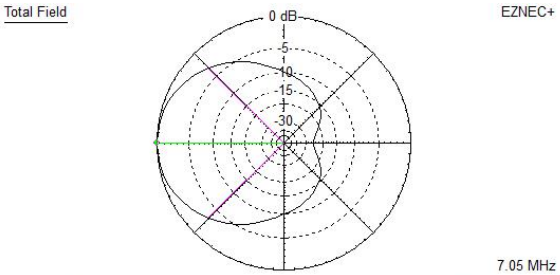
Elevation Plot		Cursor Elev	35.0 deg.
Azimuth Angle	0.0 deg.	Gain	8.7 dBref
Outer Ring	8.7 dBref		0.0 dBmax
			0.0 dBmax3D
3D Max Gain	8.7 dBref		
Slice Max Gain	8.7 dBref @ Elev Angle = 35.0 deg.		
Beamwidth	41.4 deg.; -3dB @ 15.4, 56.8 deg.		
Sidelobe Gain	-5.21 dBref @ Elev Angle = 155.0 deg.		
Front/Sidelobe	13.91 dB		



Azimuth Plot		Cursor Az	0.0 deg.
Elevation Angle	35.0 deg.	Gain	8.7 dBref
Outer Ring	8.7 dBref		0.0 dBmax
			0.0 dBmax3D
3D Max Gain	8.7 dBref		
Slice Max Gain	8.7 dBref @ Az Angle = 0.0 deg.		
Front/Back	15.29 dB		
Beamwidth	69.8 deg.; -3dB @ 325.1, 34.9 deg.		
Sidelobe Gain	-5.75 dBref @ Az Angle = 125.0 deg.		
Front/Sidelobe	14.45 dB		



Elevation Plot		Cursor Elev	45.0 deg.
Azimuth Angle	180.0 deg.	Gain	8.46 dBref
Outer Ring	8.46 dBref		0.0 dBmax
			0.0 dBmax3D
3D Max Gain	8.46 dBref		
Slice Max Gain	8.46 dBref @ Elev Angle = 45.0 deg.		
Beamwidth	60.6 deg.; -3dB @ 21.8, 82.4 deg.		
Sidelobe Gain	-15.08 dBref @ Elev Angle = 160.0 deg.		
Front/Sidelobe	23.54 dB		



Azimuth Plot		Cursor Az	180.0 deg.
Elevation Angle	45.0 deg.	Gain	8.46 dBref
Outer Ring	8.46 dBref		0.0 dBmax
			0.0 dBmax3D
3D Max Gain	8.46 dBref		
Slice Max Gain	8.46 dBref @ Az Angle = 180.0 deg.		
Front/Back	25.02 dB		
Beamwidth	89.6 deg.; -3dB @ 135.2, 224.8 deg.		
Sidelobe Gain	< -100 dBi		
Front/Sidelobe	> 100 dB		

Model Observations:

- Fairly high take off angles, but acceptable for wire antennas close to the ground.
- Respectable gain based on reference to a simple dipole. The phase difference for 20M is -85 degrees and for 40M -220 degrees.
- The 40M performance could be improved by spacing the antennas apart more. Two trees at one end that defined the 20 foot spacing, so that is what was used. A better performance would be gained at 30 feet.

Workable, and a decision was made to build this, with these model outputs as guidance and a target.

Building the Loop Array

The caveat emptor stuff first:

WARNING: this is NOT a "how to build" article. There is an assumption that readers are either of a group who can tackle a project like this on their own and have or can acquire the skills required, or are in a second group looking at the article for entertainment. This section is aimed at the former. Hopefully the latter are entertained, of course.

Spoiler: it exists and does work, not quite perfectly. But it is a keeper.

Requirements:

- Loops will be identical as reasonably possible, but are unlikely to be exactly the same. Therefore it is expected it will work in one direction better than the other. This is exacerbated by the uneven ground underneath.

- Lighten the loops up by feeding them with ladder line, lowering stress on poles, halyards, guys, etc..

- Make an effort to get the terminated feed line impedance after a 4:1 balun to be as similar to each other as possible.

- Keep costs down by using stuff from extensive junk pile and parts collection.

- Phase the antennas with the Christman delay line feed method, and utilize the spreadsheet available from *Jim Lux, W6RMK, w6rmk@earthlink.net (thanks Jim)*

- Utilize outdoor RG6 for delay lines. This stuff is cheap, (often free) rated for 2700 volts and can be used with PL259 connectors with a modified crimp method. This might be part of the system that could get changed a few times, seemed like a safe bet to use this coax for experimental purposes. That turned out pretty well.

- Make all onsite measurements with a NanoVNA and a Netbook Win7 computer.

Note: Don't think about doing something like this without having expertise with a modelling program like EZNEC or other program, an ability to make quality complex impedance measurements with a VNA, be familiar and willing to do complex impedance math and use spreadsheets with the solver tool.

Compromises:

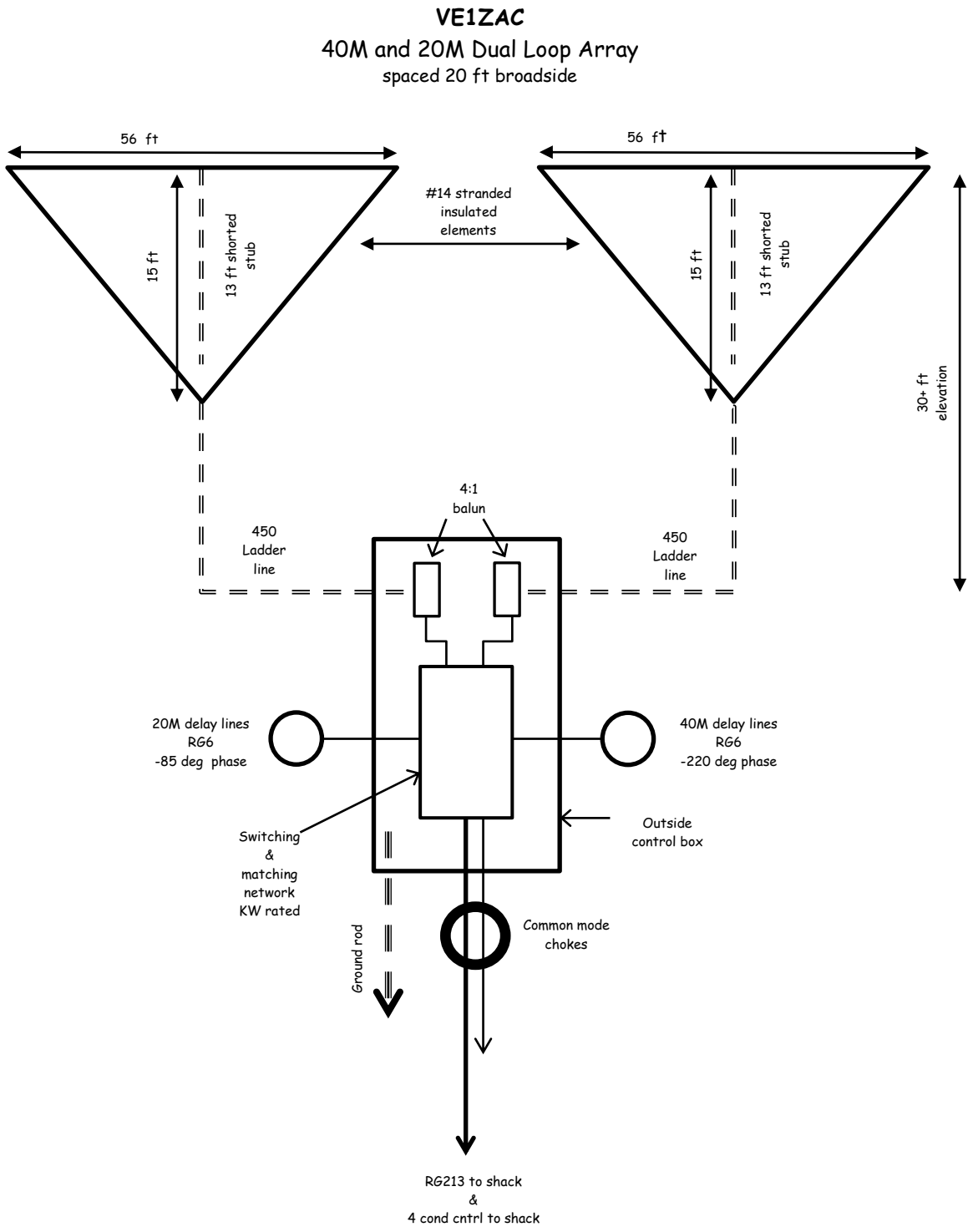
Lots of time was spent trying to get the two loops to be identical but they are still not exactly the same. Elements and feed line lengths were cut the same, and then impedance measurements were done with both elements in the air. Feedlines of 450 ohm impedance were employed and terminated in the control box with a 4:1 balun on each. Measurements were made at the unbalanced side of the balun. The R part of the impedance was within 6 ohms of each other, and the j reactance within 6 ohms. For design purposes the difference was split and the resultant impedance used as the antenna design impedance. This is needed at two frequencies of course, one on 40M and one on 20M.

Next the delay RG6 was characterized and then the W6RMK spread sheet was loaded and set to work. The input phase was determined by the EZNEC models. The feedpoint impedance was within reason, although not perfect. Matching LC networks for 50 ohm coax were made easily enough, one for each band.

It took lots of fooling around to get the spreadsheets to spit out some acceptable solutions, but after much effort they did and there were two band acceptable feeding methods.

It is worth studying up on the Christman method and read W6RMK notes on the sheet carefully. You need to juggle the inputs to wind up with acceptable impedances to match what you measure in practice on the real antennas. Not a perfect solution, but it was hoped for something close enough to work.

The antenna:


VE1ZAC
40M and 20M Dual Loop Array
spaced 20 ft broadside
56 ft
56 ft
#14 stranded insulated elements
15 ft
13 ft shorted stub
15 ft
13 ft shorted stub
30+ ft elevation
4:1 balun
450 Ladder line
450 Ladder line
20M delay lines RG6 -85 deg phase
40M delay lines RG6 -220 deg phase
Switching & matching network KW rated
Outside control box
Common mode chokes
Ground rod
RG213 to shack & 4 cond cntrl to shack

A few construction notes:

The line lengths were cut from the RG6 and terminated in modified PL259's with a sleeve insert. (Cheap ones). Since the RG6 has an aluminum braid shield, the sleeve is bored to fit over the RG6 with braid folded back, tightly, and then gently crimp the sleeve. The center conductor can be soldered in the normal way. These will be left in place for the rest of the contest season to see how they fare. If they need replacing, RG8X with recalculated lengths will be employed. (Maybe next spring)

Controls: Potter & Brumfield open frame DPDT 24 DC relays are employed, with 3 needed to reverse direction and change the delay line-feeds between bands. It is intended to feed this antenna array with an amplifier and KW. Having a predatory compact tractor roaming around the property that seems to regularly destroy innocent transmission lines means all remote coax runs have to be encased in conduit. Getting a control line in same conduit for this system meant finding something with 4 conductors and a 250 mA capability that would fit with the coax. LED lighting extension line ribbon cable is economical and fits inside a ½" conduit with an RG213. There is less than a 0.5 volt drop at the control box, over the line.

Termination networks are created after the antennas are installed and the control box in place, with the appropriate delay lines hooked up. The Christman method predicts the feed point impedance but the NanoVNA and netbook computer was taken to the control box to measure the actual complex impedance of the array in both directions and on both bands. An L match was made for an impedance midway between the values. One for each band. They resulted in SWR's in the shack of less than 1.5. Satisfactory. Both antennas are physically a bit small for the desired frequencies. In a future version the element dimensions could be lengthened slightly, maybe 5%. However the match is good over a wide range and allows working the CW and SSB portions of the two bands.

The outside control box is a repurposed (rescued from trash) tool box. Mounted on a fence post set on the ground between the antennas, and terminations for the ladder lines made on the outside worked fine. The box makes it easy to work on the delay lines, relays or feedline terminations for each band.

Control box

The control box under the antenna feed lines.

The fence post has a piece of tubing attached to hold a golf umbrella for working on the guts on a hot day, or when shade is needed to see an instrument setup to make measurements. The delay – feed lines are coiled up underneath.

Inside control box

Box under antennas, with the "Service shelter"

(Antennas are very hard to photograph. Where is a drone when you need one ?)

How does it work ?

The antenna works! Not exactly according to the model but close.

On 40M, there is a decent front to back (F/B) of 3 S units or more on some signals, and 2 S units on others , all in the NE and SW directions. It is clearly not a low take off angle antenna. On air reports give RST reports of 53N and 55N with antenna reversed and forward. During the recent WAE contest the antenna performed admirably and allowed working everything in Europe that could be heard. When compared to the OCF dipole on 40M, signals were 4 to 5 S units stronger. CHU on 7850 KHz is 4 S units F/B all the time.

On 20M, the results are startling. The F/B on everything in the NE-SW direction is 4 S units or more. No QSO style RST reports yet but during the WAE contest the worked station performance was very good and only slightly (2 S units) off the Steppir beam when compared.

Overall, this thing actually works quite satisfactorily for directional array needs on 40M, and is better than expected on 20M. It works on CW and SSB portions of the bands. It is a keeper. It also contributes to backup contest antenna needs. Power of 800 watts was used during the WAE contest with no problems.

Requirements satisfied!

Early Spring time view of lake from shack windows

References:

- Christman method Excel worksheet: *Jim Lux, W6RMK, w6rmk@earthlink.net*
- eHam "superLoop" reviews: https://www.eham.net/reviews/view-product?id=2450
- RadioWorks Superloop description: *http://www.radioworks.com/csl40.html*
- (Note: Jim Thompson has retired)
- W8JI review of "Superloop": *https://www.w8ji.com/super%20miniloop.htm*
- Greg Ordy, W8WWV Delta Loop Array: *http://seed-solutions.com/gregordy/Amateur%20Radio/Experimentation/40%20Meter%20Delta%20Loop%20Array.htm*
- *Low Band DXing. 5th Edition. ON4UN John Develdore ARRL Publications*
- *EZNEC + V 6.0 W7EL https://www.eznec.com/*