Simulation of antennas using MMANA program

Part 2

Yagi antenna simulation

Laboratory work

Aim of work: investigate Yagi antenna design and optimization.

Software: antenna analysis program MMANA (http://mmhamsoft.amateur-radio.ca/mmana/index.htm) is used.

Aim of work

The same frequency and conductor of the same radius as in dipole modeling is used.
F= 350 MHz R = 2.5 mm
λ=0.857 m

1. Create a two-element directional antenna model. The length of the active (excited) element is the resonant half-wave dipole (from previous studies). The initial length of the reflector is 0.48λ = 0.41136 m, the distance to the active dipole is 0.1λ = 0.0857 m. Reflector should be placed behind active element, to negative X direction

2. Calculate and write the antenna input impedance, the gain G and the front/back field ratio F / B.

   Z=14.12+j14.01
   G=4.98
   F/B=5.68

3. Determine the optimal F / B distance between the reflector and the active element (Dref_ad) and the reflector length L_{ref}:

L_{ref} / D_{ref_ad}	0,48λ= 0.41136 m	0,49λ= 0.41993 m	0,5λ= 0.4285 m	0,51λ= 0.43707 m	0,52λ= 0.44564 m
0,1λ= 0.0857 m	G= 4.98 dBd F/B= 5.68 dB	G= 4. 78 F/B=9.12	G=4.37 F/B=10.98	G=3.98 F/B=10.92	G=3.65 F/B=10.07
0,12λ= 0.10284 m	G= 6.53 dBd F/B= 4.92 dB	G=4.68 F/B=9.36	G=4.32 F/B=10.87	G=3.97 F/B=10.88	G=3.67 F/B=10.21
0,14λ= 0.11998 m	G= 4.82 dBd F/B= 7,13 dB	G=4.57 F/B=9.5	G=4.24 F/B=10.75	G=3.92 F/B=10.79	G=3.65 F/B=10.22
0,16λ= 0.13712 m	G= 4,71 dBd F/B= 7,55 dB	G=4.45 F/B=9.56	G=4.14 F/B=10.6	G=3.85 F/B=10.64	G=3.59 F/B=10.16

4. Adjust the active element to resonance (X = 0). Write down the antenna input impedance, gain, F/B.

Z=22.47+j2.46
G= 4.33 dBd
F/B= 11.25 dB

5. Antenna directivity pattern.

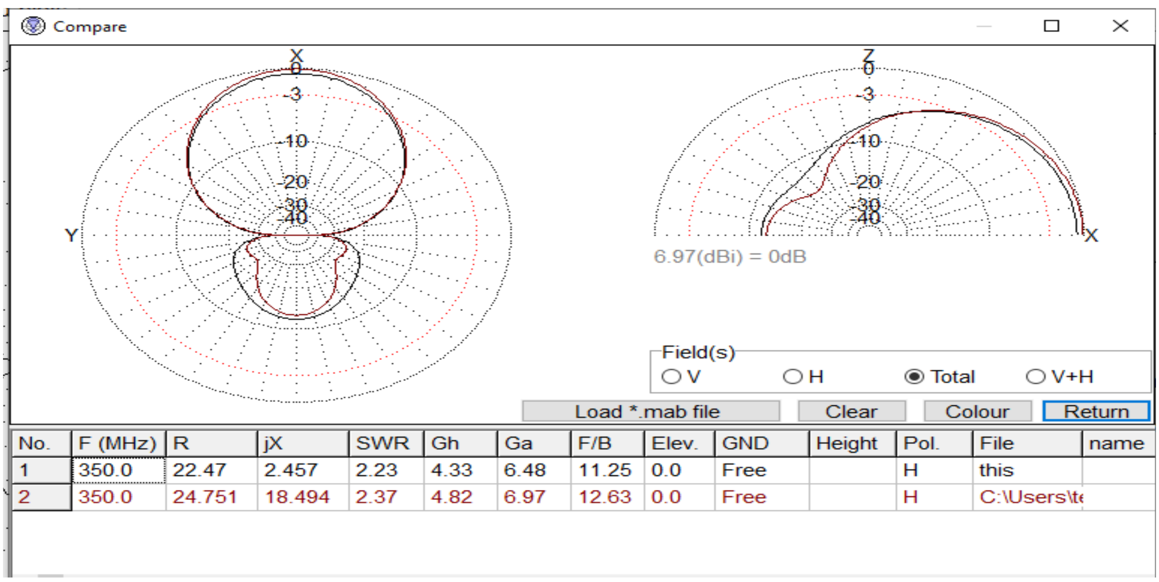
Coordinates of antenna

X1(m)	Y1(m)	Z1(m)	X2(m)	Y2(m)	Z2(m)	R(mm)	Seg
0	-0.1950	0	0	0.1950	0	2.5	-1
-0.0857	-0.21425	0	-0.0857	0.21425	0	2.5	-1

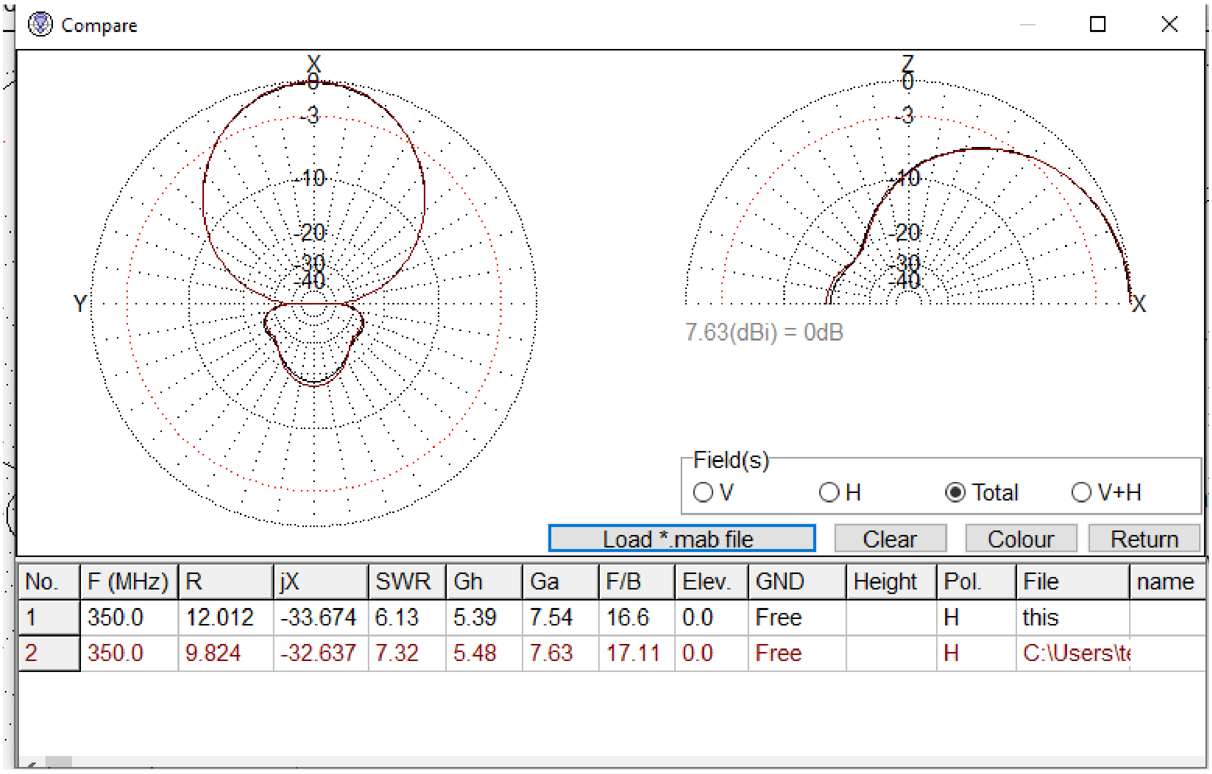
6. Optimize a two-element antenna with passive element shorter than the active one. It acts as a director. To receive radiation in the same direction, place it in the X direction in front of the active element.

L_{ref} D_{ref_ad}	0,42λ= 0.35994 m	0,43λ= 0.36851 m	0,44λ= 0.37708 m	0,45λ= 0.38565 m	0,46λ= 0.39422 m
0,1λ= 0.0857 m	G = 2.83 dBd F/B = 5.52 dB	G = 3.42 F/B = 7.25	G = 4.13 F/B = 10.2	G = 4.86 F/B = 12.63	G= 5.03 F/B= 4.78
0,12λ= 0.10284 m	G = 3.16 dBd F/B= 6.47 dB	G = 3.76 F/B=8.55	G = 4.43 F/B = 10.65	G= 4.91 F/B= 6.87	G= 4.45 F/B= 2.12
0,14λ= 0.11998 m	G= 3.39 F/B=7.22	G = 3.97 F/B = 8.76	G = 4.52 F/B = 7.41	G = 4.65 F/B = 4.09	G= 3.66 F/B=0.24
0,16λ= 0.13712 m	G= 3.52 F/B=6.96	G = 4.03 F/B = 6.72	G = 4.39 F/B = 5.0	G = 4.18 F/B = 2.14	G= 3.97 F/B= -1.14
0,18λ= 0.15426 m	G=3.53 F/B=5.57	G = 3.94 F/B = 4.9	G = 4.11 F/B = 3.19	G = 3.6 F/B = 0.67	G= 4.23 F/B= -2.19

7. Choose the best antenna with F / B and compare its sound with the radiation of the reflector antenna (use Tools-Compare)

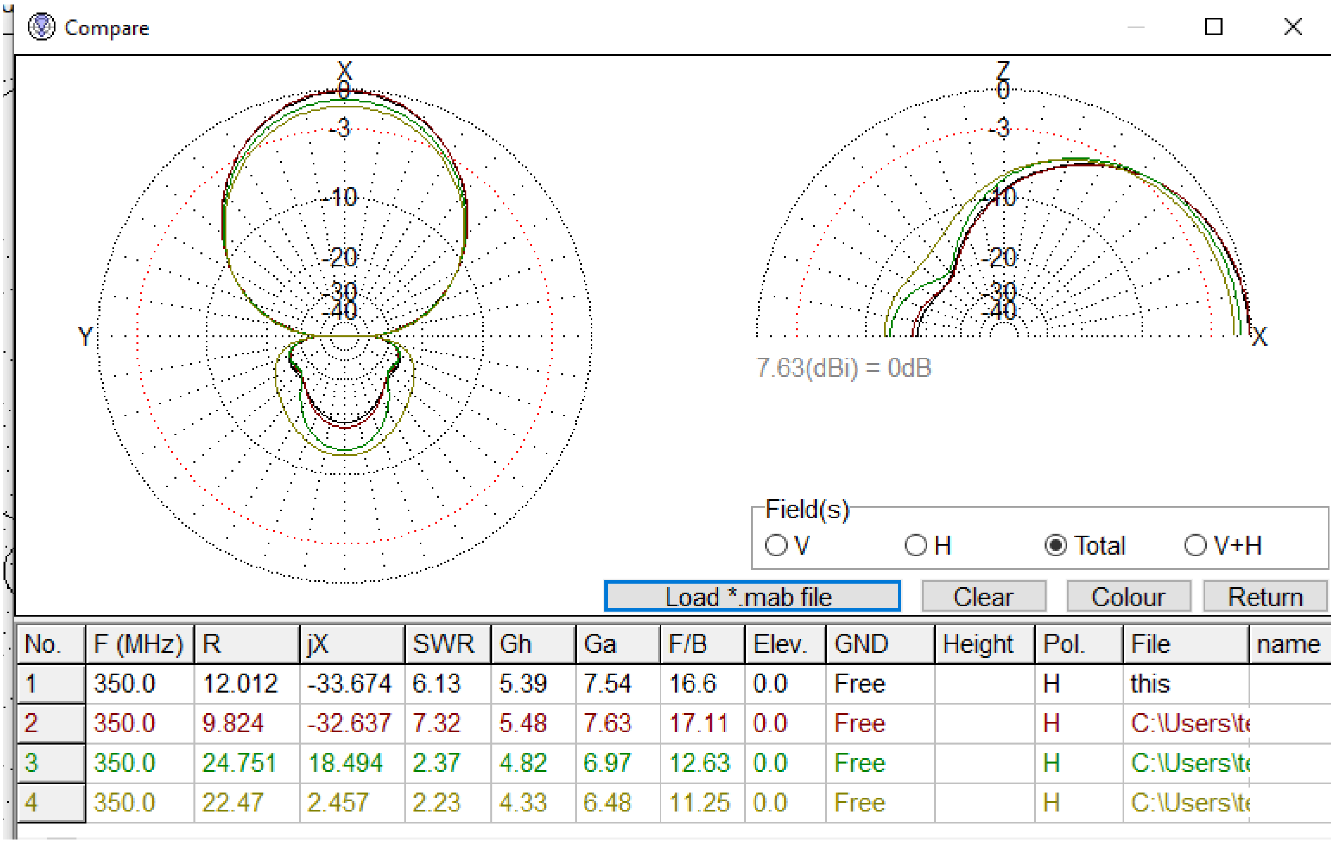


8. Make a 3-element antenna model with an optimal reflector and an optimal director. Download her chart (Save Far Fields). Without changing the distances between the elements, adjust the reflector and director lengths to get the maximum F / B. Compare optimized and non-optimized antenna diagrams.



No.	F (MHz)	R	jX	SWR	Gh	Ga	F/B	Elev.	GND	Height	Pol.	File	name
1	350.0	12.012	-33.674	6.13	5.39	7.54	16.6	0.0	Free		H	this	
2	350.0	9.824	-32.637	7.32	5.48	7.63	17.11	0.0	Free		H	C:\Users\te	

9. Compare diagrams of 2 el. antenna (active + reflector), 2 el. antenna (active+director) and 3 el. optimized yagi.



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2	350.0	9.824	-32.637	7.32	5.48	7.63	17.11	0.0	Free		H	C:\Users\te	
3	350.0	24.751	18.494	2.37	4.82	6.97	12.63	0.0	Free		H	C:\Users\te	
4	350.0	22.47	2.457	2.23	4.33	6.48	11.25	0.0	Free		H	C:\Users\te	

10. Using Plots window calculate Z, G and F/B frequency dependences of 3 el. Yagi antenna.

Z= 9.82-j32.64
G= 5.48 dBd
F/B= 17.11 dB