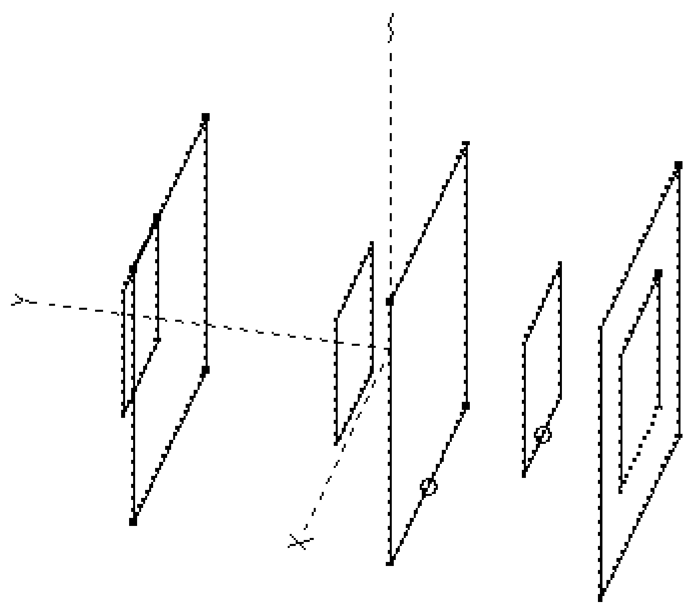
An 80/40 Quad Design

L. B. Cebik, W4RNL

The following design arranges a high-gain 3-element 80-meter (3.535-MHz design frequency) quad and a high-gain 4-element (7.04 MHz design frequency) quad in a concentric arrangement.



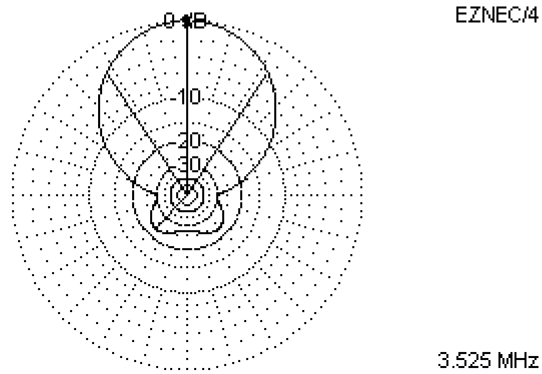
The sketch shows the element arrangement with the reflectors aligned. The 80-meter array is about 111' long, while the 40-meter array is about 118' long. The designs use AWG #12 copper wire.

At the design frequencies, we model the following performance with the quad centers at a height of 200' above average earth.

Freq.	Gain	TO Angle	F-B	Feed Z
3.525 MHz	13.6 dBi	18 deg.	27 dB	74 - j 5 Ohms
7.04 MHz	15.2 dBi	10 deg	27 dB	68 + j 6 Ohms

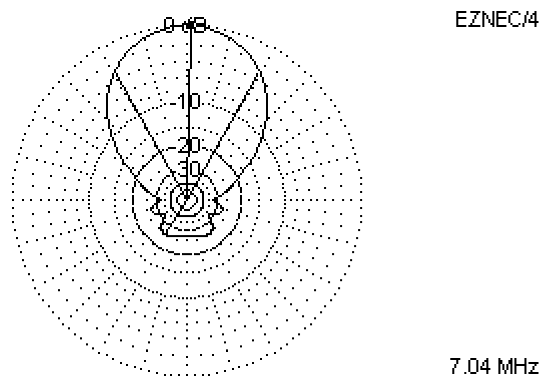
The gain remains essentially unchanged across the prescribed passbands of 3.50 - 3.55 MHz and 7.00 - 7.08 MHz. However, due to the thinness of the element diameters relative to a wavelength at these bands, the F-B ratio falls off by 9 to 10 dB between the design frequency and the passband edges.

The performance of the antenna can also be represented by sample azimuth patterns. Each pattern is taken at the TO angle listed in the performance table.



Azimuth Plot		Cursor Az	90.0 deg.
Elevation Angle	18.0 deg.	Gain	13.55 dBi
Outer Ring	13.55dBi		0.0 dBmax

Slice Max Gain	13.55 dBi @ Az Angle = 90.0 deg.
Front/Back	27.3 dB
Beamwidth	66.8 deg.; -3dB @ 56.6, 123.4 deg.
Sidelobe Gain	-9.35 dBi @ Az Angle = 227.0 deg.
Front/Sidelobe	22.9 dB



Azimuth Plot		Cursor Az	89.0 deg.
Elevation Angle	10.0 deg.	Gain	15.23 dBi
Outer Ring	15.23dBi		0.0 dBmax

Slice Max Gain	15.23 dBi @ Az Angle = 89.0 deg.
Front/Back	26.78 dB
Beamwidth	59.6 deg.; -3dB @ 60.2, 119.8 deg.
Sidelobe Gain	-9.78 dBi @ Az Angle = 236.0 deg.
Front/Sidelobe	25.01 dB

The patterns show that there is very little interaction between the two arrays, which are assumed to have separate feedlines.

The following table gives the dimensions of the array in the form of an EZNEC model file. Hence, each coordinate for a loop represents 1/2 of a loop's side. Each element is perfectly square, so one may simply multiple a horizontal loop limit coordinate by 8 to obtain the loop circumference.

EZNEC/4 ver. A4.0

3-EL 80/4-EL 40 quad #12 wire 12/14/02 8:04:03 AM

--------------- ANTENNA DESCRIPTION ---------------

Frequency = 7.04 MHz
Wire Loss: Copper -- Resistivity = 1.74E-08 ohm-m, Rel. Perm. = 1

--------------- WIRES ---------------

No.	End 1	Coord. (ft)			End 2	Coord. (ft)			Dia (in)	Segs
	Conn.	X	Y	Z	Conn.	X	Y	Z		
1	W4E2	-18.256	0	181.744	W2E1	18.2563	0	181.744	.080793	11
2	W1E2	18.2563	0	181.744	W3E1	18.2563	0	218.256	.080793	11
3	W2E2	18.2563	0	218.256	W4E1	-18.256	0	218.256	.080793	11
4	W3E2	-18.256	0	218.256	W1E1	-18.256	0	181.744	.080793	11
5	W8E2	-17.701	22.8429	182.299	W6E1	17.7014	22.8429	182.299	.080793	11
6	W5E2	17.7014	22.8429	182.299	W7E1	17.7014	22.8429	217.701	.080793	11
7	W6E2	17.7014	22.8429	217.701	W8E1	-17.701	22.8429	217.701	.080793	11
8	W7E2	-17.701	22.8429	217.701	W5E1	-17.701	22.8429	182.299	.080793	11
9	W12E2	-16.898	67.2014	183.102	W10E1	16.8984	67.2014	183.102	.080793	11
10	W9E2	16.8984	67.2014	183.102	W11E1	16.8984	67.2014	216.898	.080793	11
11	W10E2	16.8984	67.2014	216.898	W12E1	-16.898	67.2014	216.898	.080793	11
12	W11E2	-16.898	67.2014	216.898	W9E1	-16.898	67.2014	183.102	.080793	11
13	W16E2	-16.645	117.601	183.355	W14E1	16.6452	117.601	183.355	.080793	11
14	W13E2	16.6452	117.601	183.355	W15E1	16.6452	117.601	216.645	.080793	11
15	W14E2	16.6452	117.601	216.645	W16E1	-16.645	117.601	216.645	.080793	11
16	W15E2	-16.645	117.601	216.645	W13E1	-16.645	117.601	183.355	.080793	11
17	W20E2	-36.46	0	163.54	W18E1	36.4596	0	163.54	.080793	21
18	W17E2	36.4596	0	163.54	W19E1	36.4596	0	236.46	.080793	21
19	W18E2	36.4596	0	236.46	W20E1	-36.46	0	236.46	.080793	21
20	W19E2	-36.46	0	236.46	W17E1	-36.46	0	163.54	.080793	21
21	W24E2	-35.442	49.7029	164.558	W22E1	35.4418	49.7029	164.558	.080793	21
22	W21E2	35.4418	49.7029	164.558	W23E1	35.4418	49.7029	235.442	.080793	21
23	W22E2	35.4418	49.7029	235.442	W24E1	-35.442	49.7029	235.442	.080793	21
24	W23E2	-35.442	49.7029	235.442	W21E1	-35.442	49.7029	164.558	.080793	21
25	W28E2	-33.866	110.788	166.134	W26E1	33.8661	110.788	166.134	.080793	21
26	W25E2	33.8661	110.788	166.134	W27E1	33.8661	110.788	233.866	.080793	21
27	W26E2	33.8661	110.788	233.866	W28E1	-33.866	110.788	233.866	.080793	21
28	W27E2	-33.866	110.788	233.866	W25E1	-33.866	110.788	166.134	.080793	21

Total Segments: 428

-------------- SOURCES --------------

No.	Specified Pos.		Actual Pos.		Amplitude	Phase	Type
	Wire #	% From E1	% From E1	Seg	(V/A)	(deg.)	
1	5	50.00	50.00	6	1	0	V
2	21	50.00	50.00	11	0	0	V

No loads specified

No transmission lines specified

Ground type is Real, High-Accuracy

--------------- MEDIA ---------------

No.	Cond. (S/m)	Diel. Const.	Height (ft)	R Coord. (ft)
1	0.005	13	0	0

Wires 1-16 provide dimensions for the 40-meter quad, while lines 17-28 provide 80-meter dimensions.

If the builder desires to have the reflectors and the most forward directors aligned, one may simply move the 40-meter forward director back to the 110.788' mark. The result will decrease gain by 0.2 dB only, but the F-B will decrease by 9 dB. The feedpoint impedance will climb to 72 Ohms.

Moving the overall array up or down in height by 1/4 wavelength or so will have negligible effect on performance.

The arrays are designed essentially for a 70-Ohm feedline as a necessary consequence of using thin wire for the elements. It would take an element diameter of perhaps 2" to reduce the impedance to something closer to 50 Ohms. However, the 50-Ohm SWR should remain under 1.8:1 across the desired passband for both bands.

This design note presumes that the reader can translate the modeling information into construction detail of his or her choosing.