Investigation of antenna arrays

Laboratory work

Aim of work: to investigate principles of antenna arrays.

Software: antenna analysis programm MMANA

Workflow

The same frequency and conductor of the same radius are used as in the dipole modeling laboratory work.
F= 350 MHZ
λ= 0.857 m

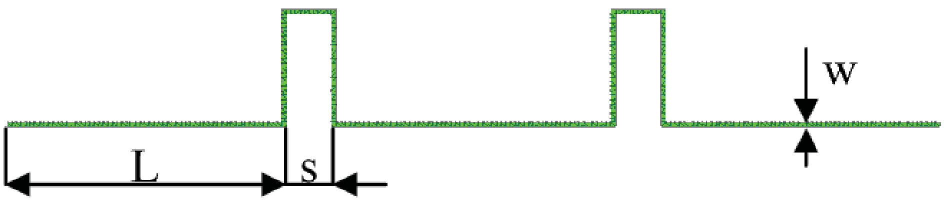
Three elements Franklin antenna

Create a half-wavelength vertical dipole model. Adjust it to resonance and save the far fields.

Z= 72.97+j1.33
G= 2.13 dB i

Create a three-element Franklin antenna model:

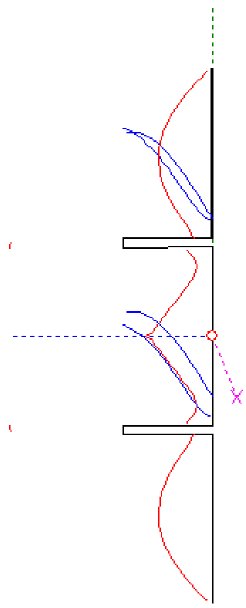
a) align antenna vertically, along the z axis
(b) the lengths of the radiating parts of the antenna L = 0,5 λ
(c) phases of phasing sections 0,25 λ
d) distances between radiating ends S <0.05 λ
(e) excitation point is in the center of the middle dipole



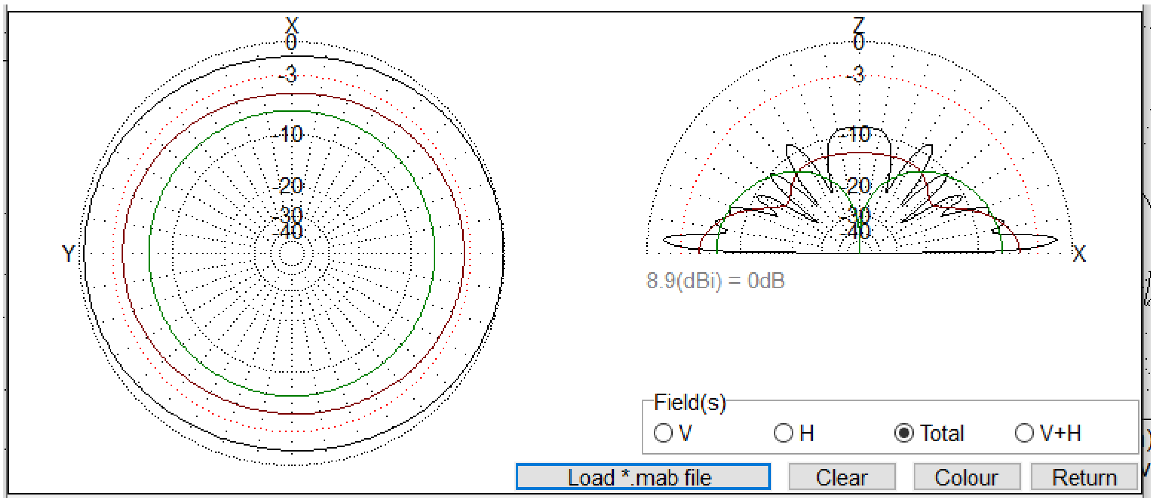
Find input impedance and gain of antennas G:

Z= 153.65-j204.44
G= 5.32 dB i

Save radiation characteristic for further analysis.



Locate the antenna above ground at 3λ and compare radiation characteristics with the single dipole and Franklin antenna.



No.	F (MHz)	R	jX	SWR	Gh	Ga	F/B	Elev.	GND	Height	Pol.	File	name
1	350.0	151.991	-204.052	8.73	---	8.9	-1.01	4.2	Real	2.571	V	this	
2	350.0	153.654	-204.443	8.72	3.17	5.32	-0.99	0.0	Free		V	C:\Users\te	
3	350.0	72.969	1.332	1.46	-0.02	2.13	0.0	0.0	Free		V	C:\Users\te	

Array of dipoles with reflectors

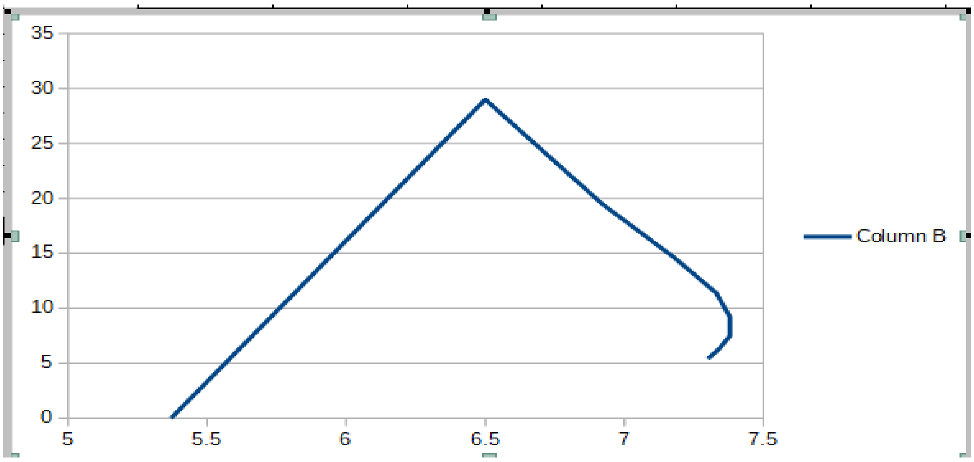
As in the Yagi antenna modeling work, create a model of a dipole with a reflector. Copy the dimensions from the previous laboratory work. Orient the antenna for vertical polarization using the Rotate command.

Find antenna directivity characteristics and save to file.
G= 4.28dBi
F/B= 10.98dB

Make vertical array of 2 antennas (Make Stack). Optimize the antenna gain by changing the distance between the antennas within (0.5-1) λ (mark G and the side sheet level in the table, which for an optimal antenna should not exceed 12dB):

d	0,5λ	0,6λ	0,7λ	0,8λ	0,9λ	1λ	1,1λ	1,2λ	1,3λ
G,dBi	5.37	6.5	6.92	7.18	7.33	7.38	7.38	7.34	7.3
F/B, dB	8.68	12.14	11.72	11.05	10.58	10.43	10.52	10.73	10.92
F/S, dB	0	29.0	19.5	14.6	11.4	9.2	7.5	6.3	5.4

Draw the dependence graphs of the optimized parameters G(d), F/S(d).



Save the directional characteristic of the optimal array.

G = 7.38 dBi
F/B = 10.58 dB
F/S = 11.4 dB

Increase the array to 4 antennas, keeping the distance between them optimal. Compare directional diagrams of single yagi with 2 and 4 element arrays.

Conclusions:

The main objective of whole lab work was to get acquainted with the concept of wire antennas, to learn basic parameters like gain, bandwidth, radiation pattern, beamwidth, polarization, and impedance and to change them to acquire desired antenna. For this purpose we have changed antenna geometry according to calculation which is given by MMANA software therefore we have checked directivity diagrams(Far fields) and investigated on radio propagation theory to know if we get the desired antenna. The lab work was divided between 3 parts. First part was to get acquainted with the modeling of wire antennas, learn to determine the basic parameters of antennas and change them.

Firstly, we have done dipole modelling with given wavelength and wire radius then we have calculated the parameters in free space and optimized the impedance to zero value by changing its length than we have checked far fields for polarization purposes.

Second part of lab was about investigation of Yagi antenna design and optimization. Yagi antenna, is a directional antenna consisting of multiple parallel elements in a line, half-wave dipoles made of metal rods so we were suppose to
create a two-element directional antenna model. Due to previous work we have created a wire line with the given parameters then we have created a reflector and optimized the yagi atenna by changing the distance and length of wire in order to get optimal two element directional antenna afterwards, we have done the same optimization process to director antenna and determined the optimal director therefore we used these reflector and director at the same time to create a yagi antenna then we compared far field polarization of this 3 antenna front and back and gain was clearly better at yagi antenna than others

On Third lab we have used antenna of previous works and created a array of antennas then we optimized the antennas by changing the distances due to wavelengths and determined the optimal array distance below 12 dB and afterwards we used this optimized antenna to create a stack of arrays of 2 and 4 then we calculated the parameters byMMANA and compared these stack of arrays with each other due to front / side, front / back polarization and gain using far fields and determined how increasing stacks of antenna effects the parameters

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