Antenna Interactions—Part 8
40 and 15-meter Yagis

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- Part 1 introduced meta-tools that give more comprehensive maps and statistics about antenna radiation patterns.[1]
- Part 2 applied those meta-tools to twisted stacked Yagis where the antennas point in different directions, identifying some problem situations that contesters may encounter.[2]
- Part 3 examined self-interactions of unused antennas within a stack. This part gave examples of siting problems in the design of a contesting station antenna farm but did not fully explore siting issues.[3]
- Part 4 introduced current tapering to clean up stack patterns.[4]
- Parts 5 through 7 identified impairments by identical antennas in each others' near fields.[5,6,7] These parts examined interactions between Yagi systems on the same band.

In this part we begin examining interactions between Yagi systems on the odd-harmonic related bands of 40 and 15 meters. Our goal: identify guidelines for minimizing undesired interactions between these systems.

40-Meter Yagi Stack

Of the HF contesting bands, 40-meter antennas may disrupt 15 meters because of the odd-harmonic relationship between the bands. Let's examine interactions between a two–Yagi stack on each of these bands.

This analysis uses K4JA's 40-meter

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[1]Notes appear on page 24.

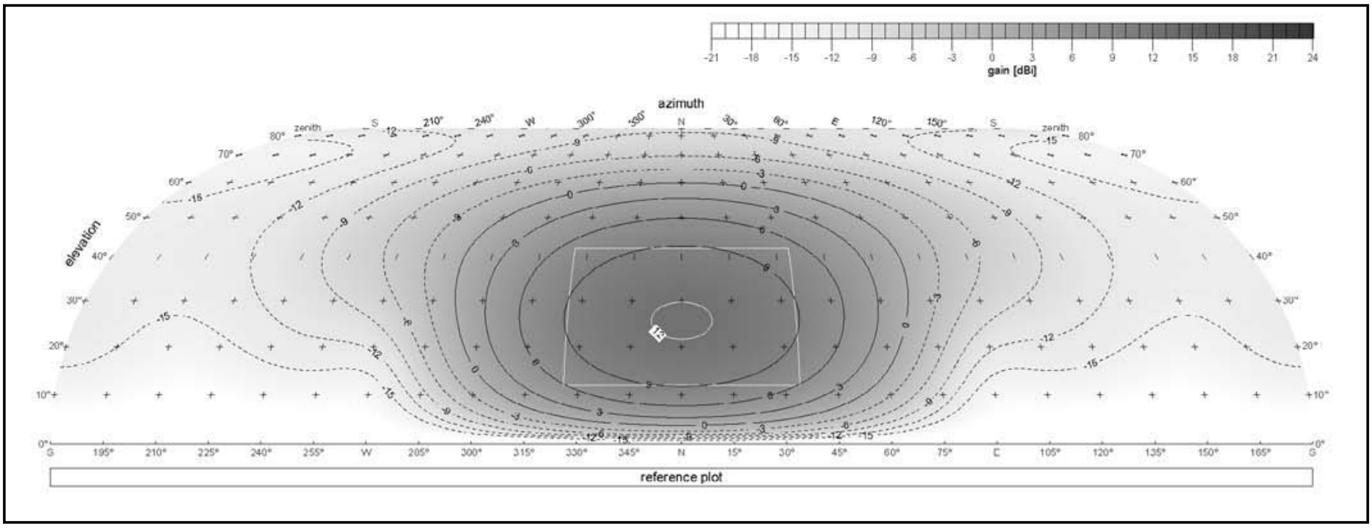

Figure 1—Map of gain for a single 40-meter 4-element OWA Yagi at ½ λ height.

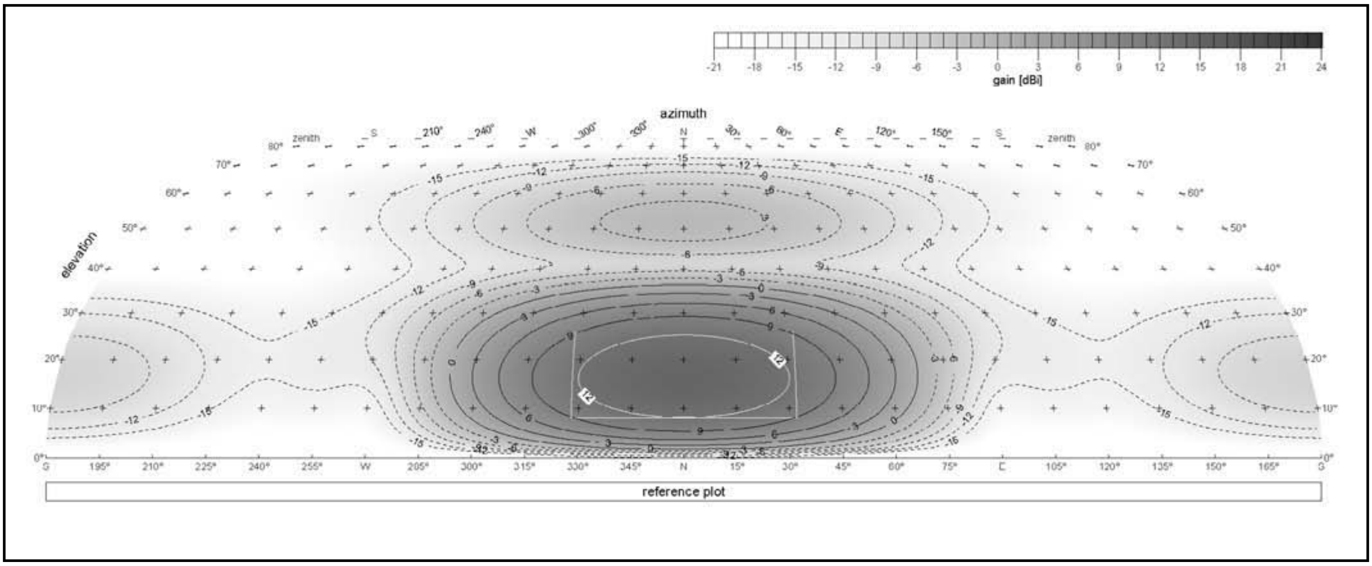

Figure 2—Map of gain for a stack of two 40-meter 4-element OWA Yagis standing at ½ and 1 λ height. Equal currents drive the antennas.

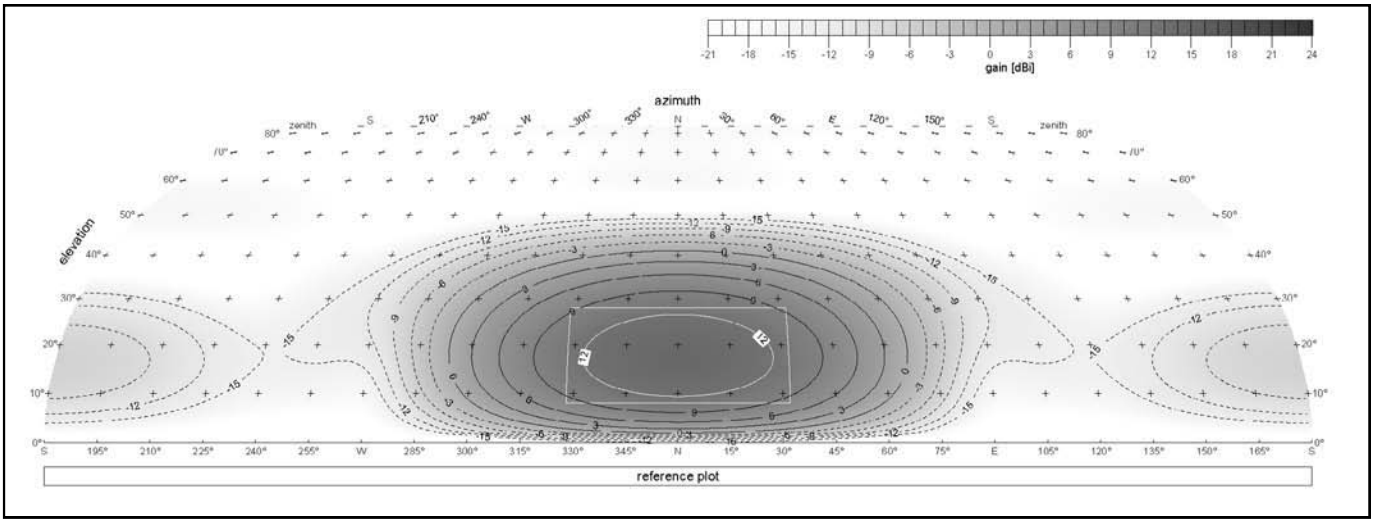

Figure 3—Map of gain for a stack of two 40-meter 4-element OWA Yagis standing at ½ and 1λ height. Unequal currents drive the antennas, with a ratio of 0.59 (top) to 1 (bottom).

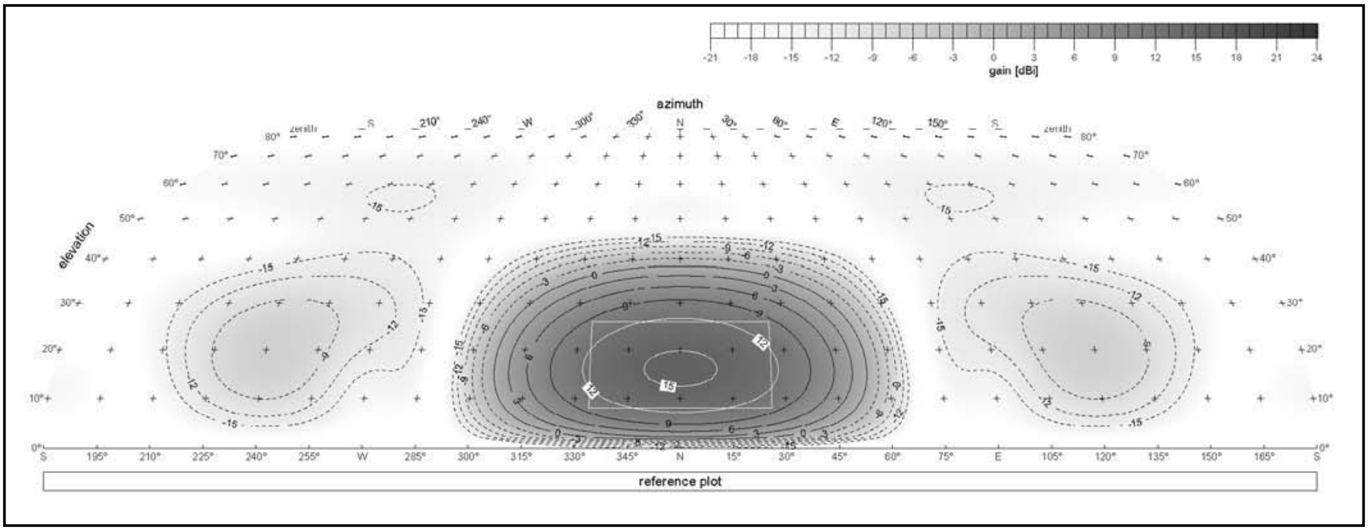

Figure 4—Map of gain for a stack of two 15-meter 6-element OWA Yagis standing at ½ and 1λ height. Unequal currents drive the antennas, with a ratio of 0.81 (top) to 1 (bottom).

OWA Yagi, a 4–element design on a 48 feet boom. Just 5 feet separates the two central elements, enough to straddle the tower mount. These two close-spaced elements characterize the OWA design, contributing to a uniform behavior over a broader range of frequencies.

Modeling this antenna requires some special considerations:

I used ON4UN's scaling utility[8] to convert the physical half-element design to an element of uniform diameter.

NEC-based modeling tools require closely spaced elements to have their segment boundaries aligned in order to generate stable, realistic results. I manually set the segment boundaries for the inner parts of all four elements at a uniform length to force alignment. Only the last one or two outer segments on each element vary in length; these segments carry relatively smaller currents and misalignment poses less risk.

In order to model the behavior of this antenna in both a 40 and 15-meter environment, I increased the element segmentation substantially. The reflector and driven element contain 41 segments. The first director contains 39 segments, and the second (front) director contains 37 segments. The inner 37 segments for all elements are identical at just under 20 inches. The additional segments for the longer elements range between about 21 and 26 inches, avoiding violation of the proscription against radical changes in segment size.

Figure 1 shows gain for a 40-meter Yagi standing ½λ in height modeled on 7.125MHz. This extremely clean pattern contains a main beam of +12.2dBi at 25° elevation. The half-power beamwidth of 64° in azimuth, lying between 12° and 42° elevation, is entirely reasonable for an antenna of this size. The only minor lobe, a vestigial rear area, peaks at just –13.8dBi.

Figure 2 maps the gain a two-Yagi 40-meter stack at ½ and 1λ heights (21.0 and 42.1m; 69 and 138 feet), fed with equal currents. The main lobe peaks at 15° elevation with +14.7dBi. The half-power beamwidth remains 64° in azimuth and spans 8–26° in elevation. A secondary lobe of –1.7dBi peaks above the main beam at 52° elevation. The only other minor lobe points to the rear with –6.9dBi.

Current tapering can improve this very good stack even further. Figure 3 maps the gain of the same stack with drive current ratios of 0.59 (top) to 1.00 (bottom).

Current tapering eliminates the secondary lobe, using that energy to round out the main beam into a slightly taller beam. The main beam peaks with +14.2dBi at 17° elevation. The half-power beamwidth spans 8–28° in elevation, an extra 2° taller. The rear minor lobe remains unchanged at –6.9dBi. This stack is very quiet; over 51% of the sky has gains below –15dBi. In fact, all elevation angles above 48° have gains below –15dBi, so you won't be using this stack to talk to your neighbor in the next town!

This is the first time in this series of articles that we've looked at current tapers for different sizes of Yagis in stacks. Note the optimum current taper ratio of 0.59:1 for this 4-element OWA stack differs considerably from the optimum 0.81:1 ratio for an identical stack employing 6-element OWA Yagis.

15-Meter Yagi Stack

Figure 4 maps the gain of the 15-meter stack used in this study. This stack contains two 6-element OWA Yagis on 32 feet booms. Each Yagi is a scaled version of the 20-meter band 6-element OWA Yagi design used in earlier articles of this series, using N6BV's *SCALE* utility program.[9] The Yagis stand at ½ and 1λ at the design frequency 21.175 MHz (7.0 and 14.1meters; 23.1 and 46.2 feet).

The model employs 17 to 21 segments per element, resulting in segment lengths between 10 and 14 inches. These segment sizes are sufficiently similar to those of the 40-meter Yagi to permit including both antennas in the same model for our analysis of interactions.

Unequal drive currents in the ratio 0.81 (top) to 1 (bottom) produce a main beam peak gain of 15.5dBi. The half-power beamwidth of 52° in azimuth is understandably narrower than that of the 40-meter stack. The half-power beamwidth elevation covers 8–26°, identical to that of the 40-meter system. Two minor lobes of –6.4dBi sit about 120° to either side of the main beam boresight. With 58% of the sky below –15dBi, this stack is clean and quiet.

Now let's see how the presence of an unused 40-meter stack affects this 15-meter stack. While examining impairments between antennas on the same band in earlier articles, we learned the most severe impairments occur when the two antenna systems point in opposite directions. Let's use that same orientation for today's study.

Influence of the Unused 40-meter Stack

Table A summarizes 15-meter pattern parameters and impairments caused by the unused 40-meter stack. The 40-meter feedpoints are open-circuited.

The first row of the table gives performance parameters for the 15-meter stack alone (no 40-meter antennas present). The columns in this table represent,

Table A

Performance parameters for the 15-meter stack and impairments caused by a nearby unused 40-meter stack. The 15-meter stack points to 180°; the 40-meter stack points to 0°. See text for an explanation of column entries.

15m loc		target #1									non-target										
dist	dir	peak gain			median gain		minimum gain		largest		median gain		worst minor lobe			largest		%sky <-15 dBi		feedpoint impedanc	
λ	°	dBi	location	delta	dBi	delta	dBi	delta	decr	incr	dBi	delta	dBi	location	delta	decr	incr		change	top	botto
no 40m		15.46	az 180° el 15°		13.67		9.94				floor		-6.42	az 298° el 19°				57.5%		26.9 -*j* 10.1	26.9 -*j* 1
0.0	0°	15.53	az 180° el 15°	0.07	13.66	-0.01	9.80	-0.14	-0.36	0.23	floor	0.00	-6.18	az 297° el 22°	0.24	-3.26	5.13	43.0%	-14.5%	26.4 -*j* 8.7	27.1 -*j* 1
0.5	0°	15.51	az 181° el 15°	0.05	13.62	-0.05	9.76	-0.18	-0.58	0.13	-13.87	1.13	-4.63	az 180° el 42°	1.79	-6.23	8.84	32.3%	-25.2%	23.9 -*j* 8.2	28.3 -*j* 1
1.0	0°	15.51	az 180° el 15°	0.05	13.61	-0.06	9.58	-0.36	-1.01	0.33	-12.93	2.07	-2.21	az 302° el 11°	4.21	-7.85	11.87	28.1%	-29.4%	21.2 -*j* 11.8	27.8 -*j*
2.0	0°	15.43	az 181° el 16°	-0.03	13.55	-0.12	9.01	-0.93	-2.13	1.12	-11.45	3.55	0.68	az 307° el 27°	7.10	-7.88	15.53	22.6%	-34.9%	27.1 -*j* 14.3	22.8 -*j* 1
4.0	0°	15.03	az 196° el 15°	-0.43	13.33	-0.34	9.16	-0.78	-3.08	1.25	-11.96	3.04	2.21	az 309° el 26°	8.63	-8.41	15.77	26.1%	-31.4%	30.7 -*j* 11.7	29.2 -*j* 1
8.0	0°	15.06	az 196° el 15°	-0.40	13.26	-0.41	9.44	-0.50	-1.97	1.28	-13.23	1.77	0.96	az 310° el 13°	7.38	-8.35	12.95	31.5%	-26.0%	26.2 -*j* 9.2	26.1 -*j* 1
16.0	0°	15.33	az 184° el 17°	-0.13	13.71	0.04	9.65	-0.29	-0.47	0.47	floor	0.00	-4.00	az 57° el 16°	2.42	-6.43	8.00	47.5%	-10.0%	27.0 -*j* 9.9	26.9 -*j* 1
28.0	0°	15.57	az 181° el 16°	0.11	13.65	-0.02	9.87	-0.07	-0.19	0.16	floor	0.00	-5.82	az 300° el 16°	0.60	-3.24	4.36	55.2%	-2.3%	26.9 -*j* 10.1	26.9 -*j* 1
32.0	0°	15.55	az 181° el 15°	0.09	13.68	0.01	9.91	-0.03	-0.14	0.13	floor	0.00	-6.03	az 298° el 16°	0.39	-2.99	3.39	55.8%	-1.7%	26.9 -*j* 10.1	26.9 -*j* 1
64.0	0°	15.46	az 180° el 15°	0.00	13.68	0.01	9.93	-0.01	-0.04	0.04	floor	0.00	-6.41	az 61° el 19°	0.01	-1.08	1.15	57.3%	-0.2%	26.9 -*j* 10.1	26.9 -*j* 1
20.0	15°	15.57	az 167° el 15°	0.11	13.67	0.00	9.93	-0.01	-0.29	0.25	floor	0.00	-5.96	az 58° el 15°	0.46	-3.39	4.30	54.8%	-2.7%	26.9 -*j* 10.1	26.9 -*j* 1
30.0	15°	15.52	az 180° el 15°	0.06	13.68	0.01	9.94	0.00	-0.12	0.16	floor	0.00	-6.32	az 61° el 18°	0.10	-1.92	2.41	56.9%	-0.6%	26.9 -*j* 10.1	26.9 -*j* 1
40.0	15°	15.48	az 181° el 16°	0.02	13.67	0.00	9.94	0.00	-0.06	0.09	floor	0.00	-6.39	az 60° el 20°	0.03	-1.30	1.36	57.2%	-0.3%	26.9 -*j* 10.1	26.9 -*j* 1
0.5	30°	15.52	az 180° el 15°	0.06	13.65	-0.02	9.58	-0.36	-0.46	0.26	-14.28	0.72	-4.38	az 240° el 12°	2.04	-5.57	8.39	35.1%	-22.4%	24.2 -*j* 11.0	27.6 -*j* 1
1.0	30°	15.57	az 181° el 15°	0.11	13.71	0.04	8.99	-0.95	-0.95	0.54	-14.32	0.68	-3.13	az 44° el 28°	3.29	-6.64	9.95	36.5%	-21.0%	28.5 -*j* 12.5	25.7 -*j* 1
2.0	30°	15.63	az 179° el 15°	0.17	13.71	0.04	8.55	-1.39	-1.39	0.52	floor	0.00	-1.61	az 45° el 27°	4.81	-7.85	12.86	41.2%	-16.3%	27.7 -*j* 10.2	26.9 -*j* 1
4.0	30°	15.66	az 173° el 15°	0.20	13.65	-0.02	7.70	-2.24	-2.24	0.55	floor	0.00	-0.57	az 42° el 12°	5.85	-8.05	12.69	42.3%	-15.2%	27.3 -*j* 9.7	27.3 -*j* 1
8.0	30°	15.63	az 182° el 15°	0.17	13.70	0.03	8.89	-1.05	-1.27	0.67	floor	0.00	-2.57	az 49° el 13°	3.85	-7.92	10.41	46.2%	-11.3%	26.7 -*j* 10.1	26.8 -*j* 1
16.0	30°	15.54	az 180° el 15°	0.08	13.68	0.01	9.99	0.05	-0.37	0.35	floor	0.00	-5.33	az 305° el 15°	1.09	-4.60	5.32	54.2%	-3.3%	26.9 -*j* 10.0	26.9 -*j* 1
32.0	30°	15.47	az 179° el 15°	0.01	13.67	0.00	9.86	-0.08	-0.08	0.09	floor	0.00	-6.27	az 299° el 17°	0.15	-1.94	2.30	57.0%	-0.5%	26.9 -*j* 10.1	26.9 -*j* 1
64.0	30°	15.48	az 180° el 15°	0.02	13.68	0.01	9.95	0.01	-0.02	0.02	floor	0.00	-6.40	az 298° el 20°	0.02	-0.71	0.76	57.2%	-0.3%	26.9 -*j* 10.1	26.9 -*j* 1
0.5	60°	15.46	az 181° el 15°	0.00	13.68	0.01	9.45	-0.49	-0.49	0.36	floor	0.00	-4.65	az 240° el 10°	1.77	-5.46	6.08	41.8%	-15.7%	28.6 -*j* 10.4	26.3 -*j* 1
1.0	60°	15.33	az 181° el 16°	-0.13	13.70	0.03	9.59	-0.35	-0.37	0.38	floor	0.00	-1.58	az 53° el 16°	4.84	-7.48	10.93	44.4%	-13.1%	26.8 -*j* 11.2	26.7 -*j* 1
2.0	60°	15.62	az 182° el 15°	0.16	13.67	0.00	9.47	-0.47	-0.47	0.39	floor	0.00	-2.36	az 49° el 15°	4.06	-7.43	9.33	51.1%	-6.4%	26.8 -*j* 9.4	27.3 -*j* 1
4.0	60°	15.57	az 183° el 15°	0.11	13.66	-0.01	9.91	-0.03	-0.29	0.31	floor	0.00	-4.41	az 52° el 13°	2.01	-5.91	6.96	54.5%	-3.0%	26.8 -*j* 10.1	26.8 -*j* 1
8.0	60°	15.50	az 183° el 15°	0.04	13.69	0.02	9.87	-0.07	-0.14	0.14	floor	0.00	-5.75	az 60° el 23°	0.67	-4.01	3.13	56.9%	-0.6%	26.9 -*j* 10.1	26.9 -*j* 1
16.0	60°	15.47	az 178° el 15°	0.01	13.67	0.00	9.91	-0.03	-0.04	0.03	floor	0.00	-6.36	az 61° el 18°	0.06	-1.00	1.17	57.3%	-0.2%	26.9 -*j* 10.1	26.9 -*j* 1
0.5	90°	15.35	az 181° el 16°	-0.11	13.61	-0.06	9.80	-0.14	-0.19	0.06	floor	0.00	-3.85	az 54° el 12°	2.57	-7.28	8.38	51.3%	-6.2%	25.7 -*j* 9.3	27.3 -*j* 1
1.0	90°	15.38	az 182° el 15°	-0.08	13.66	-0.01	9.89	-0.05	-0.27	0.21	floor	0.00	-4.71	az 64° el 25°	1.71	-6.38	9.38	53.4%	-4.1%	26.2 -*j* 10.2	27.1 -*j* 1
1.5	90°	15.53	az 180° el 15°	0.07	13.65	-0.02	9.84	-0.10	-0.14	0.17	floor	0.00	-5.68	az 61° el 24°	0.74	-5.26	4.99	54.6%	-2.9%	27.1 -*j* 10.0	26.9 -*j* 1
2.0	90°	15.44	az 179° el 15°	-0.02	13.69	0.02	9.91	-0.03	-0.09	0.10	floor	0.00	-6.16	az 61° el 22°	0.26	-3.14	3.37	57.9%	0.4%	26.9 -*j* 10.0	26.9 -*j* 1
2.5	90°	15.47	az 181° el 15°	0.01	13.68	0.01	9.93	-0.01	-0.07	0.05	floor	0.00	-6.17	az 302° el 23°	0.25	-1.98	2.78	57.5%	0.0%	26.9 -*j* 10.1	26.9 -*j* 1
5.0	90°	15.47	az 180° el 15°	0.01	13.68	0.01	9.95	0.01	-0.03	0.03	floor	0.00	-6.40	az 298° el 16°	0.02	-0.92	1.53	57.1%	-0.4%	26.9 -*j* 10.1	26.9 -*j* 1
0.5	120°	15.43	az 180° el 15°	-0.03	13.68	0.01	9.77	-0.17	-0.17	0.17	floor	0.00	-5.95	az 297° el 21°	0.47	-2.19	4.04	49.0%	-8.5%	26.9 -*j* 10.4	26.9 -*j* 1
1.0	120°	15.40	az 181° el 16°	-0.06	13.65	-0.02	9.91	-0.03	-0.22	0.17	floor	0.00	-5.48	az 55° el 13°	0.94	-5.63	6.46	57.7%	0.2%	26.9 -*j* 10.1	26.9 -*j* 1
2.0	120°	15.47	az 181° el 15°	0.01	13.67	0.00	9.92	-0.02	-0.07	0.07	floor	0.00	-5.85	az 298° el 23°	0.57	-3.52	2.37	58.2%	0.7%	26.9 -*j* 10.0	26.9 -*j* 1
4.0	120°	15.44	az 182° el 15°	-0.02	13.68	0.01	9.95	0.01	-0.08	0.09	floor	0.00	-5.68	az 293° el 23°	0.74	-2.50	2.98	55.9%	-1.6%	26.9 -*j* 10.1	26.9 -*j* 1
8.0	120°	15.48	az 178° el 15°	0.02	13.69	0.02	9.91	-0.03	-0.06	0.05	floor	0.00	-6.12	az 298° el 16°	0.30	-1.38	1.64	56.3%	-1.2%	26.9 -*j* 10.1	26.9 -*j* 1
16.0	120°	15.47	az 180° el 15°	0.01	13.69	0.02	9.93	-0.01	-0.01	0.01	floor	0.00	-6.39	az 299° el 20°	0.03	-0.78	0.70	57.2%	-0.3%	26.9 -*j* 10.1	26.9 -*j* 1
0.5	150°	15.43	az 180° el 15°	-0.03	13.68	0.01	9.77	-0.17	-0.17	0.17	floor	0.00	-5.95	az 297° el 21°	0.47	-2.23	4.07	49.0%	-8.5%	26.9 -*j* 10.4	26.9 -*j* 1
1.0	150°	15.46	az 180° el 15°	0.00	13.68	0.01	9.85	-0.09	-0.09	0.14	floor	0.00	-6.56	az 299° el 21°	-0.14	-3.59	3.32	57.0%	-0.5%	26.9 -*j* 10.1	26.9 -*j* 1
2.0	150°	15.47	az 180° el 15°	0.01	13.69	0.02	9.92	-0.02	-0.05	0.06	floor	0.00	-5.96	az 298° el 22°	0.46	-2.48	1.74	55.5%	-2.0%	26.9 -*j* 10.1	26.9 -*j* 1
4.0	150°	15.45	az 180° el 15°	-0.01	13.69	0.02	9.91	-0.03	-0.05	0.03	floor	0.00	-6.19	az 296° el 15°	0.23	-1.81	1.11	57.5%	0.0%	26.9 -*j* 10.1	26.9 -*j* 1
8.0	150°	15.46	az 180° el 15°	0.00	13.67	0.00	9.91	-0.03	-0.03	0.03	floor	0.00	-6.33	az 298° el 17°	0.09	-1.25	0.68	57.4%	-0.1%	26.9 -*j* 10.1	26.9 -*j* 1
16.0	150°	15.46	az 180° el 15°	0.00	13.68	0.01	9.94	0.00	-0.01	0.01	floor	0.00	-6.42	az 297° el 15°	0.00	-0.29	0.28	57.4%	-0.1%	26.9 -*j* 10.1	26.9 -*j* 1
24.0	150°	15.46	az 180° el 15°	0.00	13.68	0.01	9.94	0.00	-0.01	0.01	floor	0.00	-6.42	az 298° el 19°	0.00	-0.13	0.14	57.4%	-0.1%	26.9 -*j* 10.1	26.9 -*j* 1
0.5	180°	15.57	az 180° el 15°	0.11	13.71	0.04	9.95	0.01	-0.24	0.24	floor	0.00	-6.45	az 300° el 16°	-0.03	-5.59	5.49	55.3%	-2.2%	27.2 -*j* 9.8	26.8 -*j* 1
1.0	180°	15.42	az 181° el 16°	-0.04	13.64	-0.03	9.89	-0.05	-0.14	0.11	floor	0.00	-6.74	az 298° el 19°	-0.32	-2.77	1.62	59.1%	1.6%	26.9 -*j* 10.2	26.9 -*j* 1
2.0	180°	15.43	az 180° el 15°	-0.03	13.70	0.03	9.94	0.00	-0.04	0.04	floor	0.00	-6.38	az 298° el 20°	0.04	-0.93	0.79	57.2%	-0.3%	26.9 -*j* 10.1	26.9 -*j* 1
4.0	180°	15.45	az 179° el 16°	-0.01	13.69	0.02	9.93	-0.01	-0.03	0.02	floor	0.00	-6.42	az 300° el 20°	0.00	-0.50	0.69	57.4%	-0.1%	26.9 -*j* 10.1	26.9 -*j* 1
8.0	180°	15.48	az 180° el 15°	0.02	13.68	0.01	9.92	-0.02	-0.02	0.03	floor	0.00	-6.42	az 300° el 20°	0.00	-0.55	0.48	57.4%	-0.1%	26.9 -*j* 10.1	26.9 -*j* 1

from left to right:

- Location of the 15-meter stack relative to the 40-meter stack; e.g., 1 λ at 0° means the 15-meter antenna stands one wavelength in front of the 40-meter stack. "Wavelength" here always refers to wavelengths on the transmitting band (15 meters). The unused 40-meter Yagis always point to 0° azimuth. The 15-meter Yagis always point to 180°.
- Peak gain of the 15-meter stack, its azimuth and elevation, and the impairment to peak gain (change in peak gain caused by the presence of the unused 40-meter stack).
- Median gain over the target zone, and the impairment to median gain. The target zone here equates to the half-power beamwidth in azimuth and elevation.
- Minimum gain within the target zone, and the impairment to that minimum gain. Since no antenna fills a target zone uniformly, we want to know if impairments exist to the least well-served part of the target.
- Largest spot increase in gain, and largest spot decrease in gain, within the target zone. "Spot gain" refers to the gain in a specific direction (azimuth and elevation). A significant change in the gain in any one direction would be an undesirable interaction, even if the overall pattern averaged out to the same level of gain.
- Median gain outside of the main beam, and impairment to that median gain. A well-designed antenna has little sensitivity outside of its main beam; any increase in median gain indicates impaired performance. An entry of "floor" here means the median gain is less than the floor threshold of 15dBi.
- Worst (highest gain) minor lobe outside the main beam, its location, and the impairment (increase in gain of the worst minor lobe).
- Largest spot increase in gain, and largest spot decrease in gain, outside the main beam.
- Portion of the sky hemisphere with gain of < 15dBi (quiet regions of reduced QRM and QRN), and impairment to that portion.
- Feedpoint Impedance

The table reveals that the 40-meter stack introduces significant impairments to the 15-meter stack's pattern, about as severe as those introduced by another 15-meter Yagi system.

The unused 40-meter stack introduces tiny variations to main beam peak and median gain of no operational significance. However, at specific azimuths and elevations the unused antennas reduce spot gain in the main beam as much as –3.1dB. The largest reductions do not occur when the two systems are closest. The worst impairments to portions of the main beam occur when the two systems point towards each other over a broad region around a separation of about 4λ on 21MHz (96m, 320 feet).

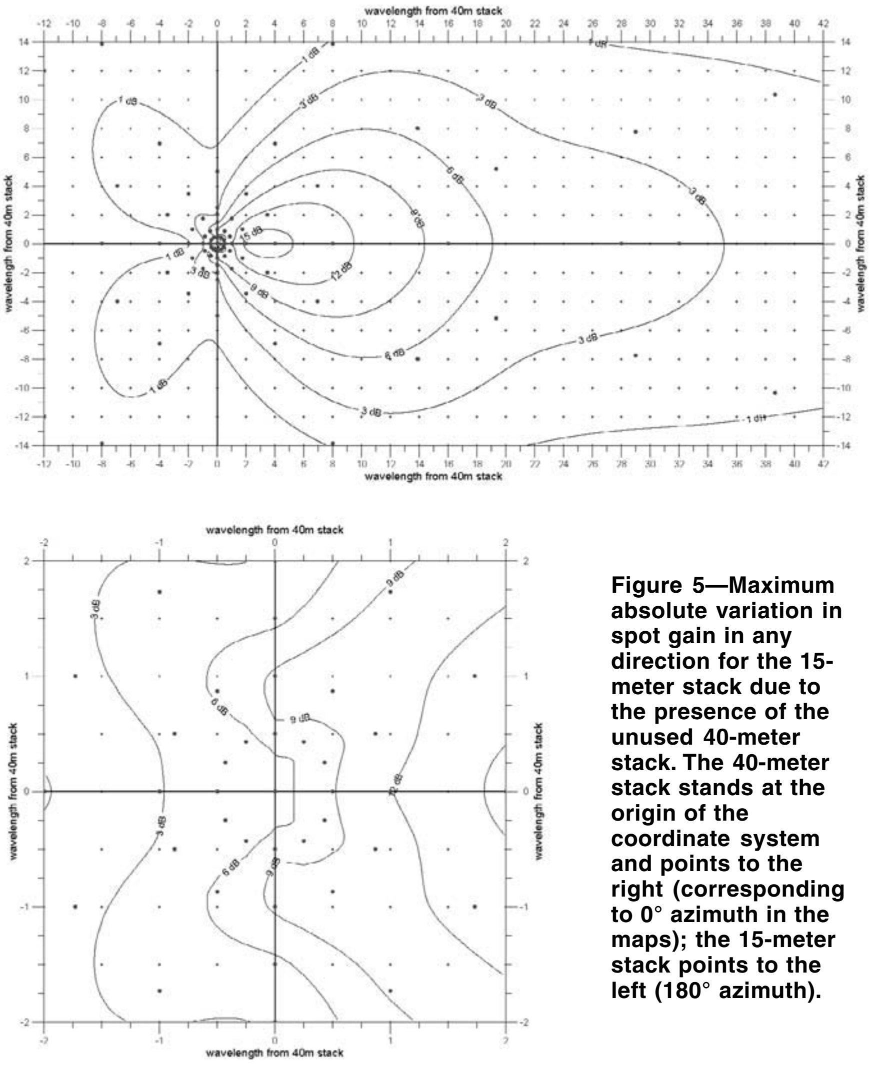

Figure 5—Maximum absolute variation in spot gain in any direction for the 15-meter stack due to the presence of the unused 40-meter stack. The 40-meter stack stands at the origin of the coordinate system and points to the right (corresponding to 0° azimuth in the maps); the 15-meter stack points to the left (180° azimuth).

In this same region the main beam boresight deviates right or left of its intended direction. While the table lists deviations up to ±16°, an examination of the underlying patterns shows these deviations have no operational significance. Minor variations in spot gain cause the shift in location of peak gain occurs, a "roughing up" of the gain pattern. (This variation differs from those seen in earlier articles, where unused antennas pulled the main beam off to one side.)

Outside the main beam, the unused 40-meter stack clutters up the sky with new minor lobes and interference patterns. The worst occur in the same area of largest impairments to the main beam.

Figure 5 maps out the largest spot change outside of the main beam as a function of the location of the 15-meter stack relative to the unused 40-meter antennas. Not surprisingly, the worst spot changes occur where the stacks point toward each other, and one requires an enormous separation (over 1km) to reduce these spot changes to below 1dB.

Much closer separations yield continued excellent performance when the 15-meter stack stands above, below and to the left of behind the 40-meter stack, as oriented in the Figure. Closer examination of the underlying patterns indicates the table somewhat overstates the separation requirements to maintain a clean pattern. With these locations, many of the spot pattern changes occur in areas of the sky with relatively low gain (around –10dBi). As long as the worst minor lobe remains below about –6dBi, and the percent of sky with below –15dBi remains above 55%, the 15-meter stack performs excellently in the presence of the unused 40-meter system. The table gives you quite a large range of potential sites meeting these goals.

Of course, if either the 15 or 40-meter stacks can rotate, then site selection must consider other relative orientations of the antennas. The table does not include those calculations. We have not yet examined the impact of an unused 15-meter stack on the 40-meter stack, either. Next time we will look at those two cases.

Summary

- An unused 40-meter stack can introduce significant impairments to the pattern of a 15-meter stack.
- The magnitude of impairment depends on the relative locations of the stacks.
- The range of relative locations over which impairments occur for these odd-harmonic related bands appears to be similar in size to the range of relative locations for which unused stacks on the same band cause impairments.
- The optimum current taper ratio for a "short" two-Yagi stack using 4-element OWA Yagis is about 0.6:1 (top:bottom). This differs from the optimum ratio of about 0.8:1 for a short two-Yagi stack using 6-element OWA Yagis. This result suggests that Yagis of different sizes may require a different current taper ratio to minimize minor lobes.

Erratum for Part 7

Part 7 Figure 3 as published in the paper edition of *NCJ* erroneously duplicated Figure 2. The PDF version of the article on the *NCJ* Web site **www.ncjweb.com** contains the correct figure.

Notes

[1] Scace, Eric K3NA; "Antenna Interactions—Part 1: Stop Squinting! Get the Big Picture", *National Contest Journal*, 2003 Jul/Aug; ARRL, Newington, CT USA.

[2] Scace, Eric K3NA; "Antenna Interactions—Part 2: Twisting Stacks", *National Contest Journal*, 2003 Sep/Oct; ARRL, Newington, CT USA.

[3] Scace, Eric K3NA; "Antenna Interactions—Part 3: When Good Aluminum Goes Bad", *National Contest Journal*, 2003 Nov/Dec; ARRL, Newington, CT USA.

[4] Scace, Eric K3NA; "Antenna Interactions—Part 4: Cleaning Up Stacked Yagis with Current Tapers", *National Contest Journal,* 2004 Jan/Feb; ARRL, Newington, CT USA.

[5] Scace, Eric K3NA; "Antenna Interactions—Part 5: How Close is Too Close?", *National Contest Journal,* 2004 Mar/Apr; ARRL, Newington, CT USA.

[6] Scace, Eric K3NA; "Antenna Interactions—Part 6: Antennas Pointing in the Same Direction", *National Contest Journal,* 2004 Jul/Aug; ARRL, Newington, CT USA.

[7] Scace, Eric K3NA; "Antenna Interactions—Part 7: Antennas Pointing in Opposite Directions", *National Contest Journal,* 2005 Jul/Aug; ARRL, Newington, CT USA.

[8] Devoldere, John ON4UN; *Low-Band DXing;* 4th edition; ARRL, Newington, CT USA.

[9] Straw, Dean N6BV; *ARRL Antenna Book CD-ROM Edition 2.0;* ARRL, Newington, CT USA.