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The effect of parasitic element on the H shaped patch antenna performance

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ABSTRACT:

Several techniques have been proposed to reduce the size of conventional management services agreements for Microstrip Patch Antennas (MPAs), Such as long-standing public service agreements, and to overcome their narrow bandwidth problem, which limits their application to modern wireless systems and increases its benefits.

This paper aimed to study all the geometry H-shape of this MSA with the dimensions. It also intends to study the Effect of Parasitic Elements on H-Shape MSA Characteristics, and Make several experiments and compare these experiences to get the best result.

1. Introduction

H-Shape Patch Antenna is very important technique because it has several advantages over the traditional wired antenna. The Microstrip Antennas (MSA) has been used in several applications including Global Positioning System, various radar systems [1-7], and satellite mobile communications. It has several advantages such as low cost, small size, light weight and the ability of integration with RF devices, MMIC circuits.

At present, there is an urgent need for RF devices, and hand-held terminals Such as smart phones, laptops and satellites, making it necessary to reduce the size of MSAs while improving their gain. Several techniques have been proposed to reduce the size of traditional administrative services such as: the rectangular MSAs, and to overcome their narrow bandwidth problem, as proposed [8], Another technique of reducing the size of MSAs of is to terminate one of the radiating edges with a short circuit, as proposed [9-10] . Another more interesting method is to modify the geometry of MSAs. The MSA forms were studied by authors [11-14]. The most interesting form is MS-Hped MSA, the results presented in [15] show that HA-Shaped MSA has a much smaller size than that of the rectangular and semicircular MSA antennas. For the purpose of practical design, more information about this type of MSAs is needed, and a study based on the full-wave method.

The H-shaped microstrip antenna consists of an H-shaped patch, supported on a grounded dielectric sheet of thickness (h) and dielectric constant (εr). The physical dimensions of the H-shaped microstrip patch antenna are shown in Figure 3-01. The patch has a total length of (L). It can be divided into three parts: a center conductor strip with length (s) and width (d), and two identical conductor strips with length (L) and width (W) on both sides. The feed point is located at the point (x0, y0).

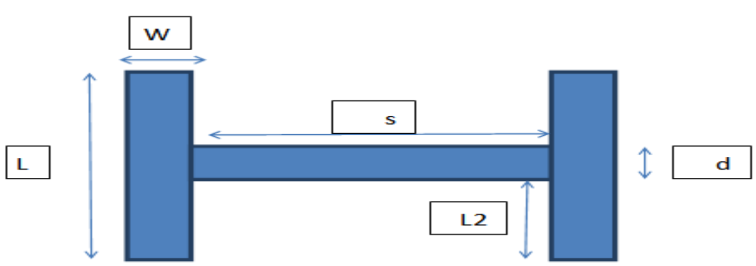


Figure 3-01: General Configuration of the H-shaped patch antenna.

2 Basic Design (H-Shaped Only)

Figure 3-02 shows the general geometry shape of this MSA with the dimensions. , as shown in Table 3.01.

The characteristics of H-Shaped are shown in this section only without any parasitic, slot or array.

2.1 ADS Geometry Layout and Dimensions

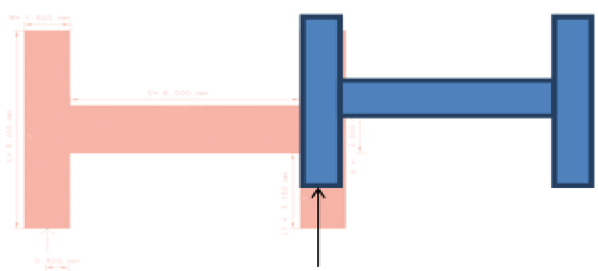


Figure 3-02: H-Shaped MSA to be studied in this thesis

Length (L)	Width (W)	L1	S	d
8.0 mm	1.6 mm	3.15 mm	8.0 mm	2.0 mm

Table 3.01: Parameters Dimensions Of H-Shape Patch Antenna

The air gap can be used to in order to get a better gain with an improved bandwidth. Several experiments have been conducted, and for further information refer to Appendix A.

Table 3.02 offers an conclusion for such experiments as it list the proposed H-Shaped MSA antenna specifications.

Frequency (f0)	Substrate	Dielectric Constant εr	Air gap High (h1)	Substrate High (h2)	Loss Tangent
8.255 GHz	Roger	3.38	5.00 mm	0.203 mm	0.0027

Table 3.02: H-Shape Antenna Specifications:

2.2 ADS Simulation Result

The frequency response, radiation pattern characteristics of power, antenna parameters and plot of absolute field fir this antenna were shown in the following figure;

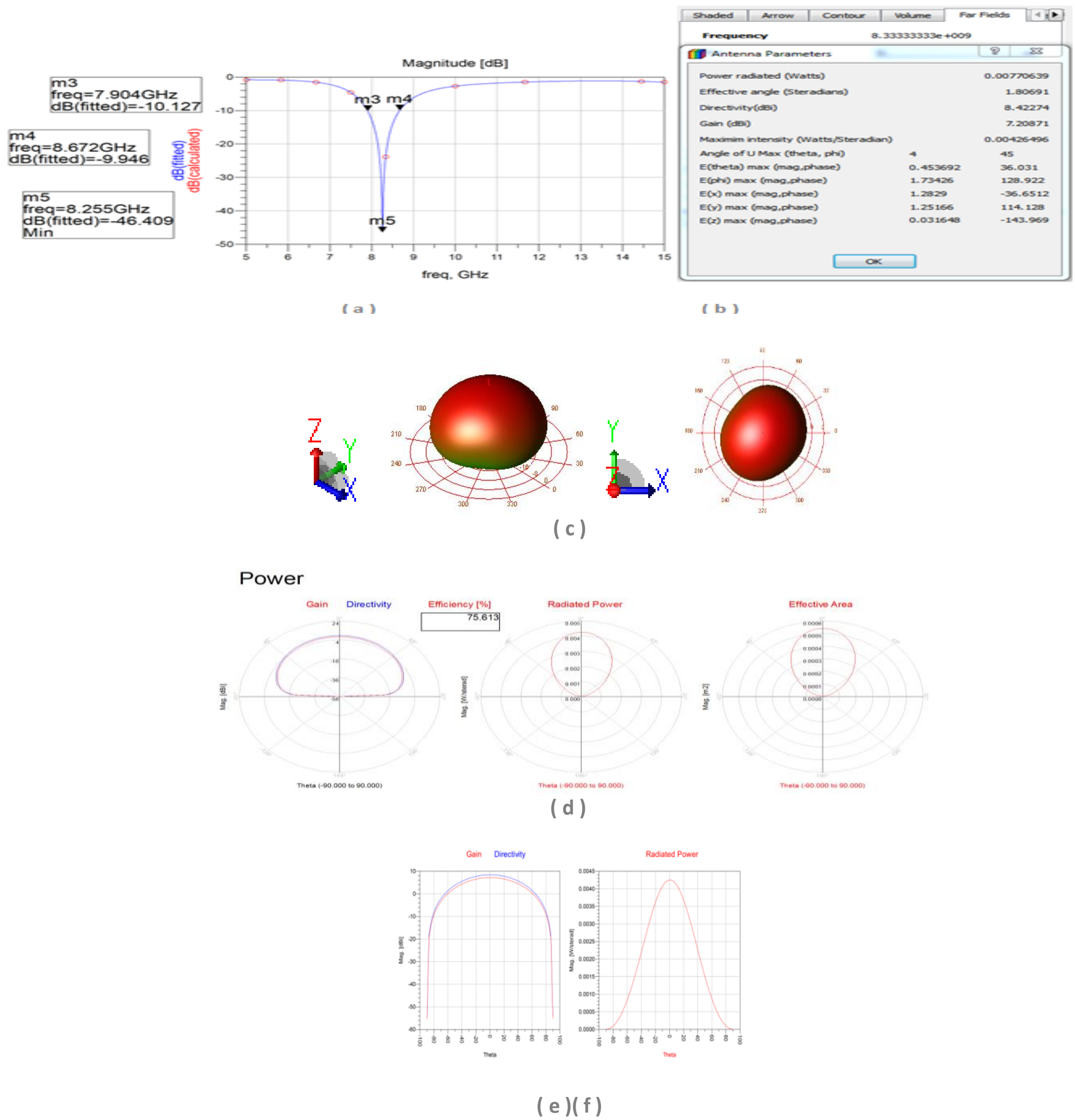


Figure 3.03: H-Shape MSA Parameters @ 8.33GHz (a): Return Loss, (b): Antenna Parameters, (c) Radiation Pattern, (d): Power Characteristics, (e): Gain vs. Directivity, (e) Radiated Power

2.3 Discussion and Conclusion

Figure (3.03) shows the result of ADS simulation for return loss (S11) of this MSA antenna, it also clarified that the best antenna radiation can be reached at about 8.225 GHz (fc)where S11=-46dB. Figure3.04 shows the parameters of simulated antenna by ADS, while Figure 3.05 shows the radiation pattern. The proposed H-Shape MSA has its best gain of 7.209 dBi at 8.33 GHz with a directivity of 8.422 dBi, giving an efficiency of 76%.

Conclusion:

This study concluded that antenna has a narrow band bandwidth of about 768 MHz, which is considered as unreliable microscope antenna characteristic.

3 Effects of Parasitic Elements on H-Shape MSA Characteristics

One of the most attractive techniques to improve MSA is adding a parasitic element to the driven element, especially the gain and BW.

When parasitic elements are used, electromagnetic energy is coupled from the driven patch to it by the main of both the space and the surface waves, and there is a gap between any two parasitic that must be small.

3.1 Effect of single parasitic element:

Here we will show the effect of adding a single parasitic slice to the nearest edge of the H-shaped component of the feeding outlet, parallel to it.

3.1.1 ADS Geometry Layout and Dimensions

Here we have fixed all dimensions for the driven element by adding a new slice with Length (Lp) , Width(Wp) and Gap(Sp).

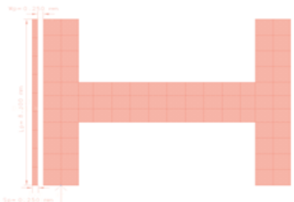


Figure 3-04: H-Shaped with single parasitic element.

Length (Lp)	Width (Wp)	Gap (Sp)
8.0 mm	Varied values	Varied values

Table 3.03: Parameters Dimensions of the parasitic element

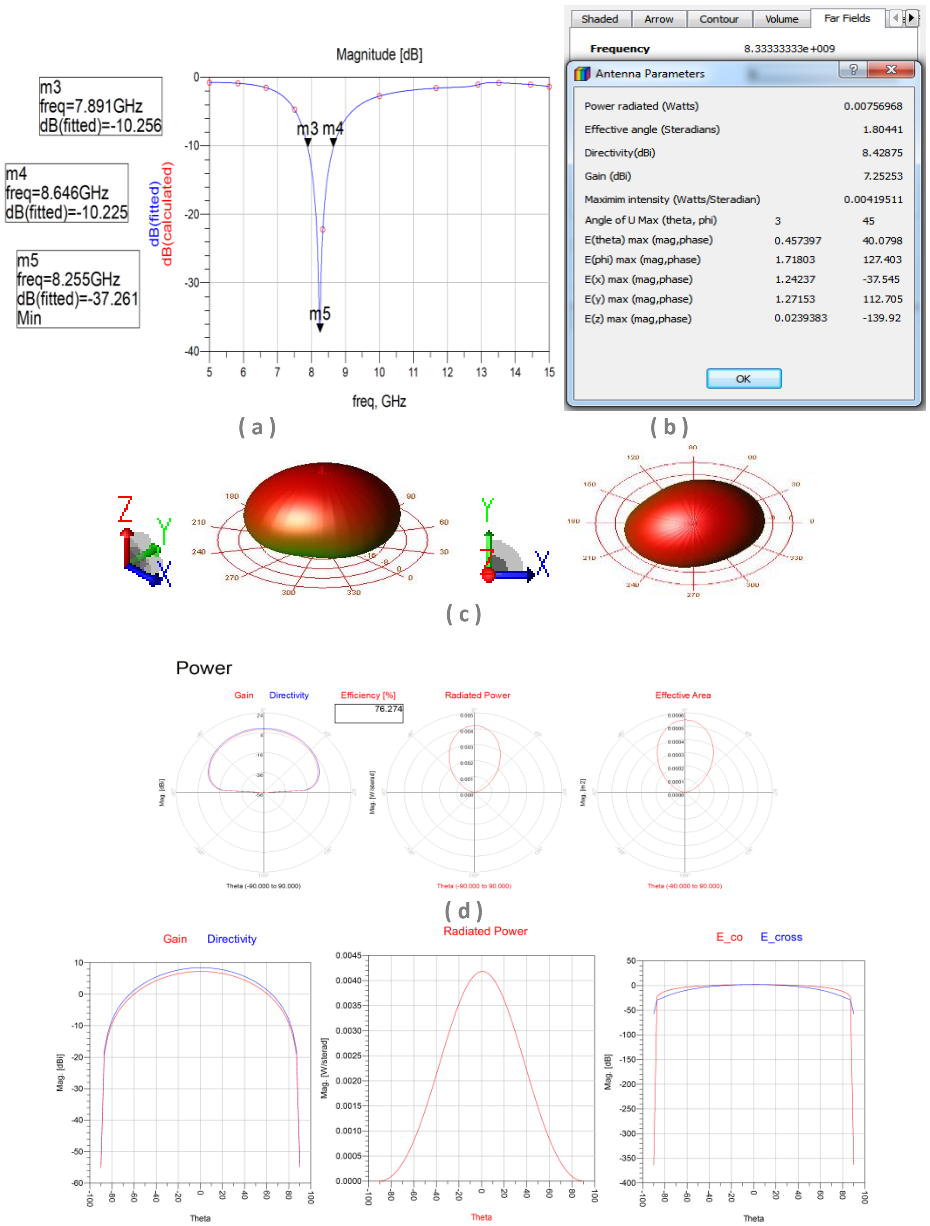
3.3.1.1.A Experiment 1 : Single Parasitic with fixed width, Wp=0.25mm,and varies gap values, Sp=varied values.

In the first experiment, we will change values Sp, Wp, Lp, and I Started with assuming very small values to know the effect on the gap between the driven element and the parasitic. When the parasitic is almost touching the driven element.

<u>3.1.1.A.1 Results of ADS Simulation for Exp. 1</u>

		First Band					
		FL/FH	BW(GHz)	BW(%)	S11	Gain(dB) @ (8.33GHz)	Gain(%)
Wp=00	Sp=00	7.904/8.672	0.768	As Reference	-46	7.21	AS Reference
0.25	0.25	7.878/8.646	0.768	0	-55	7.23	0.28%
	0.5	7.878/8.646	0.768	0	-51	7.23	0.28%
	0.75	7.891/8.646	0.755	-1.7	-40	7.24	0.42%
	1	7.891/8.646	0.755	-1.7	-39	7.24	0.42%
	2	7.891/8.646	0.755	-1.7	-37	7.25	0.55%

Table 3.4: ADS Simulation Results for Experiment #1, Wp= 0.25mm with respect to different values of Sp.



(e)(f)(g)

Figure 3.04: H-Shape MSA with single parasitic, Wp=0.25mm, Sp=2.0mm@ 8.33GHz (a): Return Loss, (b): Antenna Parameters, (c) Radiation Pattern, (d): Power Characteristics, (e) Gain vs. Directivity (e) Linear Polarizations

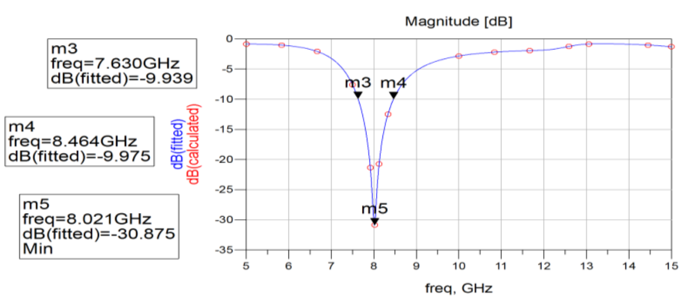
3.1.1.B Experiment 2: Single Parasitic with Varies width, Wp= varied values, and fixed gap, Sp=0.25mm.

In the second experiment, we will change values Wp= varies values, fixing the gap to be Sp =0.25mm, Lp= 8.3mm , and I Started with assuming very small values to know the effect on the gap between the driven element and the parasitic, When the parasitic is almost touching the driven element, When the parasitic is almost a few micron in width.

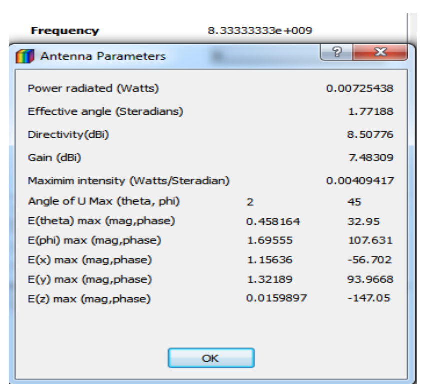
<u>3.1.1.B.1 Result of ADS Simulation for Exp. 2</u>

		First Band					
		FL/FH	BW(GHz)	BW(%)	S11	Gain(dB) @ (8.33GHz)	Gain(%)
Sp	Wp	7.9/8.67	0.77	Reference	-46	7.21	Reference
0.25	0.25	7.9/8.67	0.77	0%	-55	7.23	0.28%
	0.5	7.9/8.67	0.77	0%	-48	7.24	0.42%
	0.75	7.9/8.67	0.77	0%	-44	7.24	0.42%
	1	7.9/8.67	0.77	0%	-41	7.26	0.69%
	2	7.7/8.5	0.8	6.70%	-33	7.4	2.64%
	3	7.63/8.46	0.83	10.70%	-31	7.48	3.74%

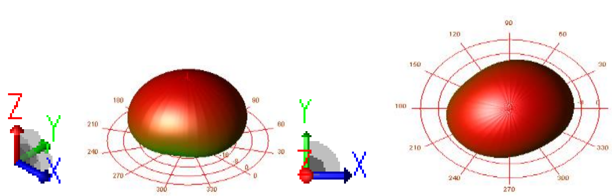
Table 3.5: ADS Simulation Results for Experiment #2 ,Sp= 0.25mm with respect to different values of Wp.



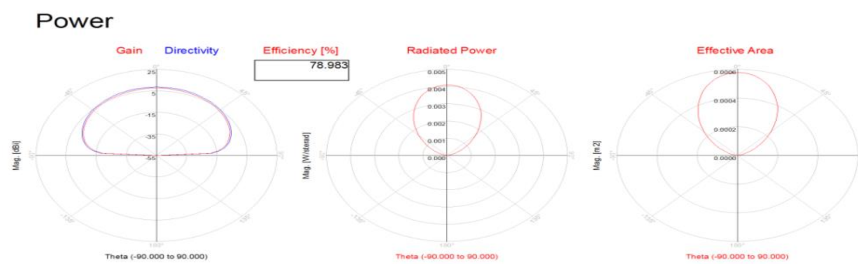
(a)



(b)



(c)



(d)

Figure 3.05: H-Shape MSA with single parasitic, Wp=3.0mm, Sp=0.25mm@ 8.33GHz (a): Return Loss, (b): Antenna Parameters, (c) Radiation Pattern, (d) Power Characteristics

3.1.2 Discussion of Experiments 1 and 2.

The simulation result for Experiments 1 and 2 are shown in Tables (3.4) and (3.5).

The table (3.4) shows that there is no bandwidth development by choosing parasitic dimensions, where there is a reversing relationship between the gap, Sp, and the return loss, S11.

The table (3.5) shows the improvement in bandwidth and BW, we conclude to increase the parasitic width leads to more improvement in the bandwidth value.

Figures 3.04 and 3.05 , shows the antenna parameters for Experiment 1and 2 ,when Sp=2.0 mm. Gain for exp1 is G= 7.253 dBi , directivity D= 8.429 dBi, and the efficiency = 76%. For exp2, the gain is G=7.483 dBi, directivity D=8.508 dBi and the efficiency is 79%.

Based on two experiments when adds a parasitic element lead to improve on the gain and bandwidth.

3.1.3 Experiment 3: Single Parasitic with different width and gap value

We use the same methodology in “Experiment 1 and 2”, studying the effect of the parasitic element for different values of Wp and Sp. The result is shown in Table (3.6).

3.1.3.1 The Result of ADS Simulation for Exp 3.

	First Band

		FL/FH	BW(GHz)	BW(%)	S11	Gain(dB) @ (8.33GHz)	Gain(%)
Wp	Sp	7.9/8.67	0.77	Reference	-46	7.21	Reference
0.25	0.25	7.9/8.67	0.77	0	-55	7.23	0.28%
	0.5	7.9/8.67	0.77	0	-51	7.23	0.28%
	0.75	7.9/8.67	0.77	0	-40	7.24	0.42%
	1	7.9/8.67	0.77	0	-39	7.24	0.42%
	2	7.9/8.67	0.77	0	-37	7.25	0.55%
0.5	0.25	7.9/8.67	0.77	0	-48	7.24	0.42%
	0.5	7.9/8.67	0.77	0	-43	7.24	0.42%
	0.75	7.9/8.67	0.77	0	-42	7.25	0.55%
	1	7.9/8.67	0.77	0	-40	7.25	0.55%
	2	7.9/8.67	0.77	0	-36	7.26	0.69%
0.75	0.25	7.9/8.67	0.77	0	-44	7.24	0.42%
	0.5	7.9/8.67	0.77	0	-42	7.25	0.55%
	0.75	7.9/8.67	0.77	0	-41	7.26	0.69%
	1	7.9/8.67	0.77	0	-40	7.26	0.69%
	2	7.9/8.67	0.77	0	-38	7.27	0.83%
1	0.25	7.9/8.67	0.77	0	-41	7.26	0.69%
	0.5	7.9/8.67	0.77	0	-40	7.26	0.69%
	0.75	7.9/8.67	0.77	0	-39	7.27	0.83%
	1	7.9/8.67	0.77	0	-38	7.27	0.83%
	2	7.9/8.67	0.77	0	-35	7.28	0.97%
2	0.25	7.7/8.5	0.8	6.70%	-33	7.4	2.64%
	0.5	7.7/8.5	0.8	6.70%	-38	7.38	2.36%
	0.75	7.76/8.59	0.83	10.70%	-40	7.38	2.36%
	1	7.78/8.59	0.81	8%	-40	7.37	2.22%
	2	7.84/8.64	0.8	6.70%	-35	7.36	2.08%
3	0.25	7.63/8.46	0.83	10.70%	-31	7.48	3.74%
	0.5	7.7/8.5	0.8	6.70%	-35	7.47	3.61%
	0.75	**7.7/8.5**	**0.8**	**6.70%**	**-40**	**7.48**	**3.74%**
	1	7.75/8.6	0.85	13.33%	-44	7.45	3.33%
	2	7.81/8.65	0.84	12%	-34	7.43	3.05%

Table 3.6: ADS Simulation Results for Single Parasitic with different width and gap values.

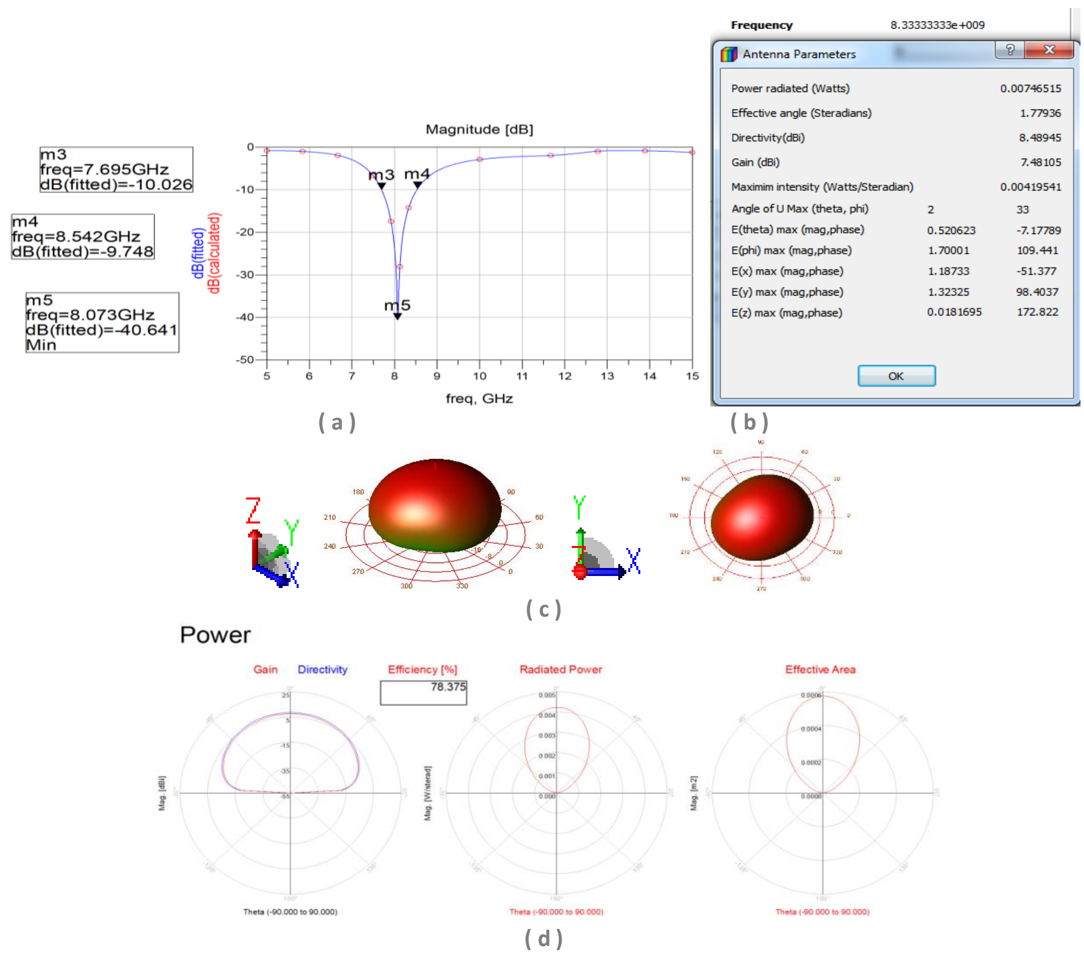


Figure 3.06: H-Shape MSA with single parasitic for Wp=3mm, and Sp=075mm @ 8.33GHz (a): Return Loss, (b): Antenna Parameters, (c) Radiation Pattern, (d): Power Characteristics, (e)

3.1.4 Discussion and Conclusion

Studying the effect of the parasitic element for various values of Wp and Sp

1- Bandwidth improvement is controlled by both the width of the parasitic element, Wp, and the gap distance, Sp.
2- Bandwidth and Gain improvement occurred when the parasitic width becomes larger, and it continued to improve by increasing Wp, but there is a limitation for this increasing as shown in the table 3.6,
3- Gain is more sensitive to change by the parasitic element with any width, Wp, and any gap distance, Sp.

4- With large values of Wp, gain has a limitation of improvement as well as the bandwidth.
5- Parasitic element has a negative effect to the return loss, S11, of the antenna.

3.3.2 Effect of Double Parasitic Elements Parallel to the Two Identical Conductor Strips of the H-Shape MSA.

We studied the effect of adding double parasitic slices to both edges of the H-Shape driven element parallel to the feeding port.

3.2.1 ADS Geometry Layout and Dimensions

Here we fixed all the dimensions for the driven element which is the H-Shaped only without the parasitic slice, adding new slice with Lp, Wp and the Sp, which is the distance between the driven element and the parasitic element.

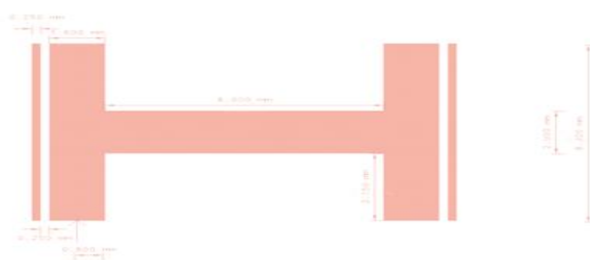


Figure 3.07: H-Shape with double parasitic element general layout.

3.2.1. A Experiment 4: Double Parasitic with fixed width, Wp=0.25mm, and different gap values

As for experiment 1, in this experiment, we varies the values of the Sp= varies values, Wp =0.25mm, Lp= 8.3mm, and fixed all the other H-Shaped parameters as it is.

3.3.2.1.A.1 ADS Simulation Result

		First Band					
		FL/FH	BW(GHz)	BW(%)	S11	Gain(dB) @ (8.33GHz)	Gain(%)
Wp	Sp	7.9/8.65	0.75	As Reference	-57	7.21	As Reference
0.25	0.25	7.9/8.65	0.75	0	-59	7.24	0.42%
	0.5	7.9/8.65	0.75	0	-52	7.25	0.55%
	0.75	7.9/8.65	0.75	0	-48	7.25	0.55%
	1	7.9/8.65	0.75	0	-39	7.26	0.69%

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	2	7.9/8.65	0.75	0	-41	7.27	0.83%

Table 3.7: ADS Simulation Results for Experiment #4, Wp= 0.25mm with respect to different values of Sp.

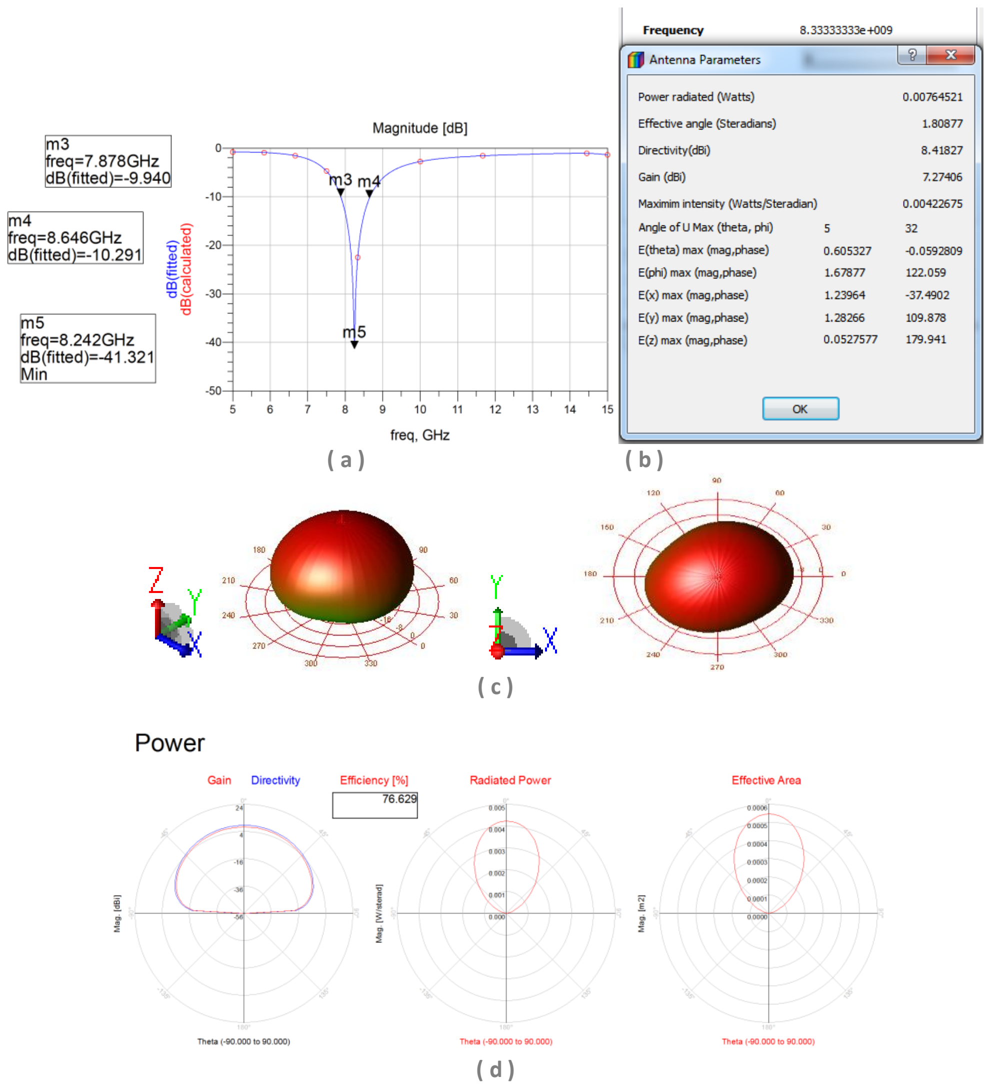


Figure 3.08: H-Shape MSA with double parasitic , Wp= 0.25 with respect to different gap values (Sp=075) @ 8.33GHz(a): Return Loss, (b): Antenna Parameters, (c) Radiation Pattern, (d): Power Characteristics

3.2.1.B Experiment 5: Double Parasitic with different width value and fixed gap, Sp=0.25mm

As for Experiment 2, in this experiment, we varies the values of the parasitic width, Wp= varies values, and fixing the gap value to be Sp =0.25mm, and Lp= 8.3mm, all the H-Shape driven patch parameters are fixed as they were.

3.2.1.B.1Results of ADS Simulation

		First Band					
		FL/FH	BW(GHz)	BW(%)	S11	Gain(dB) @ (8.33GHz)	Gain(%)
Sp	Wp	7.9/8.65	0.75	As Reference	-57	7.21	As Reference
0.25	0.25	7.9/8.65	0.75	0 %	-59	7.24	0.42%
	0.5	7.9/8.7	0.8	6.70%	-47	7.25	0.55%
	0.75	7.8/8.65	0.85	13.33%	-45	7.26	0.69%
	1	7.8/8.7	0.9	20%	-42	7.28	0.97%
	2	7.6/8.45	0.85	13.33%	-27	7.47	3.61%
	3	7.5/8.4	0.9	20%	-26	7.59	5.27%

Table 3.8: ADS Simulation Result for Experiment 5, Sp= 0.25mm with respect to different values of Wp.

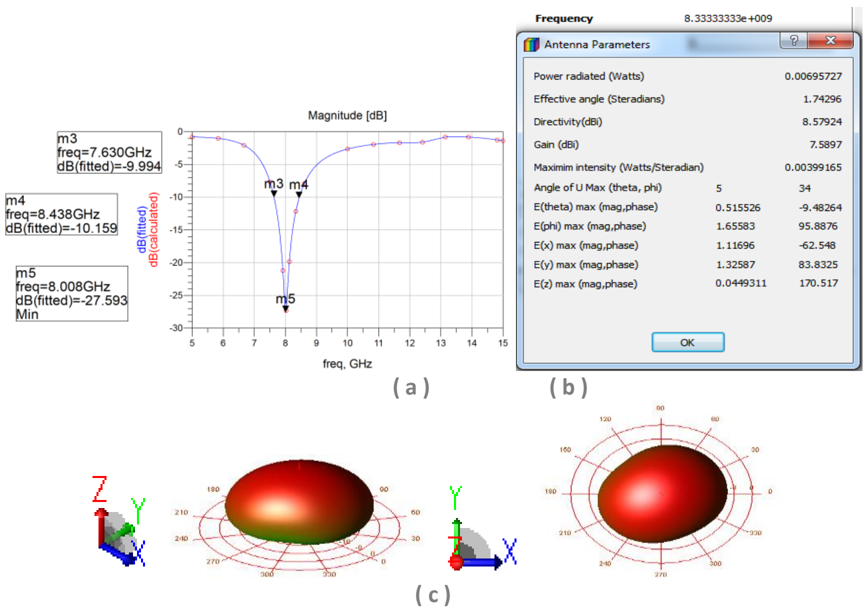


Figure 3.09: H-Shape MSA with double parasitic , Sp= 0.25 with respect to different Width values @ 8.33GHz (a): Return Loss, (b): Antenna Parameters, (c) Radiation Pattern, (d): Power Characteristics,

3.2.2 Discussion of Experiments 4 and 5

We show when use double parasitic elements give more improvement in the antenna parameters values.

3.2.3 Experiment 6: Double Parasitic with different width and gap values.

We used the same methodology in "Experiment 3", studying the effect of the double parasitic element for different values of Wp& Sp. The result is shown in Table (3.12).

3.2.3.1 The Result of ADS Simulation of Experiment 6

We shows the simulated result using ADS for different values of the parasitic element width in Table (3.12).

		First Band					
		FL/FH	BW(GHz)	BW(%)	S11	Gain(dB) @ (8.33GHz)	Gain(%)
Wp	Sp	7.9/8.65	0.75	As Reference	-57	7.21	As Reference
0.25	0.25	7.9/8.65	0.75	0	-59	7.24	0.42%
	0.5	7.9/8.65	0.75	0	-52	7.25	0.55%
	0.75	7.9/8.65	0.75	0	-48	7.25	0.55%
	1	7.9/8.65	0.75	0	-39	7.26	0.69%
	2	7.9/8.65	0.75	0	-41	7.27	0.83%
0.5	0.25	7.9/8.7	0.8	6.70%	-47	7.25	0.55%
	0.5	7.9/8.7	0.8	6.70%	-43	7.26	0.69%
	0.75	7.9/8.7	0.8	6.70%	-42	7.27	0.83%
	1	7.9/8.7	0.8	6.70%	-41	7.28	0.97%
	2	7.9/8.7	0.8	6.70%	-40	7.29	1.11%
3	0.25	7.5/8.4	0.9	20%	-26	7.59	5.27%
	0.5	7.55/8.45	0.9	20%	-29	7.58	5.13%
	0.75	7.6/8.5	0.9	20%	-32	7.59	5.27%
	1	7.65/8.55	0.9	20%	-42	7.56	4.85%
	2	7.75/8.6	0.85	13.33%	-37	7.51	4.16%

Table 3.12: ADS Simulation Results for Experiment #6

3.3.2.4 Discussion and Conclusion

Experiment 5 is the Best result for this experiment studying the ADS simulation results of this experiment shows that there are improvements in the gain and the bandwidth parameters using double parasitic elements compared to those for using only a single parasitic. When using double parasitic elements improves H-Shaped antennas BW and gain.

3.3 Effect of Double Parasitic Elements Parallel to the Central Strip Conductor of H-Shape MSA

In this section we studied the effect of adding double parasitic elements parallel to the central strip conductor of the proposed H-Shape MSA.

3.3.1 Experiment 7:

Here we studied the effect of adding the parasitic elements at both sides of the central strip conductor of the H-Shape driven element. The central band of the shape element was within the boundary of the driven element, unlike previous experiments. We changed the location of the parasitic elements as shown in figure 3.10

3.3.1.1 ADS Geometry Layout

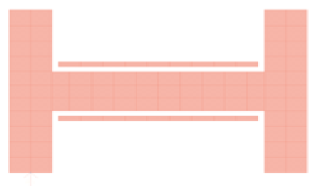


Figure 3.10: H-Shaped with double parasitic element geometry for Exp#7.

3.3.1.2 ADS Simulation Results

Table 3.15 shows the simulated result using ADS for different values of the parasitic element width and gap.

		First Band					
		FL/FH	BW(GHz)	BW(%)	S11	Gain(dB) @ (8.33Hz)	Gain(%)
Wp	Sp	7.9/8.65	0.75	As Reference	-57	7.21	As Reference
0.5	0.25	7.87/8.59	0.72	-4.00%	-27	7.16	-0.69%
	0.5	7.85/8.57	0.72	-4.00%	-25	7.15	-0.83%
	0.75	7.84/8.54	0.7	-6.67%	-23	7.14	-0.97%
	1	7.83/8.52	0.69	-8.00%	-22	7.13	-1.11%
	2	7.79/8.44	0.65	-13.33%	-20	7.1	-1.53%
1	0.25	7.83/8.52	0.69	-8.00%	-22	7.13	-1.11%
	0.5	7.8/8.49	0.69	-8.00%	-20	7.12	-1.25%
	0.75	7.79/8.44	0.65	-13.33%	-19	7.1	-1.53%
	1	7.77/8.39	0.62	-17.33%	-18	7.09	-1.66%
	2	7.75/8.32	0.57	-24.00%	-17	7.05	-2.22%

Table 3.15: Antenna Characteristics for Experiment #7

Based on experiment 7 we observe when adding a parasitic element is not always improve the antenna parameters.

3.3.2 Experiment 8:

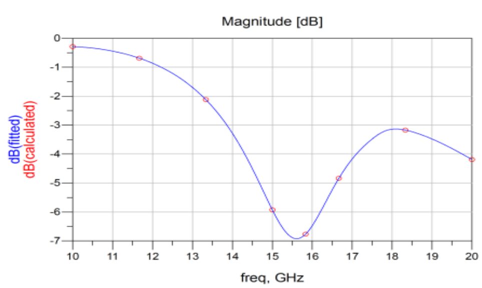
Here, the effect of changing the location of the feeding point with a parasitic element on H-Shaped antennas is verified. It affects its performance in terms of input impedance, loss of return, etc.

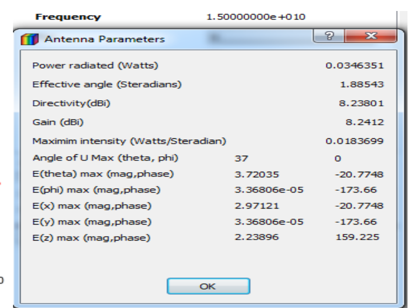
Figure 3.11: H-Shaped with double parasitic element geometry for Exp#8.

3.3.2. A H-Shape MSA with Port2 and No Parasitic

<u>3.3.2. A.1 ADS Geometry Layout</u>

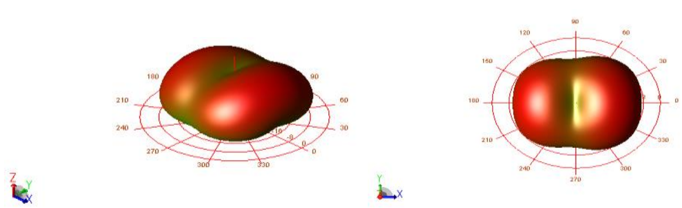
<u>*3.3.2. A.2 the Result of ADS Simulation*</u>





Frequency		1.50000000e+010
Antenna Parameters		
Power radiated (Watts)		0.0346351
Effective angle (Steradians)		1.88543
Directivity(dBi)		8.23801
Gain (dBi)		8.2412
Maximim intensity (Watts/Steradian)		0.0183699
Angle of U Max (theta, phi)	37	0
E(theta) max (mag,phase)	3.72035	-20.7748
E(phi) max (mag,phase)	3.36806e-05	-173.66
E(x) max (mag,phase)	2.97121	-20.7748
E(y) max (mag,phase)	3.36806e-05	-173.66
E(z) max (mag,phase)	2.23896	159.225
OK		

(a) (b)



(c)

Figure 3.13: ADS Simulation Result for the H-Shape MSA with Port2 and No Parasitic Element. (a) Return Loss, (b) Antenna Parameters, (c) Radiation Pattern

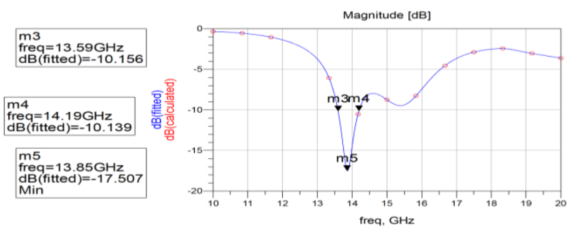
Based on the previous note in the absence of a parasitic element the ADS simulations be not good.

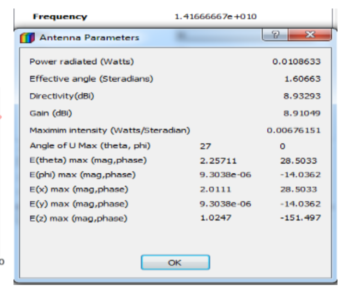
3.3.2.B.1 ADS Geometry Layout : the parasitic elements are shown in figure 3.11.

3.3.2. B.2 the result of ADS Simulation: shows in Table (3.16).

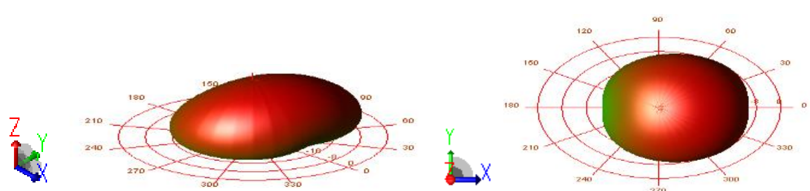
		First Band					Second Band					
		FL/FH	BW(GHz)	BW(%)	S11	Gain(dB) @ (GHz)	FL/FH	BW(GHz)	BW(%)	S11	Gain(dB) @ (GHz)	
Wp	Sp	No Good Results without parasitic for this design					No Second Band without parasitic for this design					
0.25	0.25	13.59/14.19	0.6	Reference	-17.5	8.91 @(14.17)	NON					Reference
	0.5	13.44/14.34	0.9	50%	-17.8	8.98 @14.44	14.97/15.61	0.64	Ref	-10.6	9.16 @15	
	0.75	13.27/15.66	2.39	298%	-17	9.52 @ 15.62	Merged with first band					
	1	13.11/15.7	2.59	332%	-16.7	9.62 @ 15.62	Merged with first band					
	2	12.72/15.71	2.99	398%	-15	9.9 @15.62	Merged with first band					
0.5	0.25	13.4/14.5	1.1	83%	-17.6	9.02 @14.22	14.74/15.62	0.88	38%	-11.1	9.43@ 15.62	
	0.5	13.21/15.69	2.48	313%	-17.1	9.55 @15.62	Merged with first band					
	0.75	13/15.71	2.71	352%	-16.77	9.65	Merged with first band					
	1	12.84/15.71	2.87	378%	-16.4	9.72	Merged with first band					
	2	12.46/15.65	3.19	432%	-15	9.97	Merged with first band					
1	0.25	12.79/15.69	2.9	383%	-16.7	9.61	Merged with first band					
	0.5	12.55/15.69	3.14	423%	-16.4	9.69	Merged with first band					
	0.75	12.35/15.69	3.34	457%	-16.17	9.75	Merged with first band					
	1	12.17/15.67	3.5	483%	-15.94	9.82	Merged with first band					
	2	11.88/15.63	3.75	525%	-15.33	10.03	Merged with first band					Best Gain
2	0.25	11.9/15.05	3.15	425%	-17.29	9.90 @15	Merged with first band					

	0.5	11.64/15.19	3.55	492%	-16.58	9.91 @15	Merged with first band					
	0.75	11.46/15.28	3.82	537%	-16.08	9.93 @15	Merged with first band					Best BW
	1	11.33/13.16	1.83	205%	-15.57	8.73 @12.5	13.75/15.35	1.6	150%	-15.1	9.97 @15	
	2	11.56/12.81	1.25	108%	-11.93	8.97 @12.5	14.1/15.47	1.37	114%	-13.6	10.24 @15	

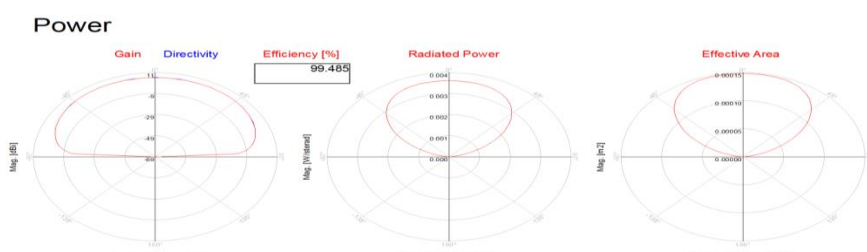




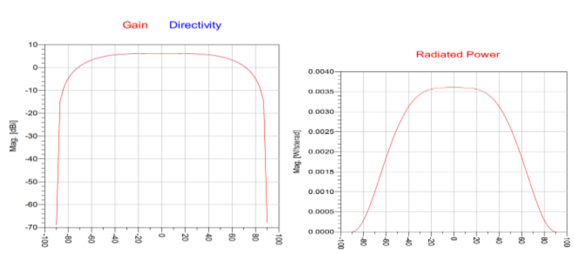
(a) (b)



(c)

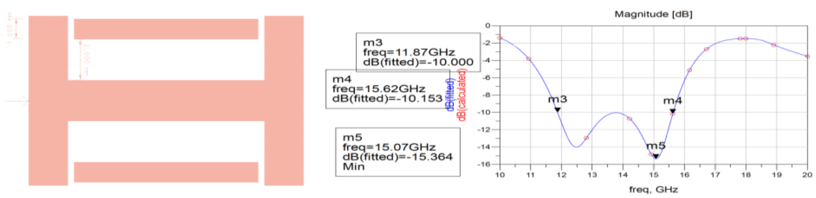


(d)

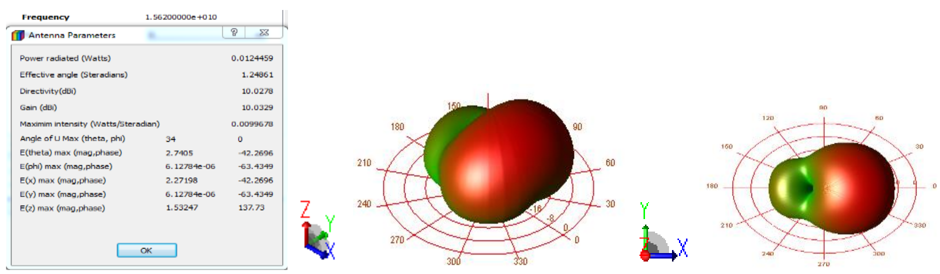


(e) (f)

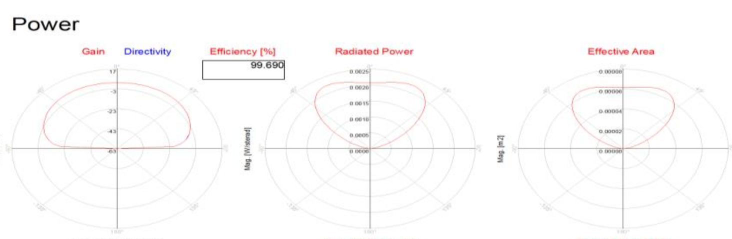
Figure 3.14: H-Shape MSA with Port2 and double parasitic ,Wp=0.25mm,Sp=0.25mm @ 14.17GHz (a): Return Loss, (b): Antenna Parameters, (c) Radiation Pattern, (d): Power Characteristics, (e) Gain vs. Directivity, (f) Radiated Power



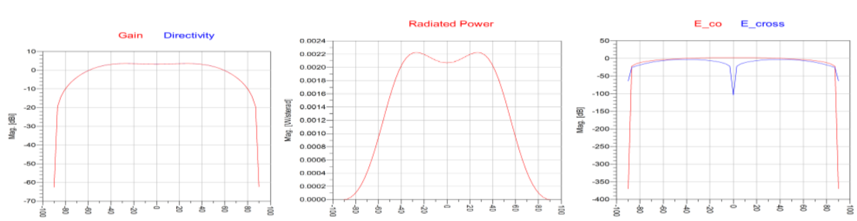
(a)(b)



(c) (d)



(e)



(f) (g) (h)

Figure 3.15: H-Shape MSA with Port2 and double parasitic ,Wp=1.0mm,Sp=2.0mm @ 15.62GHz (a) Geometry (b): Return Loss, (c): Antenna Parameters, (d) Radiation Pattern, (e) Power Characteristics, (f)Gain vs. Directivity , (g)Radiated Power (h) Linear Polarizations

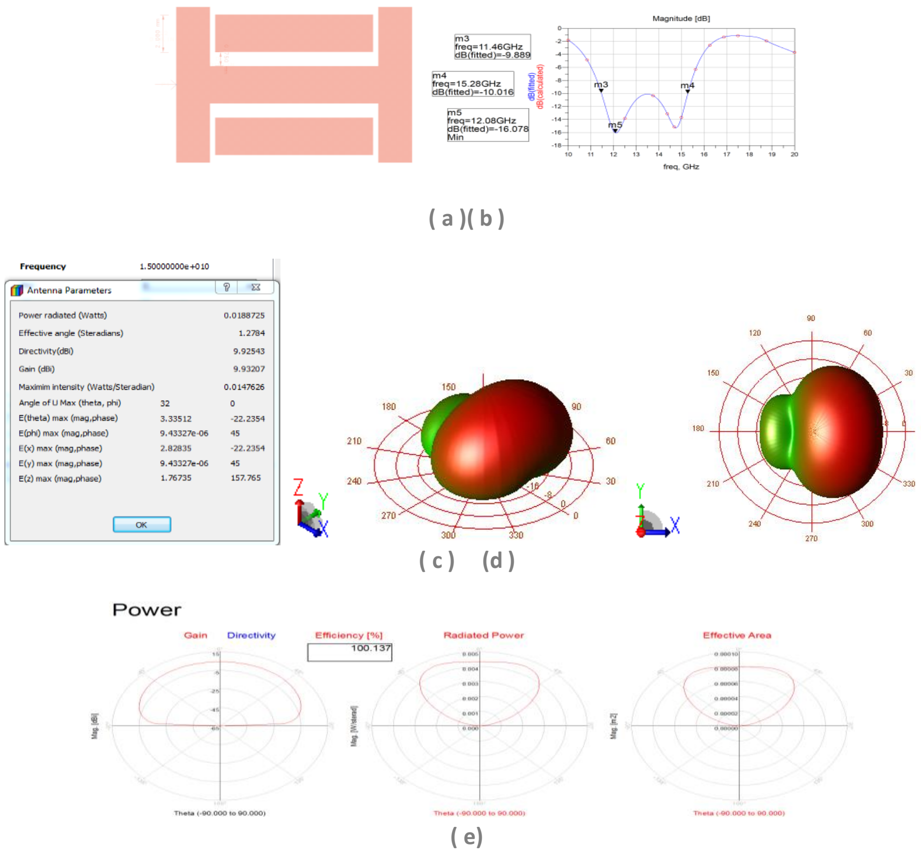
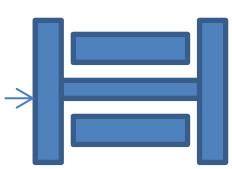
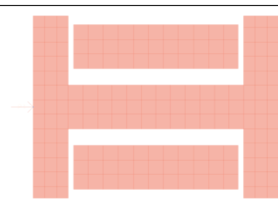


Figure 3.16: H-Shape MSA with Port2 and double parasitic ,Wp=1.0mm,Sp=0.75mm @ 15.0GHz (a) Geometry (b): Return Loss, (c): Antenna Parameters, (d) Radiation Pattern, (e): Power Characteristics

3.4 Conclusion

We note in the Experiment 8 that the best design geometry has the better antenna parameter performance among all other geometries.

In this table we conclude the geometries according to their parameters' performance

Sort order	Geometry	ADS Design	Wp (mm)	Sp (mm)	BW (GHz)	Gain (dBi)	S11 (dB)	Efficiency (%)
1st			2.00	0.75	3.82 (537%) ***	9.93 at 15 GHz (20.5%) *	-16.08 **	100.153

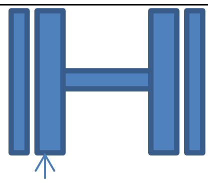
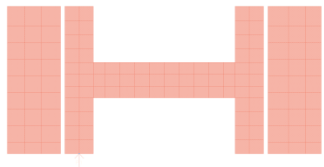
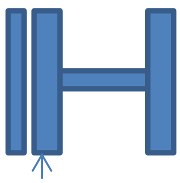
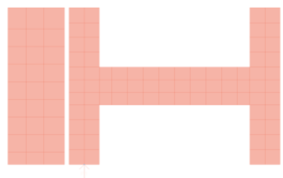
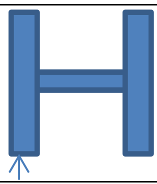
2nd			3.00	0.25	0.9 (20%)	7.59 at 8.33 GHz (5.27%)	-27.95	78.97
3rd			3.00	0.75	0.83 (10.7%)	7.48 at 8.33 GHz (3.74%)	-40.64	79.28
4th			0.00	0.00	0.75 (Ref)	7.21 at 8.33 GHz (Ref)	-46.41	76.042

Table 3.17: Sort of the studied H-Shape MSA according to their Gain and BW performance.

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