Rx antennas at IV3PRK: <u>the 4-Square Rx Vertical Array</u>

Part 1: EZNEC modeling and the array design

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After long studies and modelling with Flags and Pennants phasing, followed by not so satisfying results in the real world, I decided to go back to the phased verticals Rx arrays.

In 1994 I had built a very difficult one: the 4-square mini-phased array by K9UWA-KD9SV-W7EL design (ARRL Antenna Compendium Vol.3) and that has been my best receiving antenna for almost 10 years. But it was very critical, due to the high Q of the vertical dipole elements (inductance loaded, rather than resistance), too much WX dependent, and required a lot of maintenance with inductors rebuilding and toroids substitutions. I think I was the only one in the world to be still using successfully that Rx antenna, but even one of the authors, Gary KD9SV, suggested me to update to the new concept of verticals phasing developed by Tom, W8JI.

<u>The single element</u>

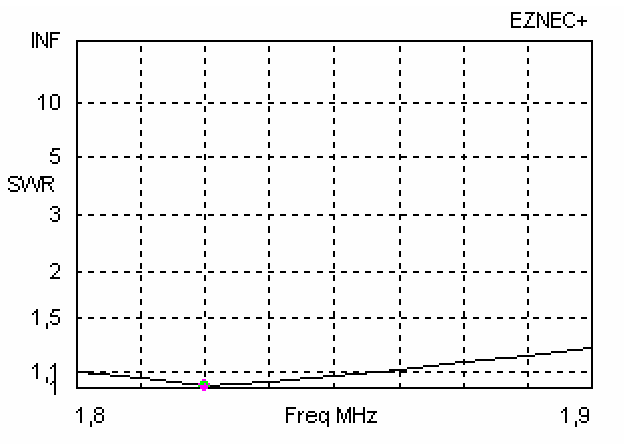
From the original RXvrhat W8JI design downloaded from http://www.w8ji.com I modified with Eznec+5 the basic element in order to use all the aluminium tubes of my old 4-square array.

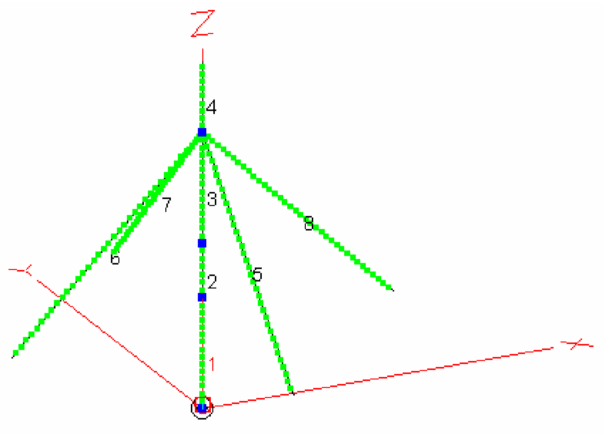
EZNEC Models	wires	segments	Gain	Avg.gain	RDF	Load R	Load X	Source R.	Source X
Original W8JI									
El. 7,62 m. all wires #16	5	250	- 16,35	- 21,21	4,86	73	336	74,75	- 0,80
Single el. mod. IV3PRK									
El. 6,00 m. (d.25/2,5mm)	5	150	- 17,89	- 22,75	4,86	73	414	73,86	- 0,03
El. 7,62 m. (wires 25/2mm.)	5	150	- 16,65	- 21,51	4,86	73	318	74,16	- 0,10
El. 7,5m (d.35/25/20 /2 mm.)	7	185	- 16,76	- 21,63	4,87	73	308	74,10	0,26
El. 9,5m. (+2 m.tip d.12 mm.)	8	195	- 16,37	- 21,22	4,85	73	296	74,19	0,30

I put also the element tips above the top hat radials, reaching a total high of 9.5 meters, to get more gain (sensitivity) and trying to further decrease the inductive part of load for the lowest Q of the antenna.

Element diameter is tapering from 35 to 25 and to 20 mm. with the tips being of 12 mm. tube.

Top hat wires are 7.5 meter long and come down at 2.25 m. level. The loads are 73 ohms of resistance and 296 ohms XL, thus a low Q of 4 which allows the desirable 1:1 SWR for a stable phasing on the narrow frequency band of my interest.



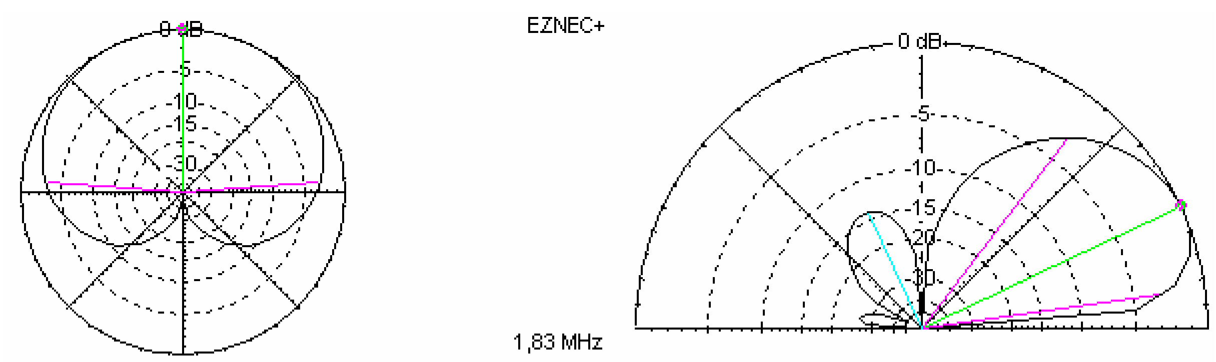


<u>Two elements end-fire</u>

The typical cardioid pattern in a two elements end-fire array results with a 90 degrees separation plus 90 degrees of phasing. So I started with this configuration putting a copy of the single element vertical at a distance of 42 meters and the following are the tabulated results of some Eznec runnings.

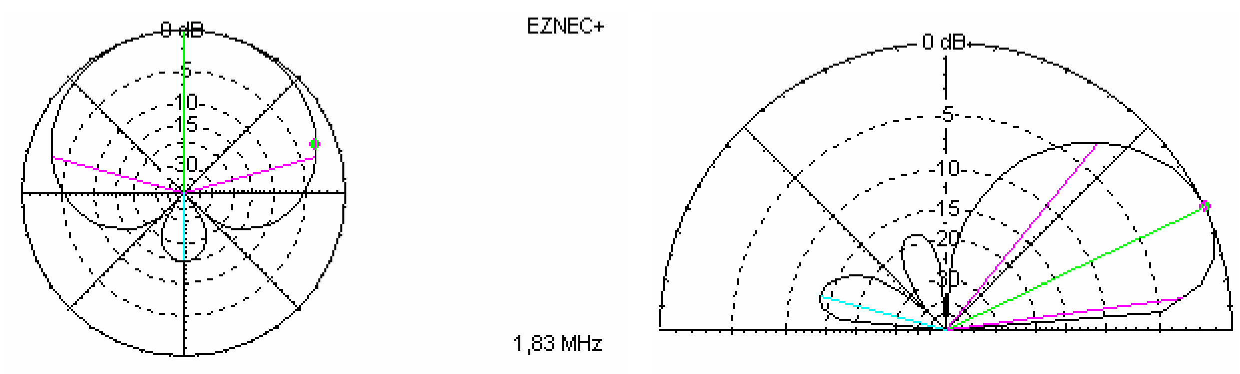
EZNEC Models	Phasing	Gain	TO angle	BW	FB	Avg.gain	RDF	Back lobe	Null angle
Rxvert_2	-80	-13,36	25	192	16	-20,82	7,46	55	90
Wires 16 - segments 390	-85	-13,36	25	186	21	-21,02	7,66	60	90
Minimec ground	-90	-13,37	25	179	27	-21,28	7,91	60	90
2 elements end-fire	**-95**	**-13,40**	**25**	**172**	**51**	**-21,50**	**8,10**	**65**	**20**
42 m. separation	-100	-13,44	25	166	28	-21,69	8,25	65	30
	-105	-13,5	25	162	21	-21,94	8,44	65	36
	-110	-13,57	25	156	18	-22,19	8,62	25	41
Best Null angle =>	**-115**	**-13,67**	**25**	**151**	**15**	**-22,46**	**8,79**	**15**	**45**
	-120	-13,81	25	145	13	-22,73	8,92	15	50
	-125	-13,91	25	141	12	-23,00	9,09	15	54
	-130	-14,06	25	136	10	-23,27	9,21	15	60
	-135	-14,23	25	131	9	-23,54	9,31	20	70
	-140	-14,42	25	127	7	-23,80	9,38	20	75
	-145	-14,63	25	123	6	-24,06	9,43	20	80

At 95 degrees phasing we get a beautiful pattern with 50 dB of front to back, but if we look at the elevation plot we see a not desirable secondary high angle lobe.



Two vertical elements – ¼ wave separation – 95 degrees phasing

In my situation it is most desirable to get a better RDF and to reduce the high angle QRM from other European stations. On 160 meters the arrival angle of the stations at 500 km. distance is about 45 degrees, so that's where we must put the "Null". With 115° phasing the main secondary lobe goes down to a low angle, but we get a wide null between 30° and 60° for a deep reduction of the back signals coming from about 200 km. to 800 km. Also the main -3dB beamwidth is reduced from 172 to 151 degrees with an improvement in the RDF.

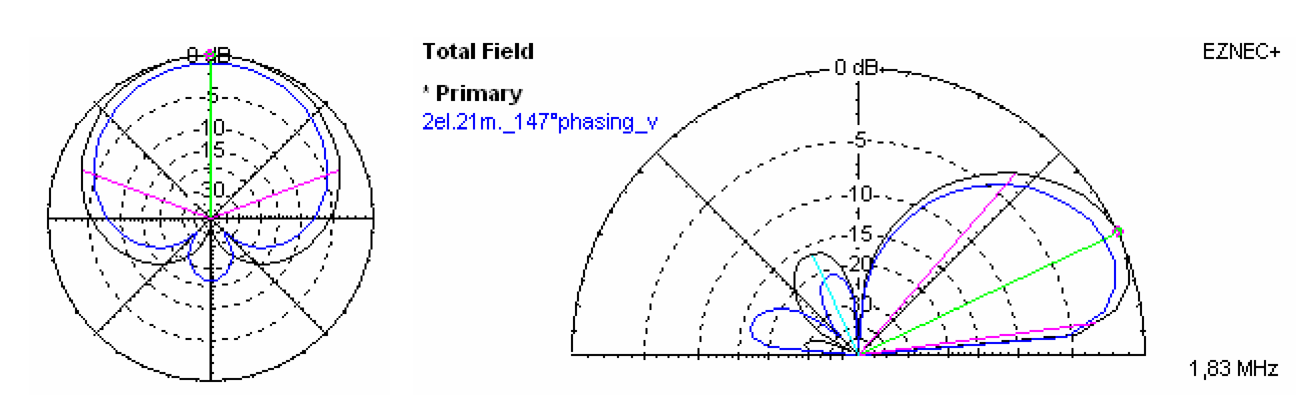


Two vertical elements – ¼ wave separation – 115 degrees phasing

The next step has been to reduce the distance between those elements to 21 meters, i.e. 1/8 wavelength, which does not work with TX antennas due to the mutual coupling, but has been already successfully used (even small spacing) with all kinds of resistance loaded receiving antennas. After reducing the distance from 42 m. to 21 m., the gain drops by about 3 dB, but the beamwidth also is narrower and that produces a better RDF.

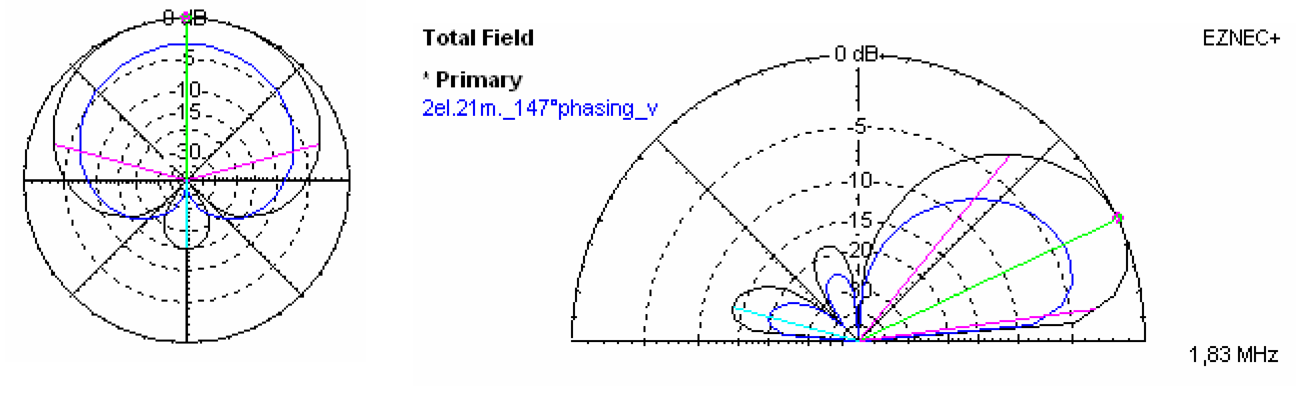
EZNEC Models	Phasing	gain	TO angle	BW	FB	Avg.gain	RDF	Back lobe	Null angle
Rxvert_2	-100	-14,56	25	188	9	-22,03	7,47	40	90
Wires 16 - segments 390	-110	-15,02	25	173	11	-22,88	7,86	45	90
Minimec ground	-120	-15,59	25	160	14	-23,85	8,26	50	90
2 elements end-fire	-125	-15,84	25	155	16	-24,29	8,45	55	90
21 m. separation	-130	-16,19	25	149	20	-24,86	8,67	60	90
	-135	-16,57	25	143	28	-25,47	8,90	60	15
	-136	-16,73	25	141	37	-25,73	9,00	65	15
Best Cardioid Pattern =>	**-137**	**-16,81**	**25**	**139**	**60**	**-25,85**	**9,04**	**65**	**20**
	-138	-16,90	25	138	38	-25,99	9,09	65	20
	-140	-17,07	22	136	28	-26,26	9,19	65	30
	-145	-17,40	22	131	19	-26,80	9,40	15	40
	-146	-17,49	22	130	18	-26,95	9,46	15	42
Best Null Angle =>	**-147**	**-17,59**	**22**	**129**	**17**	**-27,09**	**9,50**	**15**	**45**
	-148	-17,69	22	127	16	-27,23	9,54	15	46
	-149	-17,79	22	126	15	-27,37	9,58	15	48
	-150	-17,89	22	125	14	-27,52	9,63	15	50
	-155	-18,42	22	120	11	-28,24	9,82	15	57
	-160	-19,03	20	114	8	-28,95	9,92	20	65

Now the highest F/B and the best cardioid pattern is achieved with 137° phasing (primary black trace), but in order to get the desirable high angle null and an even better RDF the phasing has to be something more, around 147 degrees.



Two vertical elements – 1/8 wave separation – 137 (black) and 147 (blue) degrees phasing

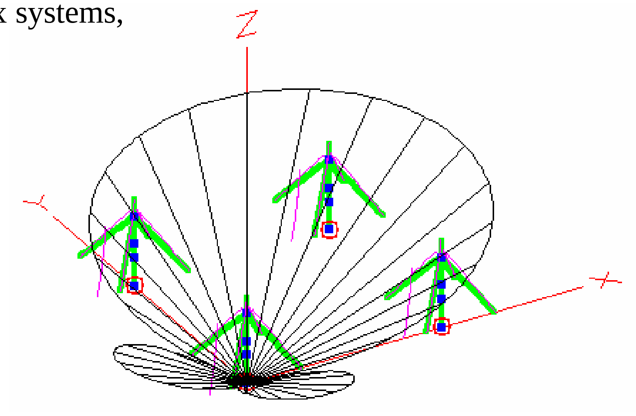
With half the space we can get the same pattern and a narrower lobe. There is a lower signal output, but an improvement in the RDF, the most important of the receiving antenna parameters, so that's the way to go on: a four elements square with 1/8 wave on a side could fit on my lot.



Two verticals : ¼ wave distance - 115° phasing (primary black) and 1/8 wave distance - 147° phasing (blue)

The four elements square – Crossfire feeding

At first I modelled the diamond configuration with the crossfire feeding suggested by W8JI and utilized in the DX Engineering four square Rx systems, along the diagonal of the array. Element 1 is on the back with the required phasing delay; elements 2 and 3 are on the side, fed with half the delay of the back one, and element 4 is on the front without delay lines.

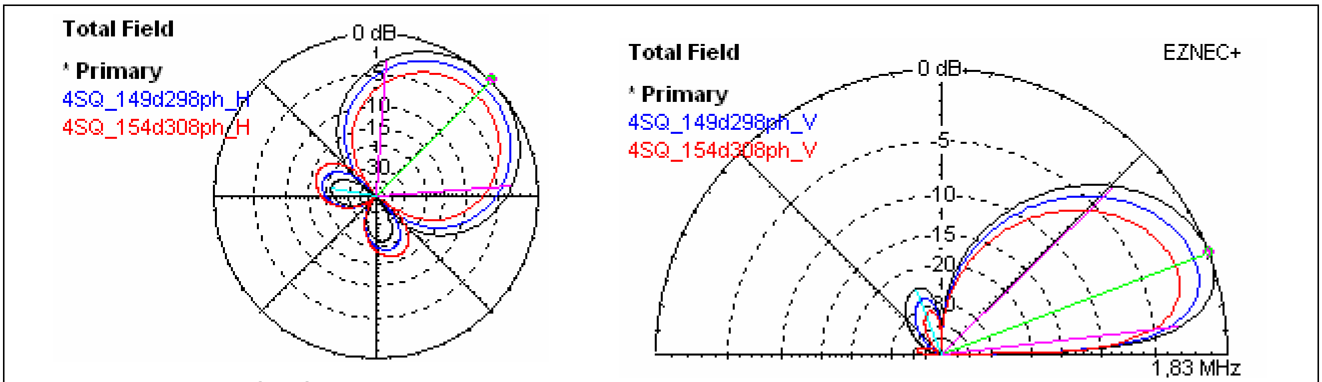


The DX Eng instructions manual calculates the delay line to the back element from the diagonal of the array multiplied by 0.95 and the VF of the coax cable. The delay lines to the middle elements are half that length after a phase inversion.

So, for this array the delay lines (75 ohm CATV F6 cable) should be: 29.7 x 0.95 x 0.85 = 24 meters to the back element and 12 meters to the middle elements. As, at the frequency of 1.83 MHz 1 meter = 2.20° , the electrical line lengths result to be 62 and 31 degrees, corresponding to phasing delays of 298 and 149 degrees.

EZNEC Model	Source phasing			Equivalent Crossfire			Take off	- 3dB	Front to	Average		Secondary	Null
	Elem. 1	El. 2 - 3	Elem. 4	Elem. 1	El. 2 - 3	Gain	angle	BWdh	Back	Gain	RDF	Back Lobe	Angle
Rxvert_4A	0	-120	-240	120	-60	-16,34	22	105	18	-26,30	9,96	60	90
4 elem. Square	0	-130	-260	100	-50	-17,98	22	95	23	-28,57	10,59	53	90
wires 32	0	-135	-270	90	-45	-18,92	22	90	28	-29,83	10,91	65	90
segments 780	0	-140	-280	80	-40	-19,94	22	85	35	-31,19	11,25	65	15
Minimec Ground	0	-142	-284	76	-38	-20,37	22	83	38	-31,77	11,40	65	25
Loads: R 73 + XL 293	0	-143	-286	74	-37	-20,60	22	82	41	-32,06	11,46	65	25
21 m. separation	0	-144	-288	72	-36	-20,82	22	81	44	-32,35	11,53	70	30
29,7 diagonal	0	-145	-290	70	-35	-21,05	21	81	47	-32,65	11,60	70	30
Diamond	0	-146	-292	68	-34	-21,29	21	80	52	-32,95	11,66	70	30
Crossfire feeding	0	-147	-294	66	-33	-21,53	21	79	59	-33,26	11,73	70	30
	0	-148	-296	64	-32	-21,78	21	78	66	-33,57	11,79	70	40
DX Eng. Design ==>	**0**	**-149**	**-298**	**62**	**-31**	**-22,03**	**20**	**77**	**62**	**-33,88**	**11,85**	**70**	**40**
	0	**-150**	**-300**	**60**	**-30**	**-22,29**	**20**	**76**	**63**	**-34,21**	**11,92**	**70**	**45**
Elem. 1 = back	**0**	**-151**	**-302**	**58**	**-29**	**-22,55**	**20**	**75**	**66**	**-34,53**	**11,98**	**70**	**45**
Elem. 2 - 3 = middle	**0**	**-152**	**-304**	**56**	**-28**	**-22,81**	**20**	**74**	**55**	**-34,85**	**12,04**	**75**	**45**
Elem. 4 = front	**0**	**-153**	**-306**	**54**	**-27**	**-23,09**	**20**	**73**	**48**	**-35,18**	**12,09**	**75**	**45**
	0	**-154**	**-308**	**52**	**-26**	**-23,36**	**20**	**72**	**43**	**-35,52**	**12,16**	**75**	**45**
	0	**-155**	**-310**	**50**	**-25**	**-23,65**	**20**	**71**	**37**	**-35,85**	**12,20**	**75**	**45**
	0	**-156**	-312	**48**	**-24**	**-23,94**	**20**	**70**	**37**	**-36,20**	**12,26**	**75**	**45**
	0	-157	-314	46	-23	-24,23	20	69	33	-36,54	12,31		45
	0	-158	-316	44	-22	-24,53	20	68	31	-36,88	12,35	15	50
	0	-160	-320	40	-20	-25,16	20	66	27	-37,58	12,42	15	60
	0	-165	-330	30	-15	-26,85	20	61	18	-39,30	12,45	15	80
	0	-170	-340	20	-10	-28,77	20	55	10	-40,91	12,14	15	90

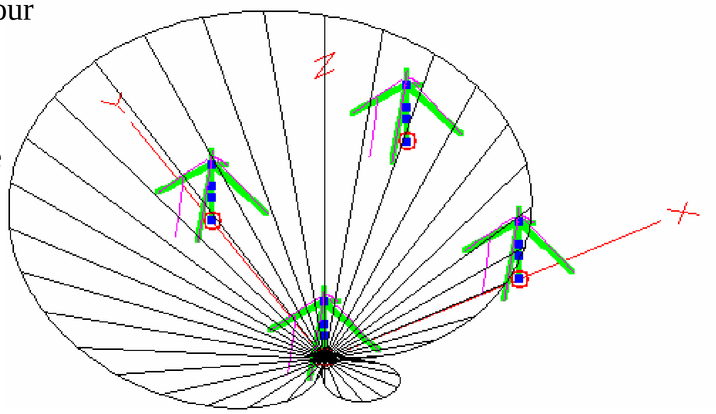
We can get a **fantastic pattern**, with front to back ratio of 60 dB, an RDF factor of 12 dB and the desired rejection null angle at 45 degrees. The phasing is not critical, as one degree, or 40 cm. of error in the delay lines does not make any difference!



4 Square – Crossfire feeding: 145/290 phasing (primary black) – 149/298 (blue trace) – 154/308 (red trace)

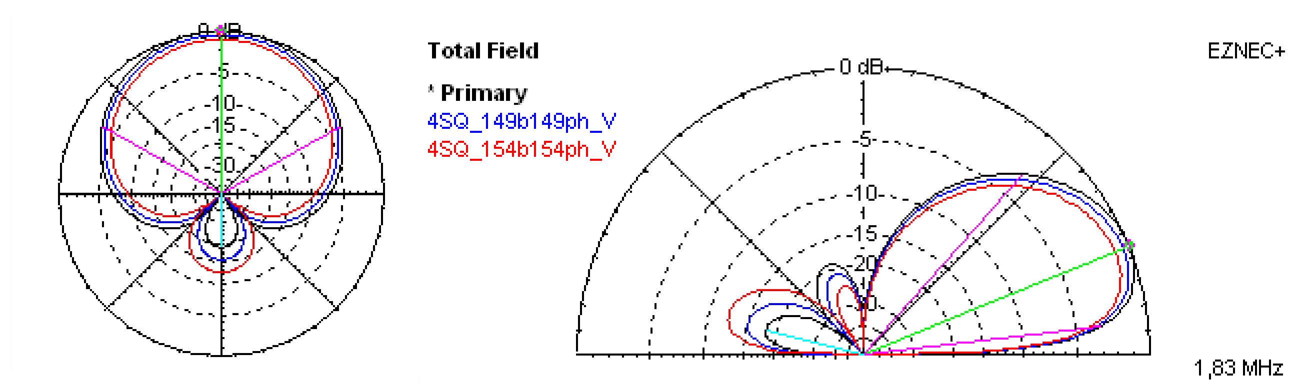
The four elements square – End-fire/Broadside feeding

But such a beautiful azimuth lobe is even too narrow, around 75 degrees beamwidth, and cannot fully cover all the directions with four switching positions. So I investigated on the possibility to have other 4 directions with an alternative feeding system. I know that the broadside spacing should be above ½ wavelength, as in the 8 elements circle arrays, but I remember that my previous four-square mini array was working well with only such a phasing system.
The next table summarizes the Eznec+5 runs with the different phasing system on the same antenna model.



EZNEC Model	Source phasing		Equivalent feeding to		Gain	Take off angle	- 3dB BWdh	Front to Back	Average Gain	RDF	Secondary Back Lobe	Null Angle
	El. 1 - 3	El. 2 - 4	El. 2 - 4	Diff.gain								
Rxvert_4B	0	120	60	3,79	-12,55	23	147	14	-21,02	8,47	51	5
4 elem. Square	0	130	50	4,79	-13,19	23	136	21	-22,12	8,93	58	15
wires 32	0	135	45	5,36	-13,56	23	131	31	-22,72	9,16	61	25
segments 780	0	140	40	5,97	-13,97	22	126	29	-23,36	9,39	65	30
Minimec Ground	0	142	38	6,23	-14,14	22	124	24	-23,63	9,49	66	35
Loads: R 73 + XL 293	0	143	37	6,37	-14,23	22	123	22	-23,76	9,53	67	40
21 m. separation	0	144	36	6,50	-14,32	22	122	20	-23,90	9,58	67	40
29,7 diagonal	0	145	35	6,64	-14,41	22	121	19	-24,04	9,63	14	45
End-fire + broadside	0	146	34	6,78	-14,51	22	120	18	-24,17	9,66	15	45
feeding	0	147	33	6,93	-14,60	22	119	17	-24,31	9,71	15	45
	0	148	32	7,08	-14,70	22	118	16	-24,45	9,75	15	45
	0	**149**	**31**	**7,23**	**-14,80**	**22**	**117**	**15**	**-24,59**	**9,79**	**16**	**50**
	0	**150**	**30**	7,39	**-14,90**	**22**	**116**	**14**	**-24,73**	**9,83**	**16**	**50**
Front elem. Nr. 2 - 4	**0**	**151**	**29**	7,55	**-15,00**	**22**	**116**	**14**	**-24,88**	**9,88**	**16**	**55**
Back elem. Nr. 1 - 3	**0**	**152**	**28**	7,70	**-15,11**	**22**	**115**	**13**	**-25,02**	**9,91**	**16**	**55**
	0	**153**	**27**	7,88	**-15,21**	**22**	**114**	**12**	**-25,16**	**9,95**	**17**	**60**
	0	**154**	**26**	8,04	**-15,32**	**22**	**113**	**12**	**-25,30**	**9,98**	**17**	**60**
	0	**155**	**25**	8,22	**-15,43**	**22**	**112**	**11**	**-25,44**	**10,01**	**17**	**60**
	0	**156**	24	8,39	-15,55	22	111	10	-25,58	10,03	17	65
	0	157	23	8,57	-15,66	22	110	10	-25,72	10,06	17	65
	0	158	22	8,75	-15,78	22	109	9	-25,86	10,08	18	70
	0	160	20	9,14	-16,02	22	107	8	-26,13	10,11	18	70
	0	165	15	10,19	-16,66	21	102	6	-26,76	10,10	19	80
	0	170	10	11,39	-17,38	21	97	4	-27,28	9,90	19	85

The main lobe is shifted 45 degrees from the previous one, as desired, the front to back is not so pronounced and also the RDF is about 2 dB lower, but we have a very good null at 45/50 degrees. Using the same phasing lines of the crossfire fed system we can build a very nice 8 directions switching array, with the only nuisance being that 7/8 dB more gain compared to the diagonal positions.

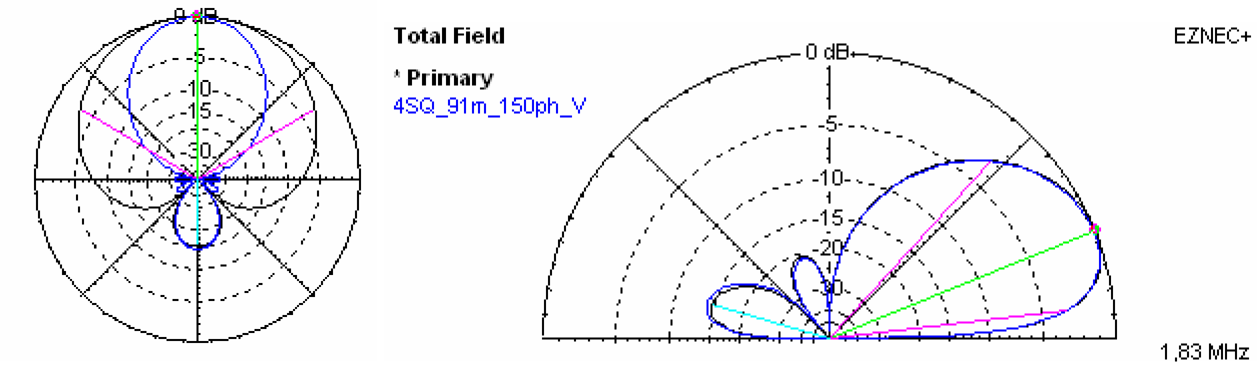


4 Square –Endfire/Broadside: 145/145 phasing (primary black) – 149/149 (blue trace) – 154/154 (red trace

At this point I wanted to verify which should have been the results of modelling this type of array with a much greater broadside spacing, 91 meters, as used in every cell of the best 8 elements circular Rx systems.

EZNEC Model	Source phasing		Equivalent feeding to			Take off	- 3dB	Front to	Average		Secondary	Null
Rxvert_4Bb	El. 1 - 3	El. 2 - 4	El. 1 - 3	Diff.gain	Gain	angle	BWdh	Back	Gain	**RDF**	Back Lobe	Angle
4 elem. Square	140	0	40	-0,38	-13,94	22	54	28	-26,50	**12,56**	65	30
wires 32	145	0	35	-0,42	-14,39	22	54	19	-27,06	**12,67**	14	45
segments 780	150	0	30	-0,74	-14,88	22	53	14	-27,63	**12,75**	16	50
91 m. separation	155	0	25	-1,18	-15,41	22	53	11	-28,18	**12,77**	17	60

It’s very interesting to note that the output signal (gain) does not change and also the front to back and the null angle are the same as for close spacing. The beauty of such a wide spacing is the narrow beamwidth which causes an RDF improvement of 3 dB. Amazing, but a lot of space is required!



4 Square –Endfire/Broadside – 150 deg. phasing: 21 m. wide (primary black) – 91 m. wide (blue trace)

The final design

Thanks to the new features of Eznec 5 it is possible to model the entire antenna system with transmission lines, transformers and matching networks, so I choose my preferred design and verified the correct impedance value at the 50 ohms receiver input.

After substituting the four phased sources with the effective delay lines, I performed a few runs and we see the results are the same, except the F/B ratio went down to more realistic numbers.

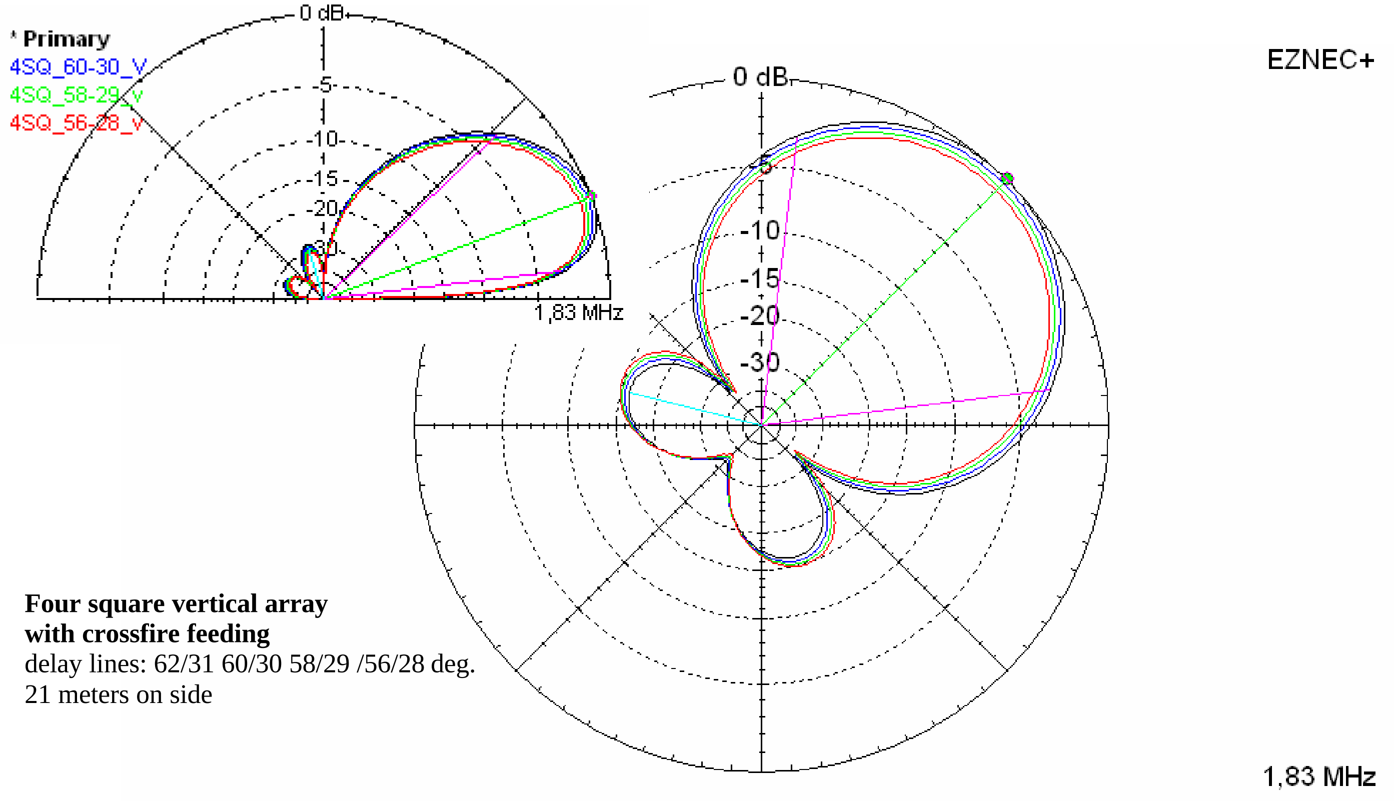
Rx Four Square Array: DIAGONAL beaming

EZNEC Model	Delay lines degrees		**Delay lines meters**			Take off	- 3dB	**Front to**	Average		Secondary	**Null**
Rxvert_4A_TL	Elem. 1	El. 2 - 3	**Elem. 1**	**El. 2 - 3**	Gain	angle	BWdh	**Back**	Gain	**RDF**	Back Lobe	**Angle**
4 elem. Square	64	32	**24,8**	**12,4**	-22,03	21	77	**33**	-33,89	**11,86**	72	**45**
Top loaded 9,5 m. high	62	31	**24,0**	**12,0**	-22,28	21	76	**33**	-34,21	**11,93**	73	**45**
21 m. separation	60	30	**23,2**	**11,6**	-22,54	20	75	**34**	-34,52	**11,98**	74	**45**
Loads: R 73 + XL 293	58	29	**22,4**	**11,2**	-22,80	20	74	**34**	-34,84	**12,04**	76	**50**
Feed lines 75 ohm F6	56	28	**21,7**	**10,8**	-23,07	20	73	**36**	-35,16	**12,09**	76	**50**
m.34,81 to each elem.	54	27	**20,9**	**10,4**	-23,34	20	72	**37**	-35,48	**12,14**	76	**55**
Crossfire feeding	52	26	**20,1**	**10,1**	-23,62	20	71	**40**	-35,81	**12,19**	76	**60**

Rx Four Square Array: SIDE beaming

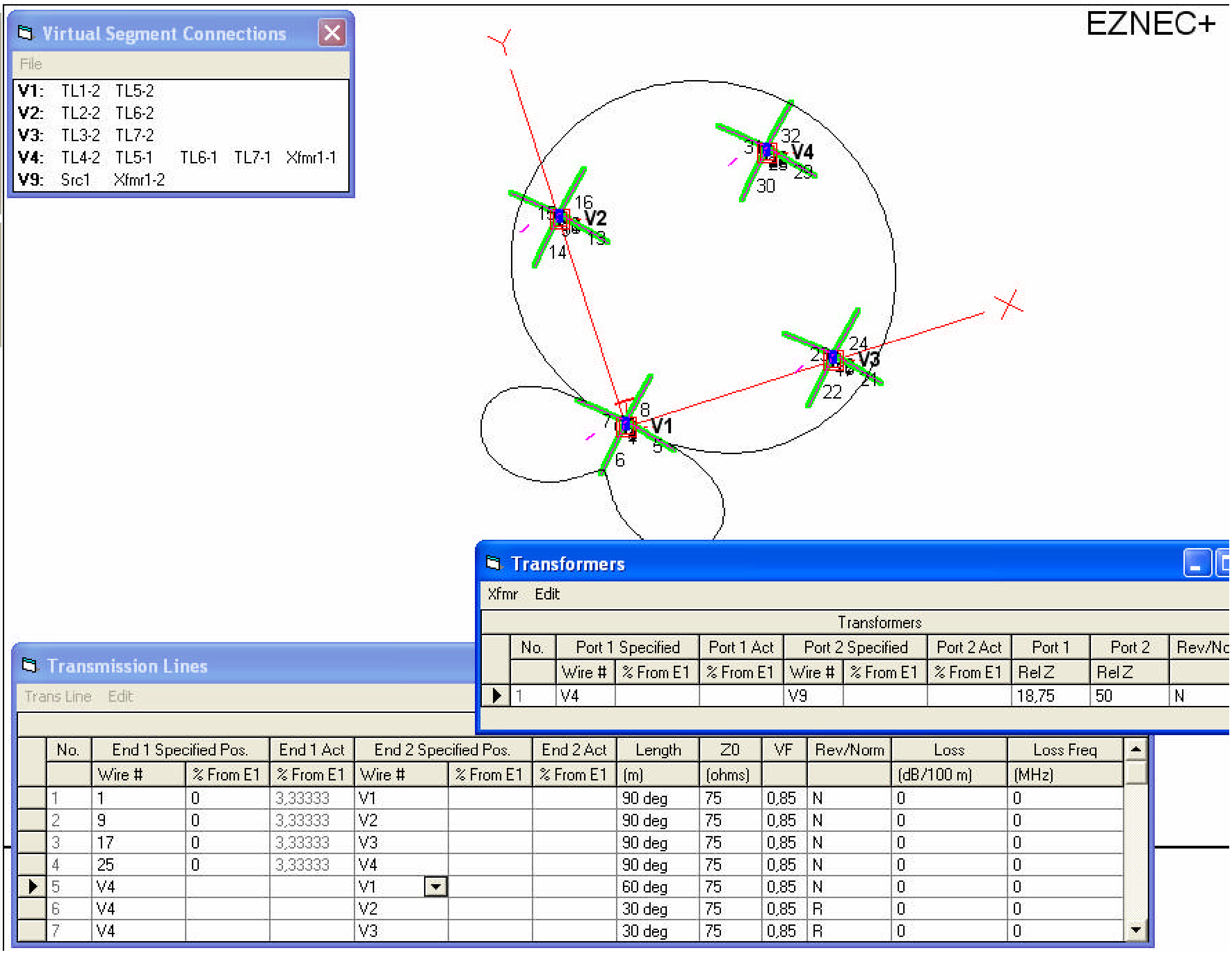
EZNEC Model	Delay lines degrees		**Delay lines meters**			Take off	- 3dB	**Front to**	Average		Secondary	**Null**
Rxvert_4B_TL	Elem. 1-3	El. 2 - 4	**Elem. 1**	**El. 2 - 4**	Gain	angle	BWdh	**Back**	Gain	**RDF**	Back Lobe	**Angle**
4 elem. Square	0	32	**0,0**	**12,4**	-14,87	22	117	**15**	-24,69	**9,82**	16	**50**
Top loaded 9,5 m. high	0	31	**0,0**	**12,0**	-14,96	22	116	**14**	-24,82	**9,86**	16	**50**
21 m. separation	0	30	**0,0**	**11,6**	-15,06	22	115	**13**	-24,95	**9,89**	16	**50**
Loads: R 73 + XL 293	0	29	**0,0**	**11,2**	-15,16	22	114	**13**	-25,09	**9,93**	17	**50**
Feed lines 75 ohm F6	0	28	**0,0**	**10,8**	-15,26	22	113	**12**	-25,22	**9,96**	17	**55**
m.34,81 to each elem.	0	27	**0,0**	**10,4**	-15,36	22	112	**12**	-25,35	**9,99**	17	**60**
Endfire/Broadside Feeding		26	**0,0**	**10,1**	-15,46	22	112	**11**	-35,81	**20,35**	17	**65**

Referring to the diagonal crossfire case we see that, starting from the DX Eng suggested delay lines of 62/31 degrees and going down, it could be possible to get better F/B and RDF parameters step by step, but with an increase in the secondary back lobes. I don’t like that too much and thus my choice will be for 60/30 degrees, i.e. the 23,2 and 11,6 meters delay lines (blue trace below). Of course the same 11,6 meters delay lines will be kept and switched for the end-fire/broadside feeding.



Four square vertical array
with crossfire feeding
delay lines: 62/31 60/30 58/29 /56/28 deg.
21 meters on side

The following is a screen printout recording the main Eznec settings for the crossfire feeding.



Virtual Segment Connections

File

V1:	TL1-2	TL5-2			
V2:	TL2-2	TL6-2			
V3:	TL3-2	TL7-2			
V4:	TL4-2	TL5-1	TL6-1	TL7-1	Xfmr1-1
V9:	Src1	Xfmr1-2			

Transformers

Xfmr Edit

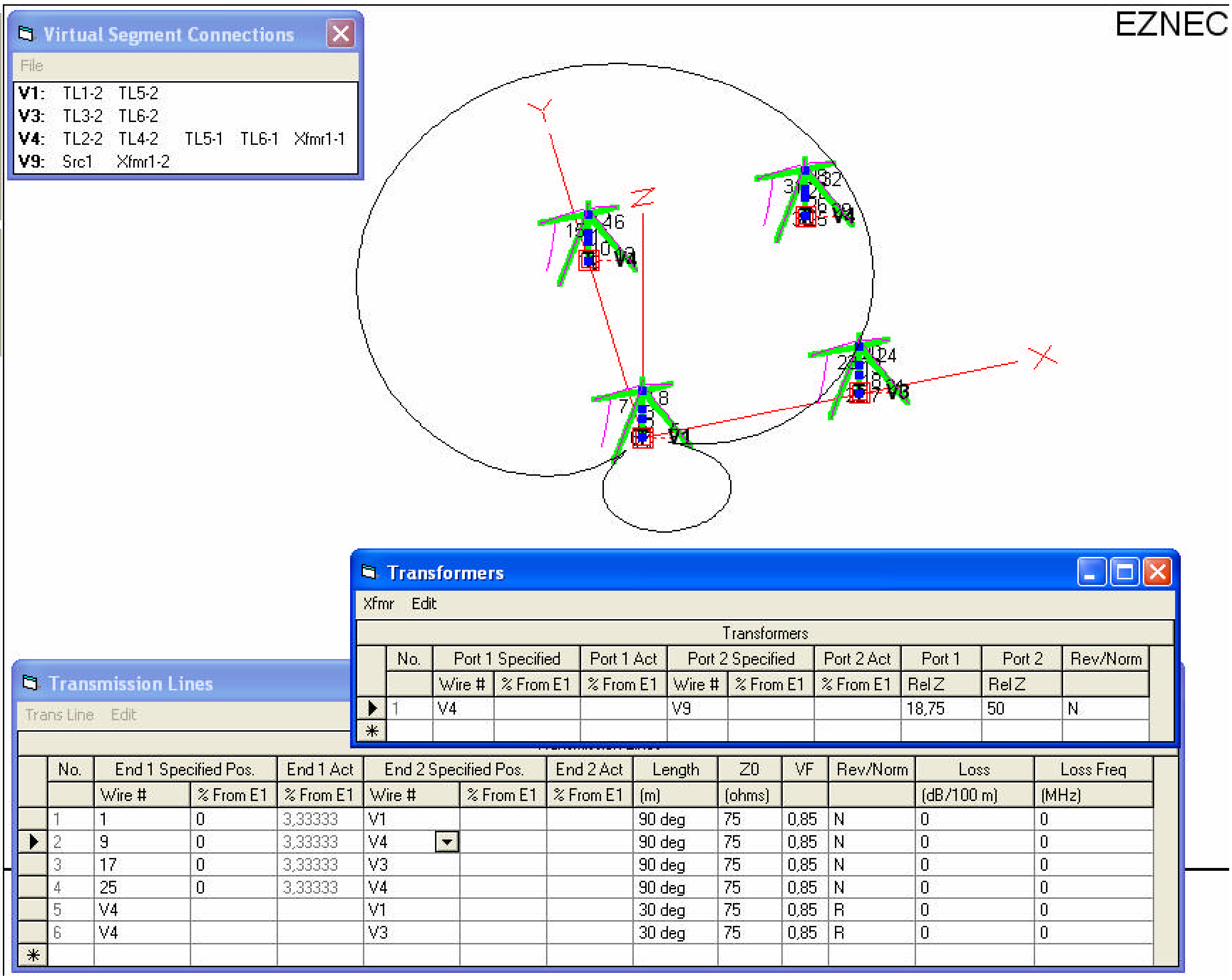
No.	Port 1 Specified		Port 1 Act	Port 2 Specified		Port 2 Act	Port 1	Port 2	Rev/No
	Wire #	% From E1	% From E1	Wire #	% From E1	% From E1	RelZ	RelZ	
1	V4			V9			18,75	50	N

Transmission Lines

Trans Line Edit

No.	End 1 Specified Pos.		End 1 Act	End 2 Specified Pos.		End 2 Act	Length	Z0	VF	Rev/Norm	Loss	Loss Freq
	Wire #	% From E1	% From E1	Wire #	% From E1	% From E1	(m)	(ohms)			(dB/100 m)	(MHz)
1	1	0	3,33333	V1			90 deg	75	0,85	N	0	0
2	9	0	3,33333	V2			90 deg	75	0,85	N	0	0
3	17	0	3,33333	V3			90 deg	75	0,85	N	0	0
4	25	0	3,33333	V4			90 deg	75	0,85	N	0	0
5	V4			V1			60 deg	75	0,85	N	0	0
6	V4			V2			30 deg	75	0,85	R	0	0
7	V4			V3			30 deg	75	0,85	R	0	0

and the these are the settings for the end-fire/broadside feeding

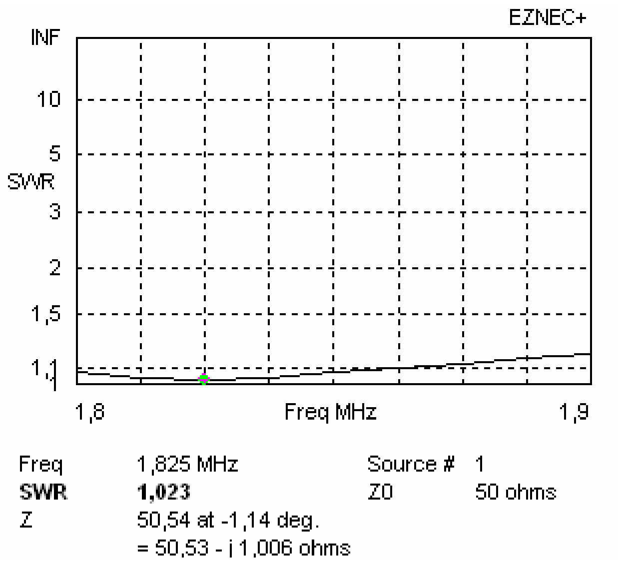


No.	Port 1 Specified Wire #	Port 1 Specified % From E1	Port 1 Act % From E1	Port 2 Specified Wire #	Port 2 Specified % From E1	Port 2 Act % From E1	Port 1 Rel Z	Port 2 Rel Z	Rev/Norm
1	V4			V9			18,75	50	N

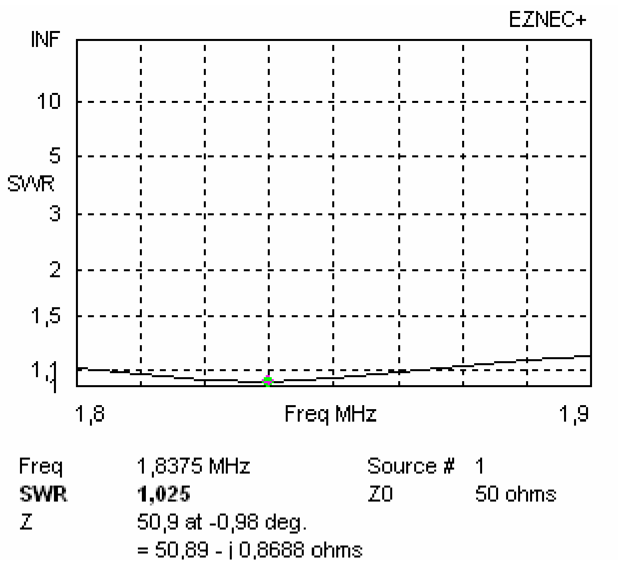
No.	End 1 Specified Pos. Wire #	End 1 Specified Pos. % From E1	End 1 Act % From E1	End 2 Specified Pos. Wire #	End 2 Specified Pos. % From E1	End 2 Act % From E1	Length (m)	Z0 (ohms)	VF	Rev/Norm	Loss (dB/100 m)	Loss Freq (MHz)
1	1	0	3,33333	V1			90 deg	75	0,85	N	0	0
2	9	0	3,33333	V4			90 deg	75	0,85	N	0	0
3	17	0	3,33333	V3			90 deg	75	0,85	N	0	0
4	25	0	3,33333	V4			90 deg	75	0,85	N	0	0
5	V4			V1			30 deg	75	0,85	R	0	0
6	V4			V3			30 deg	75	0,85	R	0	0

Finally this is the SWR sweep, for both configurations to the 50 ohms output RX line, where we can detect only a very small shift of the minimum point of the curve from 1.825 to 1.837 MHz !

Crossfire feeding

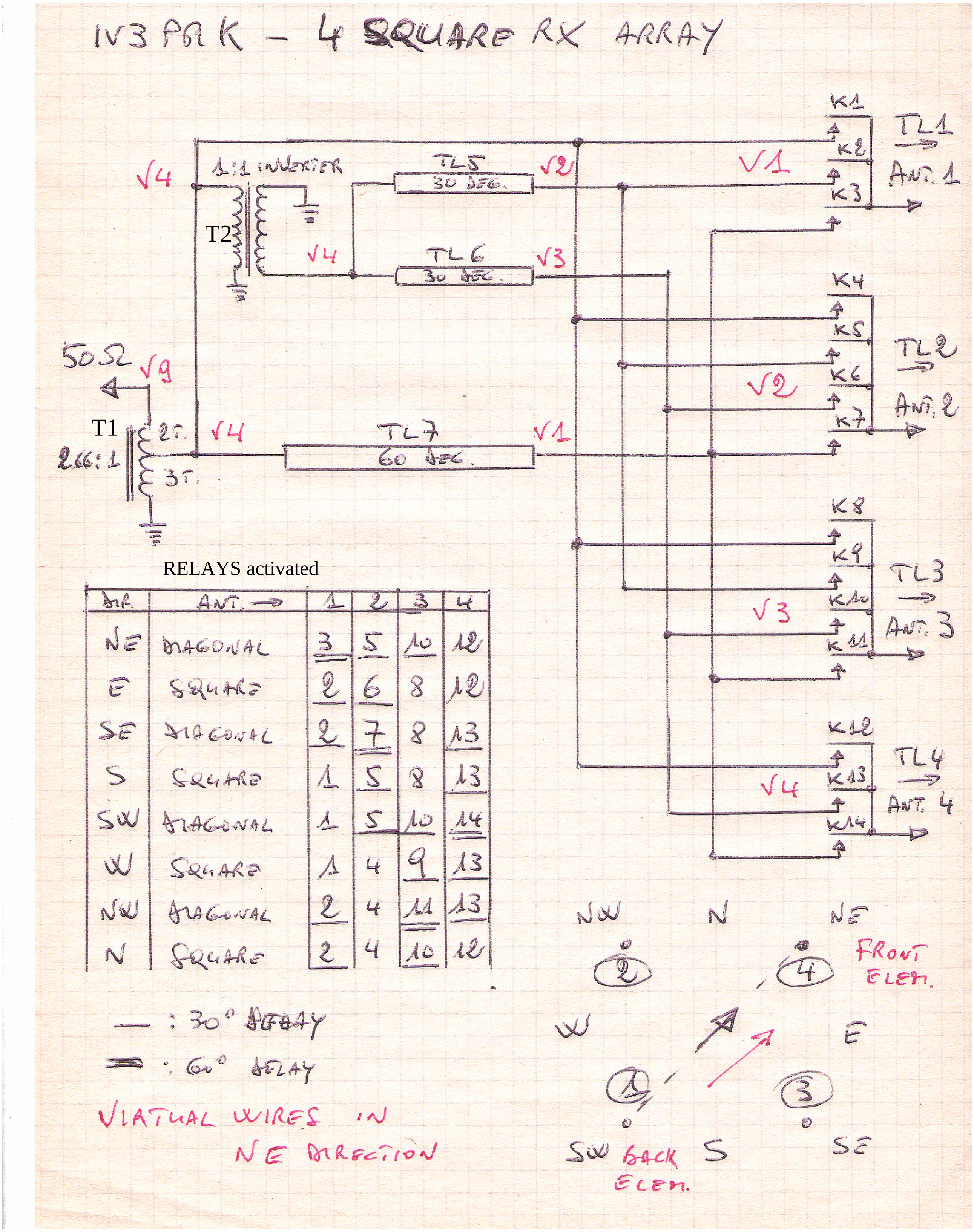


End-fire/Broadside feeding



Construction notes

This is the switching sketch. All the relays are in the deactivated default position with no antenna connected.



DIR.	ANT. →	1	2	3	4
NE	DIAGONAL	3	5	10	12
E	SQUARE	2	6	8	12
SE	DIAGONAL	2	7	8	13
S	SQUARE	1	5	8	13
SW	DIAGONAL	1	5	10	14
W	SQUARE	1	4	9	13
NW	DIAGONAL	2	4	11	13
N	SQUARE	2	4	10	12

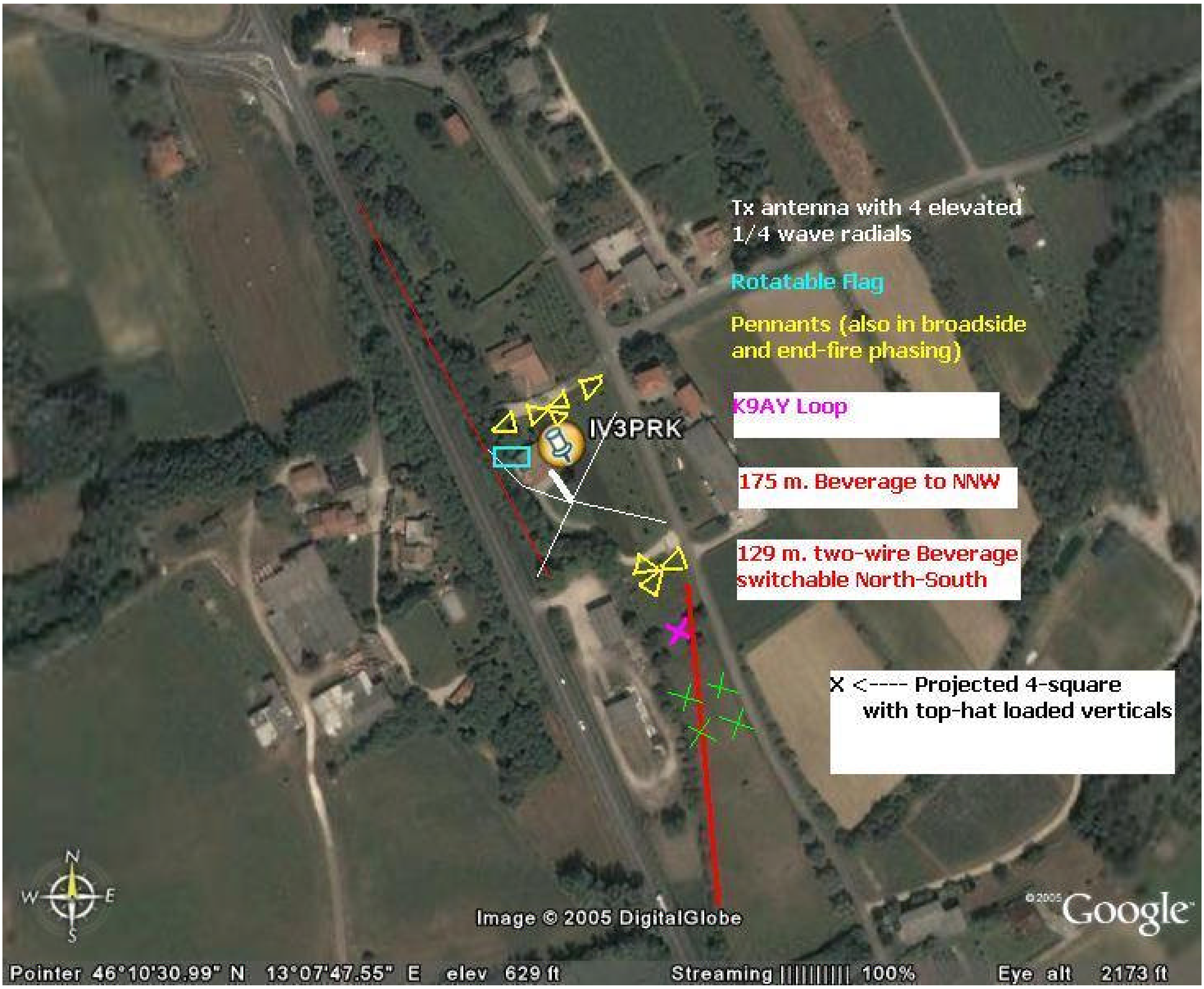
TL1 to TL4 are ¼ wave transmission lines to the antenna elements – 34.81 meters long – 75 ohm CATV F6 style cable with a VF of 0.85.
TL5 and TL6 are the F6 cable delay lines of 30 degrees: 11.60 meters long
TL7 is the F6 cable delay line of 60 degrees: 23.20 meters long.
T1: output transformer from 18.75 ohms to 50 ohms of the feed line to the receiver.

Zp/Zs (50/18,75) = 2,66
Turns ratio = SQR(2,66) = 1,63
Number of primary turns :5 / 1,63 = 3,03 = number of secondary turns.
Thus a five turns through the two holes with a tap on the third turn.

T2: phase inverter 1:1 transformer with 6 twisted turns on binocular BN73-202.

<u>Base loading of the single verticals:</u>

R 73 ohms: Carbon composition resistors (50/55 ohms) + ground resistance
XL 293 ohms: required inductance 25 µH at 1.83 MHz : two solutions are available:
Ferrite Rods R33-037-400: 10 cm. long – mu 800 - AL 62 = 20,3 turns
Toroids FT50-61 - mu 125 - AL 68 = 19,4 turns



IV3PRK 160 meters Rx antennas in march 2008

IV3PRK 160 m. antennas (year 2005): in front the K9AY loop, than the 4-squareRx mini-array, the southern group of Pennants, the shunt-fed tower and, on the back, the rotatable Flag

The new lot, 27 meters wide, where could fit the projected 4-square Rx array.
On the left: a 2 meters high fence and the 220 V power line (insulated twisted wires).
In front: a 1.50 meters high fence and a crossing telephone cable, 5 meters high
On the right: the main telephone line.

Could the taller top hat loaded verticals, with an adequate ground system, be more suitable than the short active antennas in this environment ?

Luis IV3PRK March 2008