MULTIBEAM ANTENNA ARRAY FOR WLAN AND CAR TO CAR COMMUNICATIONS

A Master Degree Thesis
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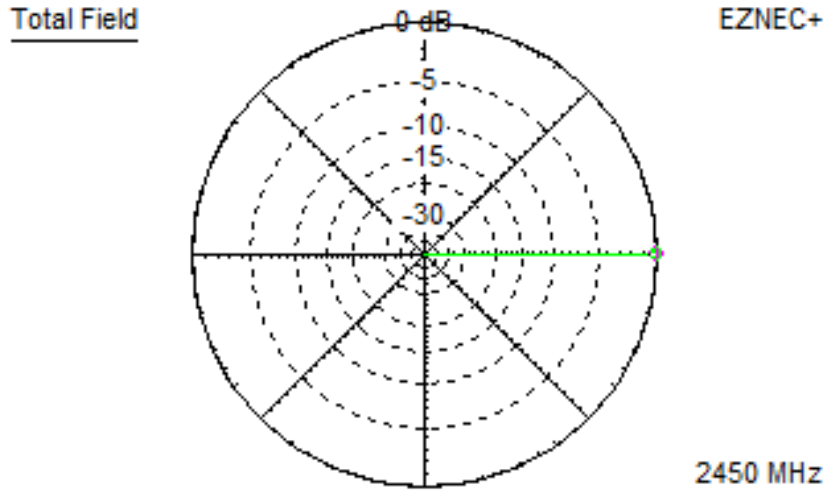
Motivation

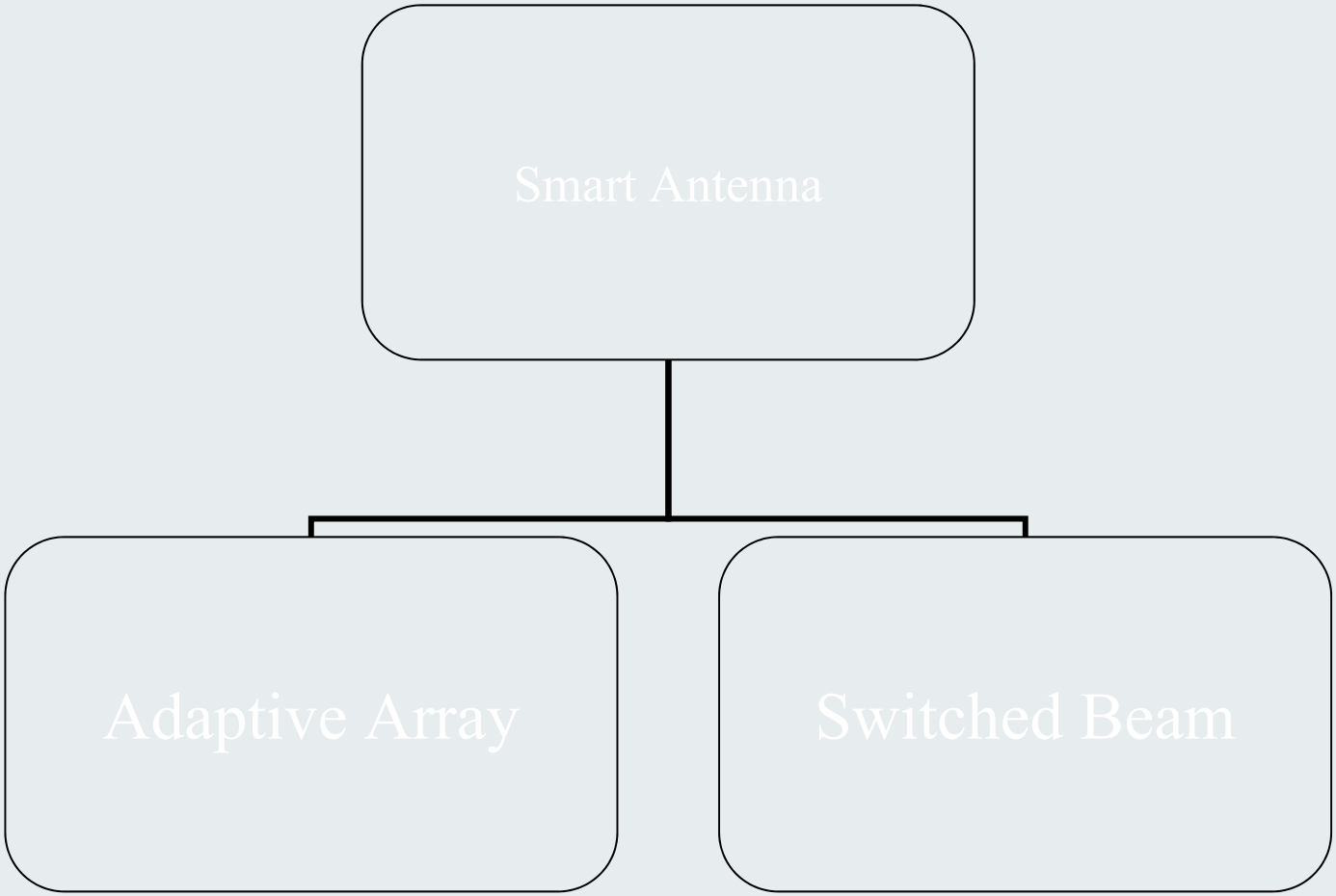
- Wireless Communication is being empolyed in modern day Communication system
- Earlier, Conventional omni-directional Antenna was being used.
- Usually a single monopole Antenna
- Lower gain.
- Causes co-channel Interference
- Non Steerable beam

Antenna For Wireless Communication 2



Azimuth Plot		Cursor Az	0,0 deg.
Elevation Angle	0,0 deg.	Gain	5,14 dBi
Outer Ring	5,14 dBi		0,0 dBmax
			0,0 dBmax3D
3D Max Gain	5,14 dBi		
Slice Max Gain	5,14 dBi @ Az Angle = 0,0 deg.		
Front/Side	0,0 dB		
Beamwidth	?		
Sidelobe Gain	< -100 dBi		
Front/Sidelobe	> 100 dB		

Switched Multibeam Antenna



Switched Multibeam Antenna

- Multibeam antenna
- only one beam is activated at a particular time
- Smart Antenna technology enables a beam to be selected.
- Switched Multibeam makes it possible for only one beam to be activated at a particular time
- It is possible to select the beam that is optimum for reception or transmission in the direction of communication

Switched Multibeam Antenna

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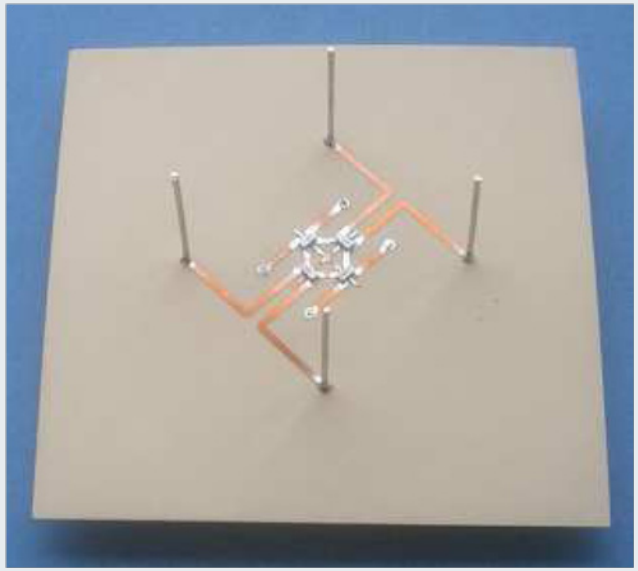
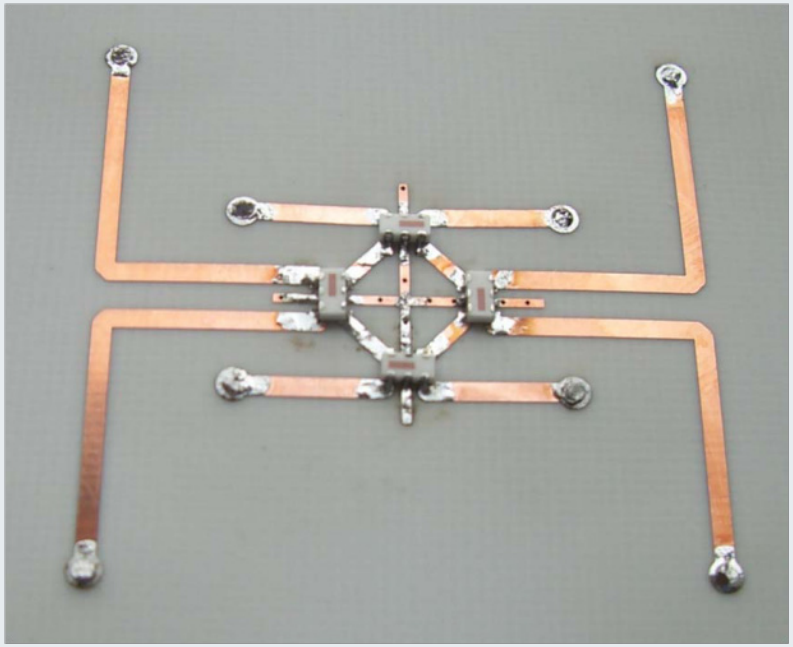
Square Array antenna with four monopoles





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Switched Multibeam antenna

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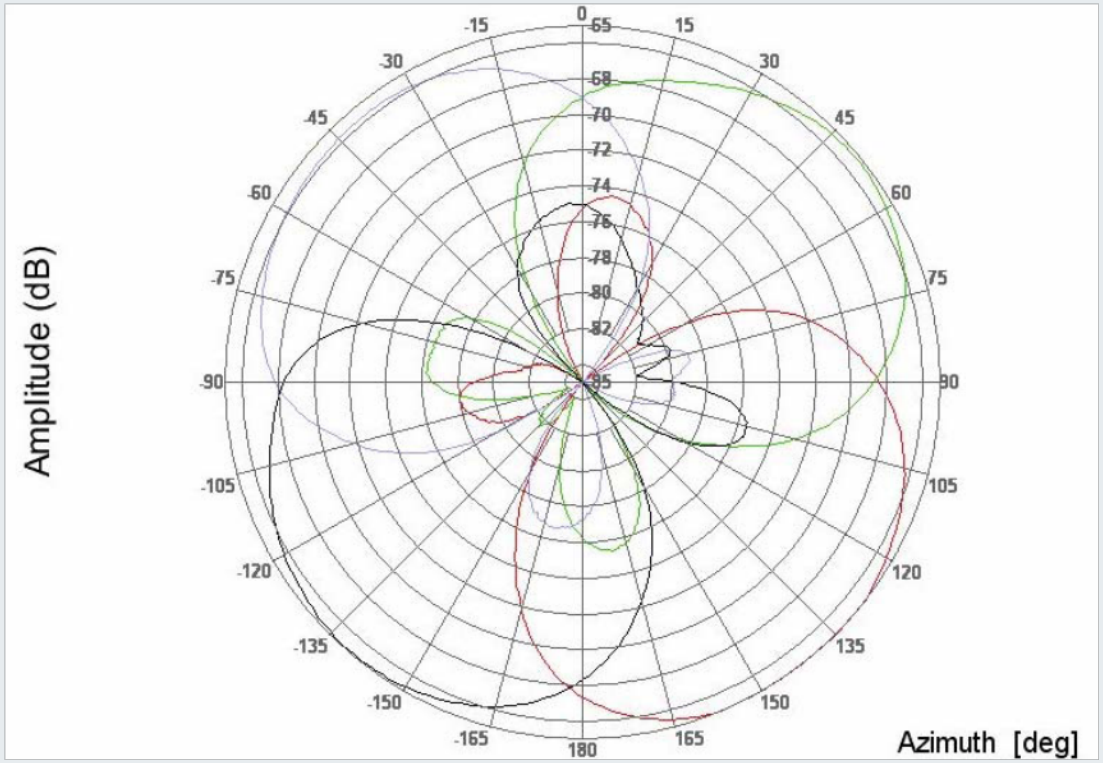
- **Has four λ/4 active monopoles**



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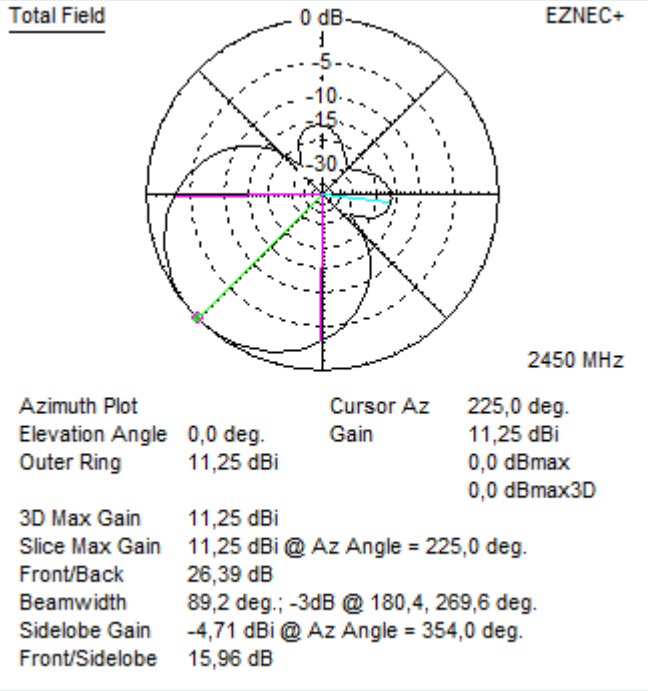
MAIN TASK

- Reduce the beamwidth
- Increase the gain
- Create more narrower beams



DESIGN AND SIMULATIONS

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Adding Parasitic elements

- Parasitic elements do not have RF feed source
- Absorb power radiated by the active element and reradiate it
- Increases the gain but can be destructive
- First Used in Yagi-Uda Antenna
- Functions either as reflector or director

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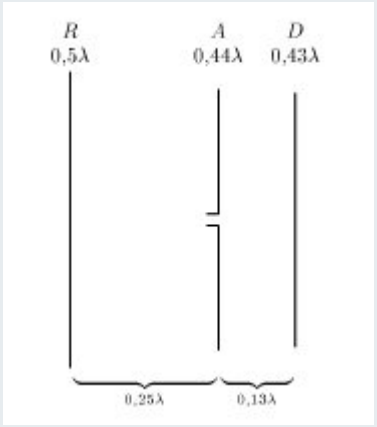
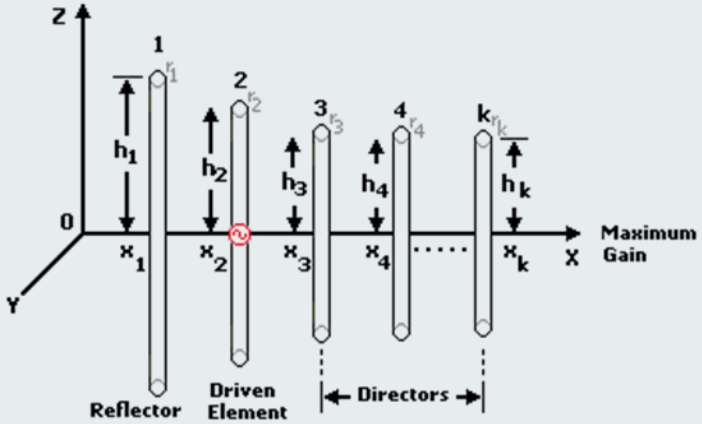
Design and Simulations

Functions as a reflector when the length is longer than that of the active element or with inductive load

Functions as a director when it is shorter than the active element or with capacitive load





Geometry of a K elements Yagi-Uda

Design and Simulations

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Using PIN Diodes to Switch off unwanted Parasitic elements

- **Consists of 3 layers (P-layer, Intrinsic layer and N-layer)**
- **Operates in 2 modes (Forward bias and Reverse bias)**

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Design and Simulations

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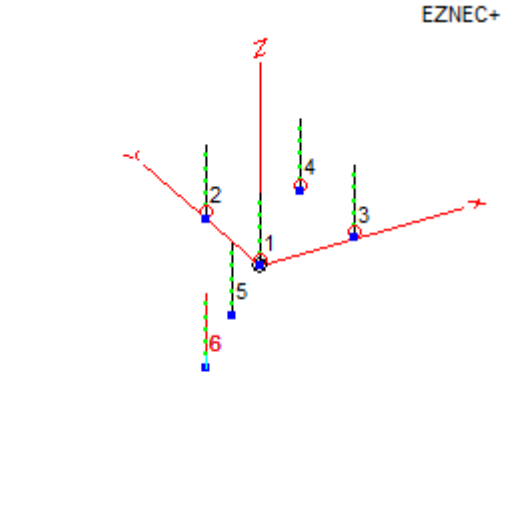
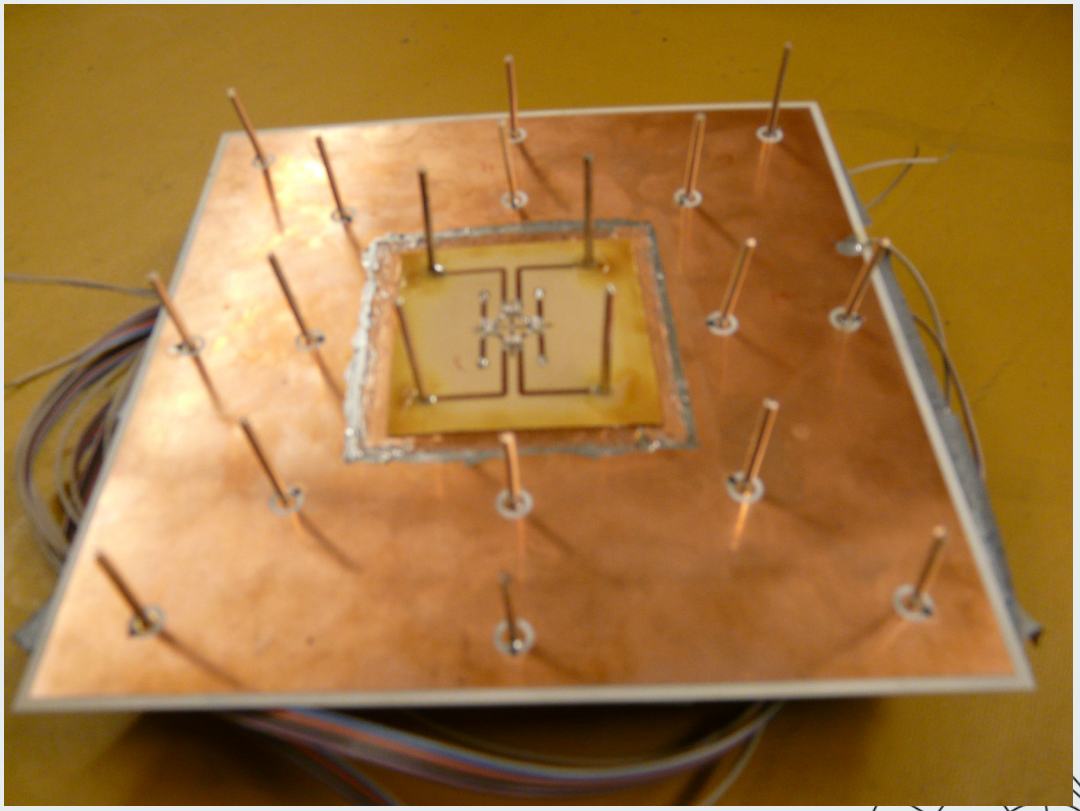
Original Square array with some added parasitic element





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Design and Simulations

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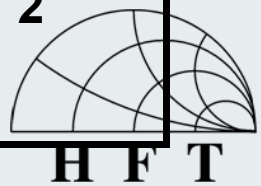
Wire No	End 1	Coordinate (mm)			End 2	Cordinate (mm)			Dia (mm)
		X	Y	Z		X	Y	Z	
1		0	0	0		0	0	28	2
2		0	35	0		0	35	28	2
3		35	0	0		35	0	28	2
4		35	35	0		35	35	28	2



Design and Simulations

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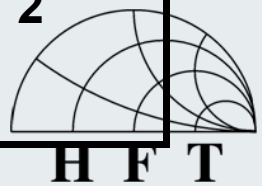
Wire No	End 1	Coordinate (mm)			End 2	Cordinate (mm)			Dia (mm)
		X	Y	Z		X	Y	Z	
5		-24	-24	0		-24	-24	23	2
6		-48	-48	0		-48	-48	23	2
7		17.5	-26	0		17.5	-26	23	2
8		17.5	-52	0		17.5	-52	23	2



Design and Simulations

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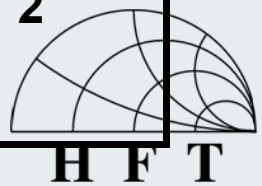
Wire No	End 1	Coordinate (mm)			End 2	Cordinate (mm)			Dia (mm)
		X	Y	Z		X	Y	Z	
9		59	-24	0		59	-24	23	2
10		83	-48	0		83	-48	23	2
11		61	17.5	0		61	17.5	23	2
12		61	17.5	0		61	17.5	23	2



Design and Simulations

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Wire No	End 1	Coordinate (mm)			End 2	Cordinate (mm)			Dia (mm)
		X	Y	Z		X	Y	Z	
13		59	59	0		59	59	23	2
14		83	83	0		83	83	23	2
15		17.5	61	0		17.5	61	23	2
16		17.5	87	0		17.5	87	23	2

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Design and Simulations

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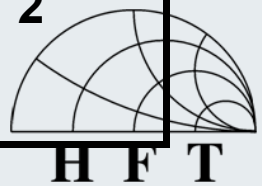
Wire No	End 1	Coordinate (mm)			End 2	Cordinate (mm)			Dia (mm)
		X	Y	Z		X	Y	Z	
17		-24	59	0		-24	59	23	2
18		-48	83	0		-48	83	23	2
19		-26	17.5	0		-26	17.5	23	2
20		-52	17.5	0		-52	17.5	23	2



Design and Simulations

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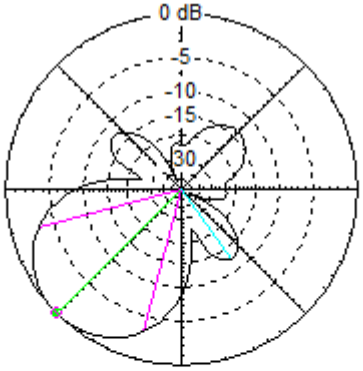
New Beams obtained

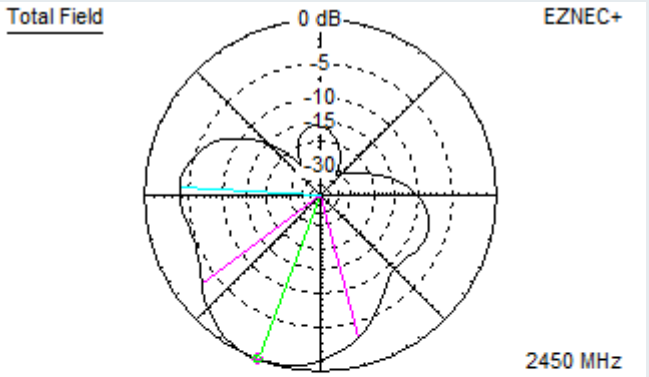
With wires No 5 and 6



Azimuth Plot		Cursor Az	225,0 deg.
Elevation Angle	0,0 deg.	Gain	13,29 dBi
Outer Ring	13,29 dBi		0,0 dBmax
			0,0 dBmax3D

3D Max Gain	13,29 dBi
Slice Max Gain	13,29 dBi @ Az Angle = 225,0 deg.
Front/Back	13,51 dB
Beamwidth	60,0 deg.; -3dB @ 195,0, 255,0 deg.
Sidelobe Gain	0,99 dBi @ Az Angle = 306,0 deg.
Front/Sidelobe	12,3 dB

With Wires 7 and 8



Azimuth Plot		Cursor Az	249,0 deg.
Elevation Angle	0,0 deg.	Gain	11,31 dBi
Outer Ring	11,31 dBi		0,0 dBmax
			0,0 dBmax3D

3D Max Gain	11,31 dBi
Slice Max Gain	11,31 dBi @ Az Angle = 249,0 deg.
Front/Back	20,91 dB
Beamwidth	68,4 deg.; -3dB @ 216,3, 284,7 deg.
Sidelobe Gain	7,46 dBi @ Az Angle = 177,0 deg.
Front/Sidelobe	3,85 dB

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Designs and Simulations

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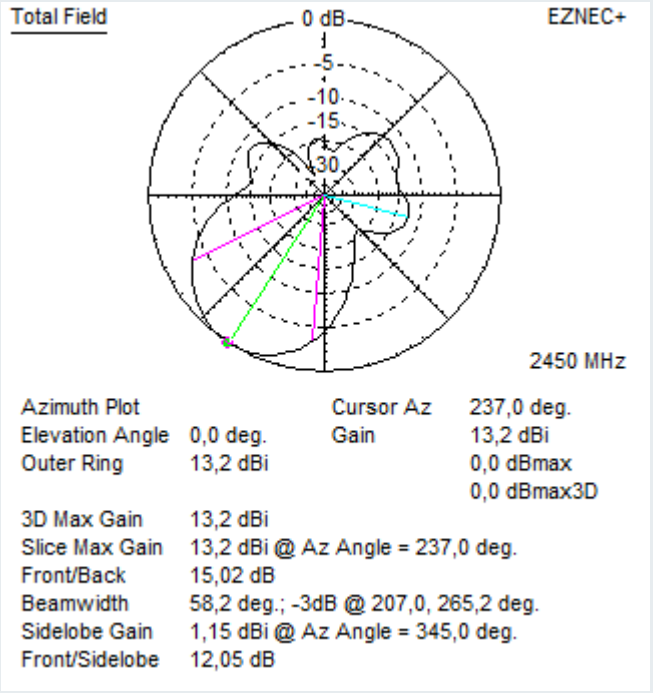
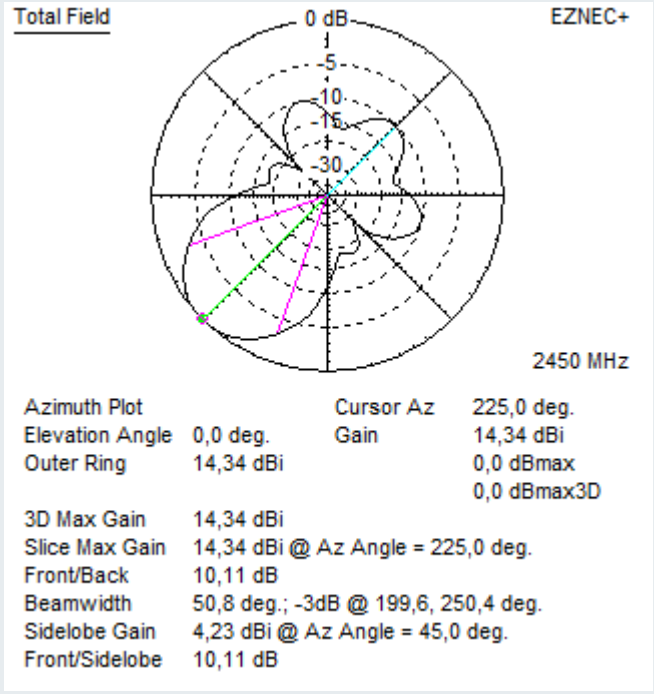
New beams obtained (contd)

With 5,6,7&8



Azimuth Plot		Cursor Az	237,0 deg.
Elevation Angle	0,0 deg.	Gain	13,2 dBi
Outer Ring	13,2 dBi		0,0 dBmax
			0,0 dBmax3D
3D Max Gain	13,2 dBi		
Slice Max Gain	13,2 dBi @ Az Angle = 237,0 deg.		
Front/Back	15,02 dB		
Beamwidth	58,2 deg.; -3dB @ 207,0, 265,2 deg.		
Sidelobe Gain	1,15 dBi @ Az Angle = 345,0 deg.		
Front/Sidelobe	12,05 dB		

with 5,6,7,8,19 and 20



Azimuth Plot		Cursor Az	225,0 deg.
Elevation Angle	0,0 deg.	Gain	14,34 dBi
Outer Ring	14,34 dBi		0,0 dBmax
			0,0 dBmax3D
3D Max Gain	14,34 dBi		
Slice Max Gain	14,34 dBi @ Az Angle = 225,0 deg.		
Front/Back	10,11 dB		
Beamwidth	50,8 deg.; -3dB @ 199,6, 250,4 deg.		
Sidelobe Gain	4,23 dBi @ Az Angle = 45,0 deg.		
Front/Sidelobe	10,11 dB		

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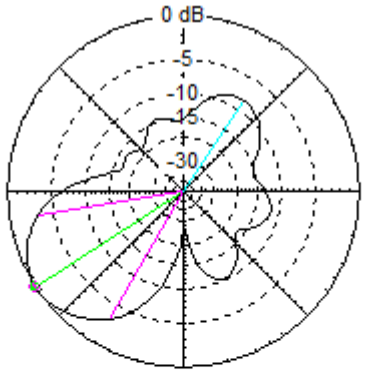
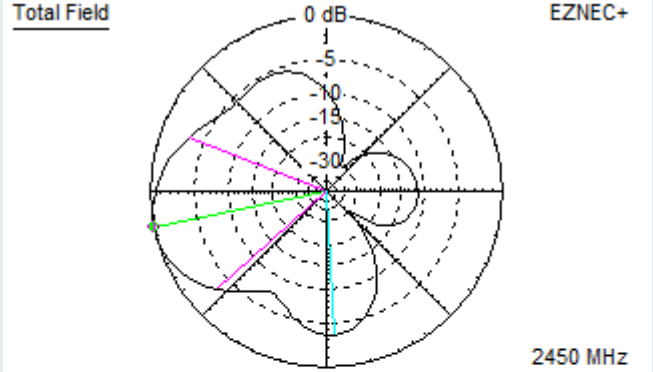
With 5,6 19 and 20



Azimuth Plot		Cursor Az	213,0 deg.
Elevation Angle	0,0 deg.	Gain	14,0 dBi
Outer Ring	14,0 dBi		0,0 dBmax
			0,0 dBmax3D
3D Max Gain	14,0 dBi		
Slice Max Gain	14,0 dBi @ Az Angle = 213,0 deg.		
Front/Back	11,22 dB		
Beamwidth	50,3 deg.; -3dB @ 189,7, 240,0 deg.		
Sidelobe Gain	5,75 dBi @ Az Angle = 57,0 deg.		
Front/Sidelobe	8,25 dB		

with 19 and 20



Azimuth Plot		Cursor Az	192,0 deg.
Elevation Angle	0,0 deg.	Gain	11,63 dBi
Outer Ring	11,63 dBi		0,0 dBmax
			0,0 dBmax3D
3D Max Gain	11,63 dBi		
Slice Max Gain	11,63 dBi @ Az Angle = 192,0 deg.		
Front/Back	11,87 dB		
Beamwidth	63,0 deg.; -3dB @ 158,7, 221,7 deg.		
Sidelobe Gain	8,24 dBi @ Az Angle = 273,0 deg.		
Front/Sidelobe	3,39 dB		

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Design and Simulations

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PIN Diodes was used to switch off and on the parasitic elements

- **At forward bias the parasitic element is switched on**
- **At Zero or reverse bias, the parasitic element is switched off**
- **An Inductor is connected to absorb any current due to DC power supply**

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CONSTRUCTION AND TEST RESULTS

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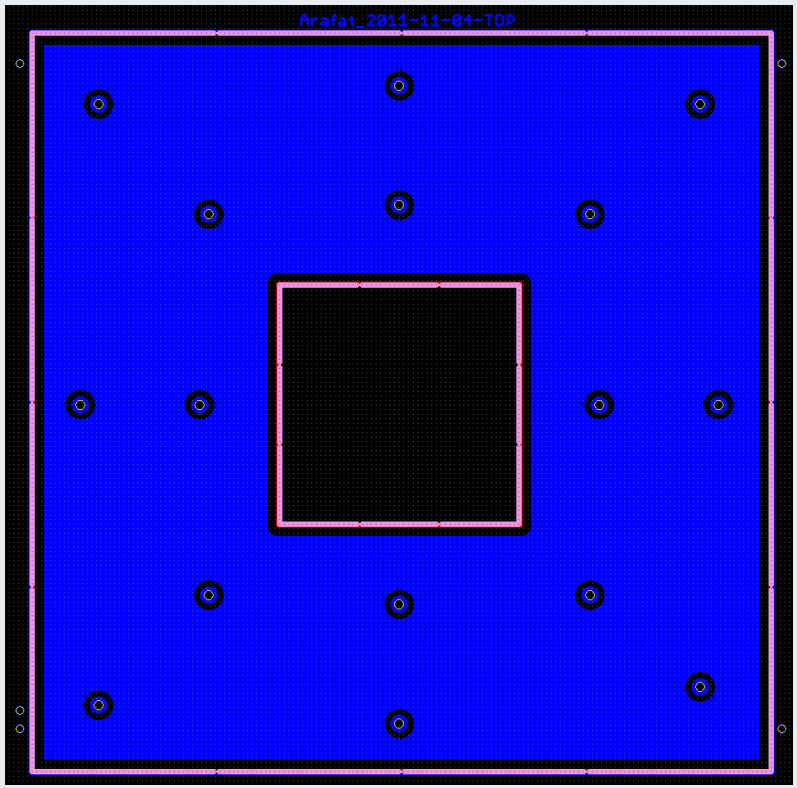
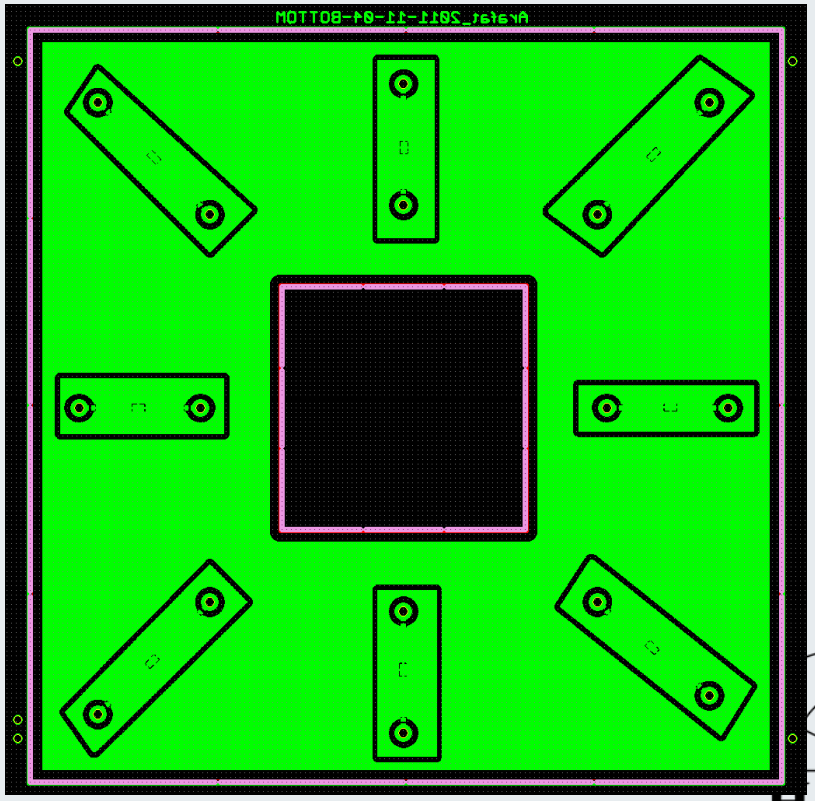
Layout done with Eagle card

Top Side



Bottom Side



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Construction and Test results

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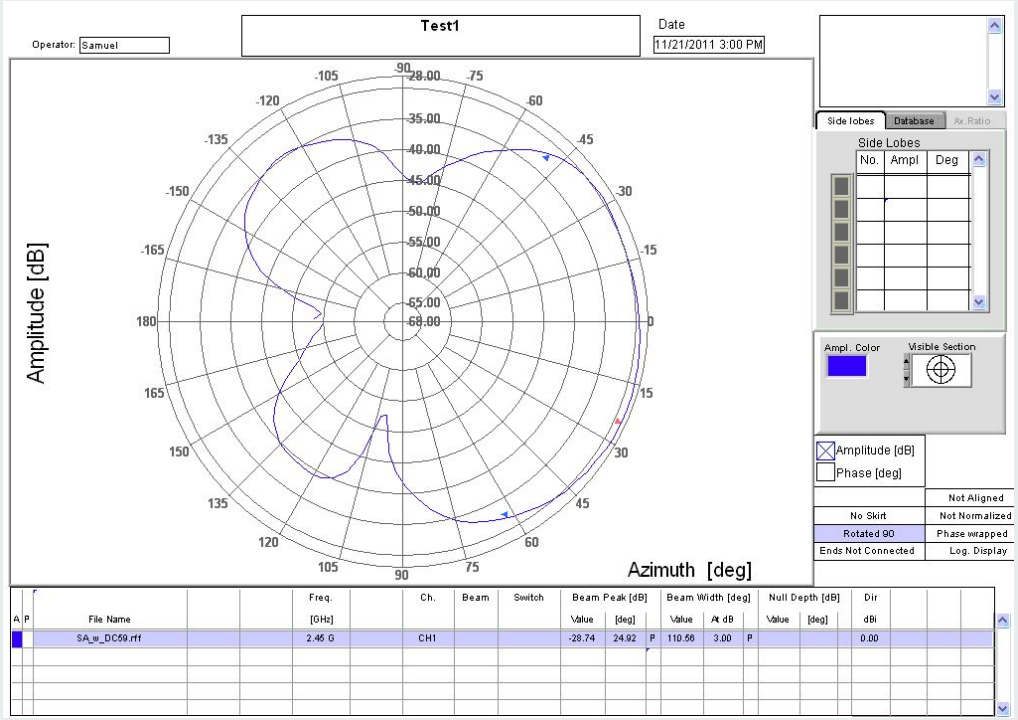
Results:

With four Active element



Beamwidth of 110^0

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Construction and Test results

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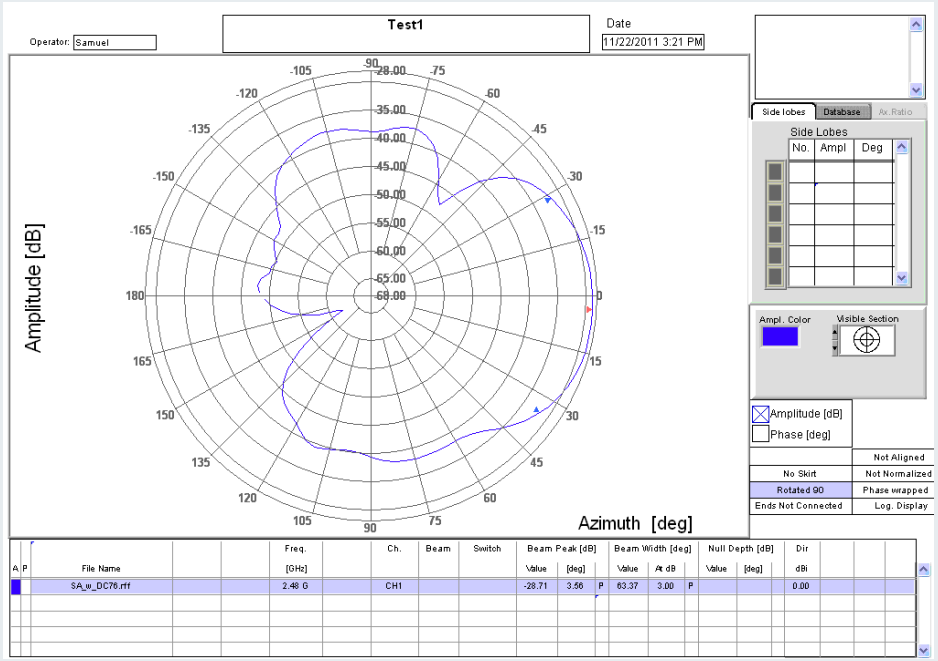
Beam formed with 2 Parasitic elements (5 &6)



Beamwidth is 63.37^0 in the direction of 3.56^0

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Construction and Test results

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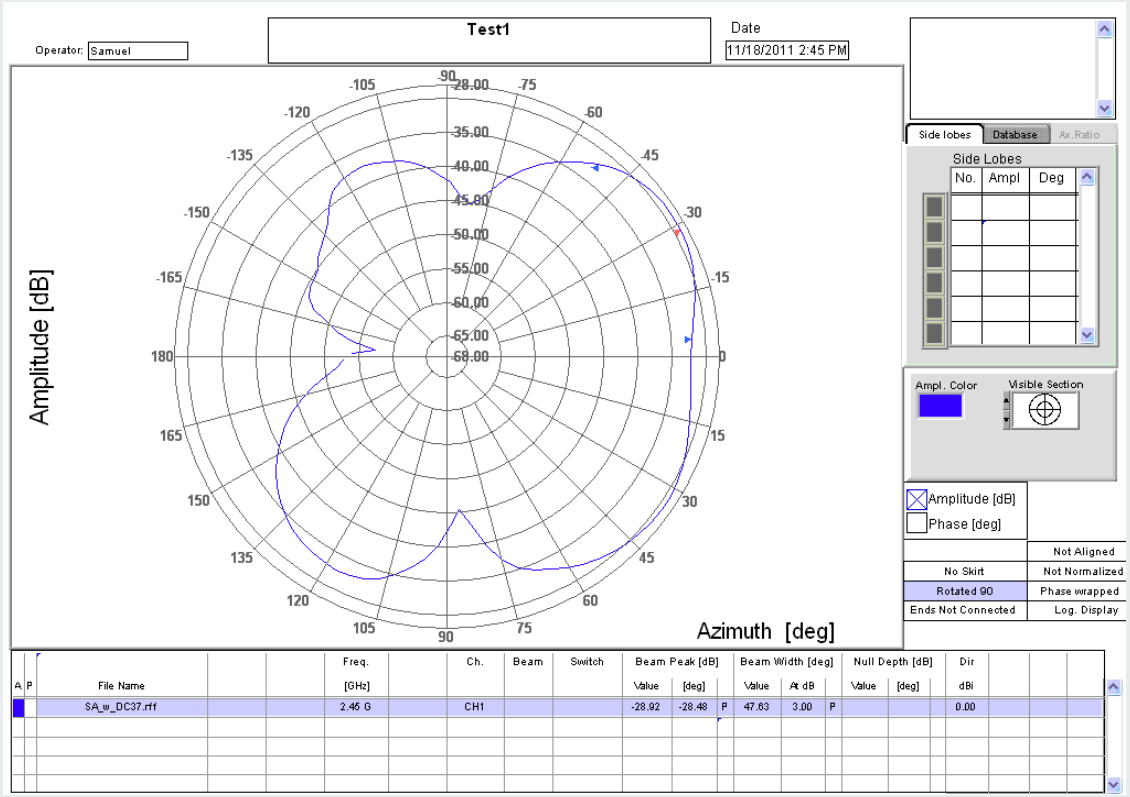
Beam formed with 2 Parasitic elements (7 & 8)



Beamwidth is 47.63^0 in the direction of -28.48^0

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Construction and Test results

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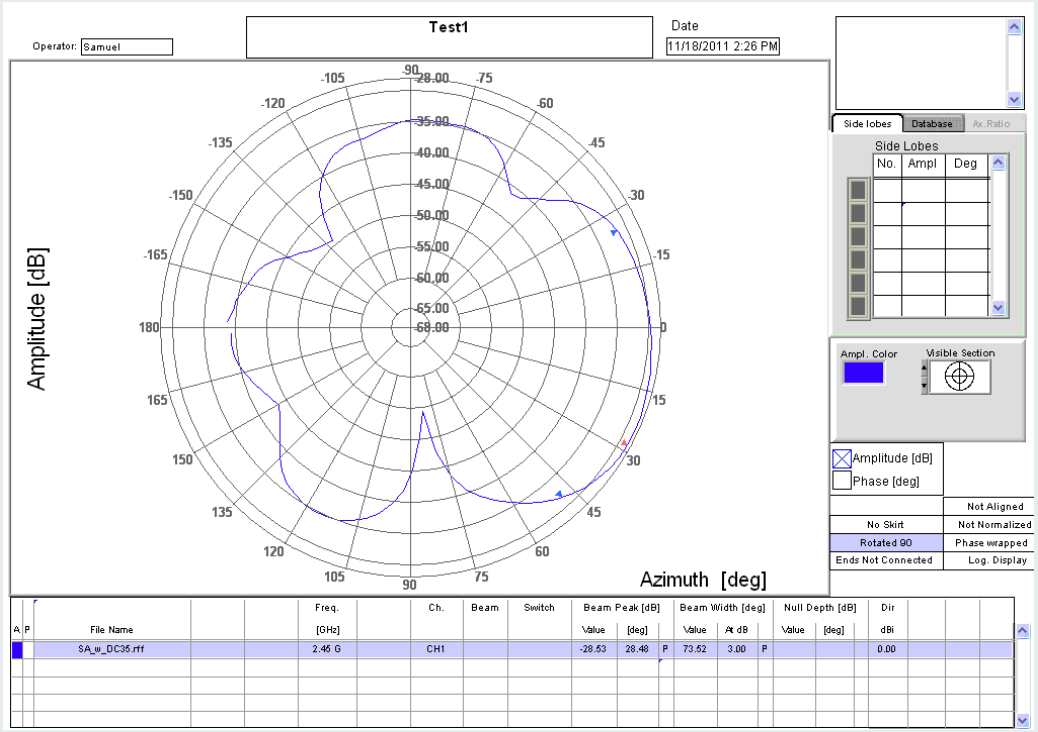
Beam formed with four parasitice elements (5,6,7&8)



Beamwidth is 73.52^0 in the direction of 28.48

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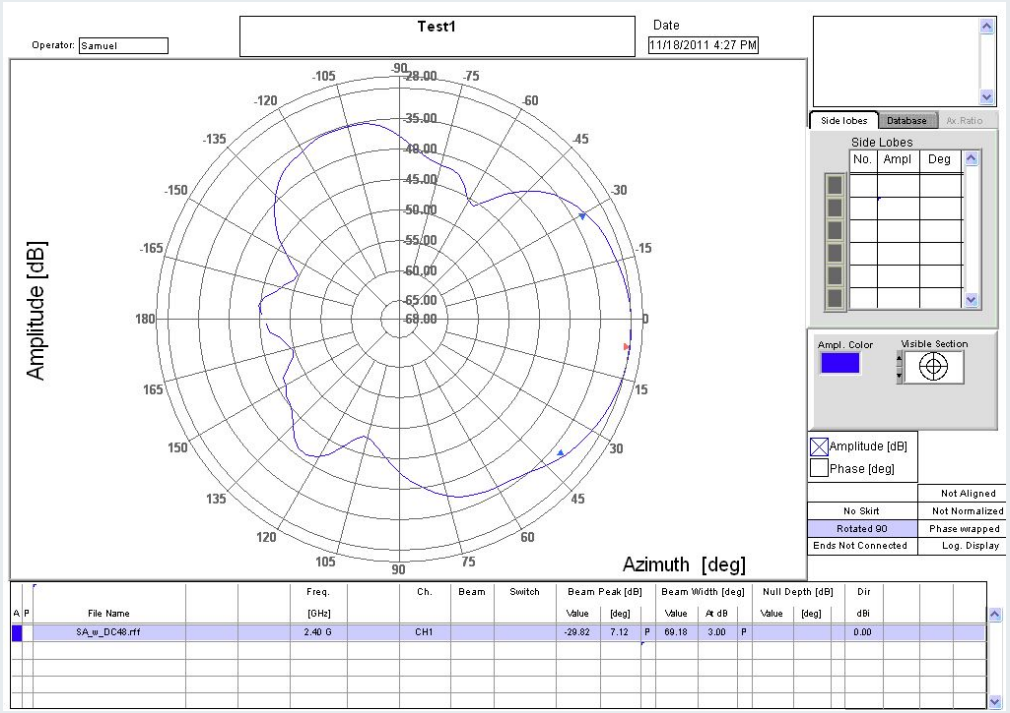
Construction and Test results

UNIVERSITÄT DUISBURG ESSEN

Beam formed with four Parasitic elements (5, 6, 19 & 20)



Beamwidth is 69.18 in the direction of 7.12

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Construction and Test results

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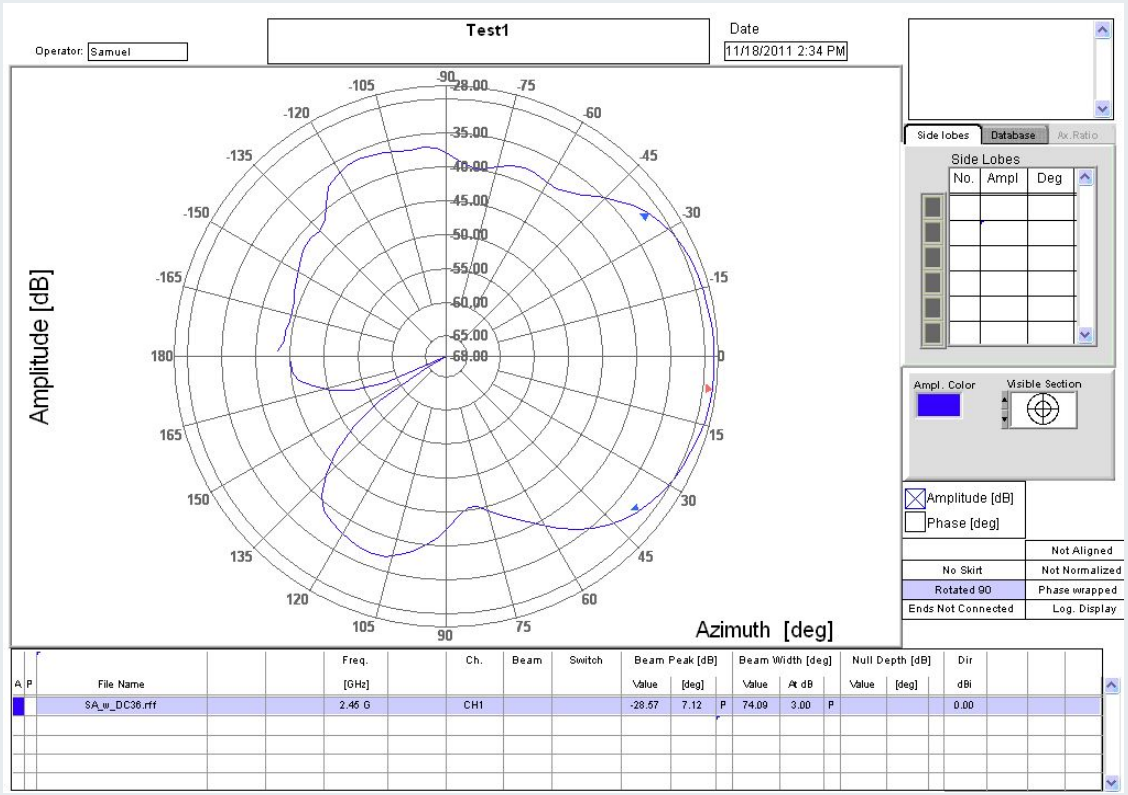
Beam formed with 6 parasitic elements (5,6,7,8,19&20)



Beamwidth is 74.09^0 in the direction 7.12. No transmission or reception at 155^0

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Construction and Test results

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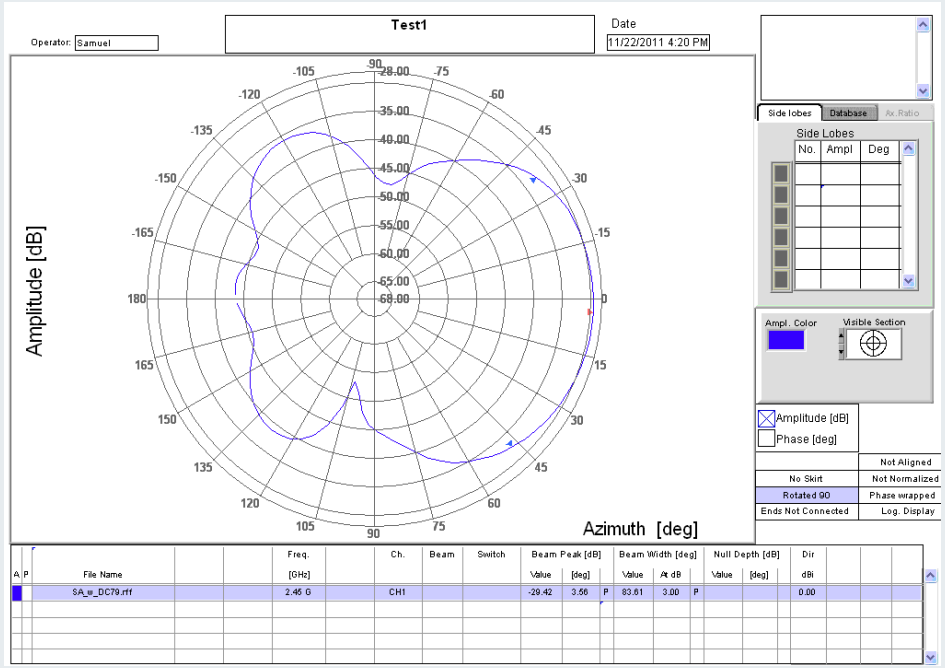
An Improved beam (with parasitic elements 5 and 6)



Beamwidth is 83.61 in the direction of 3.56

Radiation due to spurios currents from the inductor and the flexible wires was minimized

The beam looks more symmetric

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SUMMARY AND CONCLUSION

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BEAMWIDTH REDUCED

IMPROVEMENT IN GAIN

MORE NARROWER BEAMS OBTAINED

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APPRECIATION

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THANK YOU SO MUCH FOR YOUR ATTENTION

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