A STUDY OF MICROSTRIP COUPLERS WITH GROUND PLANE APERTURE

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MAY – 2007

Submitted in partial fulfillment of degree of bachelor of Technology

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CERTIFICATE

This is to certify that the work entitled, "A Study of Microstrip couplers with Ground Plane Aperture " submitted by Navadha ,Trisha Khimta , and Vaibhav Raghuvanshi in partial fulfillment for the award of degree of bachelor of technology in electronics and communication of Jaypee University of Information Technology has been carried out under my supervision. This work has not been submitted partially or wholly to any other University or institute for the award of this or any other degree or diploma.

Tapas Chakravarty

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY
JUIT

ACKNOWLEDGEMENT

No Project or task can be successfully completed without the help of those people who act as "guiding light" helping to smoothen out the rough edges, providing the inspiration when you feel you have reached a spot you can't seem to get out of.

We are extremely grateful to Mr.Tapas Chakarvarty,our respected teacher for his guidance and motivation.His thinking and straightforward attitude have inspired us to complete this project under stiff time limits.

We are especially indebted to him for his initiative, encouragement, constructive criticism and familiarizing us with all technical aspects of this project over and above, the way he familiarized us with ways to correct the mistakes.

We are also grateful to our HOD Dr. Sunil Vidya Bhooshan and our lecturer Mr. Rohit Sharma for acting as the Guiding Force to us.

We would also like to thank all the faculty members for their sincere devotion to impart us with the best of knowledge and skills available.

Also, we would like to express our thanks to our friends ,who have supported, encouraged and criticized our efforts which have been instrumental in giving the project its final shape.

Trisha.
Navadha.
Vaibhav

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ABSTRACT

Edge coupled microstrip couplers have been studied extensively. In this project , a parametric study on the behaviour of microstrip couplers in presence of ground plane aperture is done. It is shown that with the introduction of ground plane aperture, the bandwidth (considering the coupling ratio ±1dB) is increased resulting in a broadband operation using a single edge coupled section. The method is outlined and results presented.

CHAPTER 1

INTRODUCTION

MICROSTRIP LINES:

A microstrip line consists of a single ground plane and a thin strip conductor on a low loss dielectric substrate above the ground plate. Strip line may be described as half-shielded, by the ground plane on one side. This line consists of a single dielectric substrate with ground plane on one side and a strip on the other face. The top ground plane of stripline configuration is not presenting this case. Microstrips are used in printed circuit designs where high frequency signals need to be routed from one part of the assembly with higher efficiency to the other with minimal signal loss due to radiation. In microstrip lines there is an easy access to the top surface which makes it very convenient to mount discrete (active or passive) devices and to make minor adjustments after the circuit has been fabricated. The microstrip configuration is a mixed dielectric transmission structure since its electromagnetic fields extend in the space. Because of the concentration of electric field in the dielectric region below the strip most of the energy of the wave is concentrated there. Due to absence of a top ground plate and the dielectric substrate above the strip ,the electric field lines remain partially in the air and partially in the lower dielectric substrate. This makes the mode of propagation not pure TEM but what is called quasi-TEM. Due to open structure and any presence of discontinuity, the microstrip line radiates electromagnetic energy. This radiation loss is proportional to square of frequency. The use of thin and high dielectric materials reduces the radiation loss of the open structure where the fields are mostly confined inside the dielectric. There are three types of losses that occur in microstrip lines: conductor (or ohmic) losses, dielectric losses, and radiation losses. An idealized microstrip line, being open to a semi-infinite air space, acts similar to an antenna and tends to radiate energy. Substrate materials with low dielectric constants (5 or less) are used when cost reduction is the priority. Similar materials are also used at millimeter-wave frequencies to avoid excessively tight mechanical tolerances. However, the lower the dielectric constant, the less the concentration of energy is in the substrate region and, hence, the more are the radiation losses. Radiation losses depend on the dielectric constant, the substrate thickness, and the circuit geometry. The use of high-dielectric-constant substrate materials reduces radiation losses because most of the EM field is concentrated in the dielectric between the conductive strip and the ground plane. The real benefit in having a higher dielectric constant is that the package size decreases by approximately the square root of the dielectric constant. This is an advantage at lower

frequencies but may be a problem at higher frequencies.

In most conventional microstrip designs with high substrate dielectric constant, conductor losses in the strip conductor and the ground plane dominate over dielectric and radiation losses. Conductor losses are a result of several factors related to the metallic material composing the ground plane and walls, among which are conductivity, skin effects, and surface roughness. With finite conductivity, there is a non-uniform current density starting at the surface and exponentially decaying into the bulk of the conductive metal. This is the alleged skin effect and its effects can be visualized by an approximation consisting of a uniform current density

flowing in a layer near the surface of the metallic elements to a uniform skin depth, d. The skin depth of a conductor is defined as the distance to the conductor (Fig. 7) where the current density drops to 1/e from a maximum current density of Imax, or 37 percent of its value at the surface of the conductor. To minimize conductor loss while simultaneously minimizing the amount of metallic material flanking the dielectric, the conductor thickness should be greater than approximately three to five times the skin depth. In a microstrip line, conductor losses increase with increasing characteristic impedance due to the greater resistance of narrow strips. Conductor losses follow a trend which is opposite to radiation loss with respect to W/h.

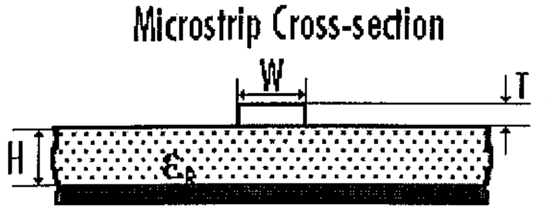
In a microstrip line, the wavelength, Λ , is given by:

$$\Lambda = \lambda / (\varepsilon\ eff)^{0.5}$$

where:

eeff = the effective dielectric constant, which depends on the dielectric constant of the substrate material and the physical dimensions of the microstrip line, and

λ = the free-space wavelength.



To reduce the losses a shielded microstrip line with a housing. The main purposes of the housing or package are to provide mechanical strength, EM shielding, germetization, and heat sinking in the case of high-power applications. Packaging must protect the circuitry from moisture, humidity, dust, salt spray, andother environmental contaminants. In order to protect the circuit, certain methods of sealing can be used: conductive epoxy, solder, gasket materials,and metallization tape.

MICROSTRIP COUPLERS:

Microstrip couplers consists of two coupled microstrip lines in which electromagnetic field from one microstrip line can be coupled to second adjacent microstrip line. The lines are coupled over a length with spacing between the adjacent edges. The width W of the lines are designed for desired impedance. Microstrip coupler is a backward coupler. The electric field in the input line induces an equal and opposite charge on the centre of the two lines .This results in an electric field in the coupled line directed oppositely as compared with that in the input line. Whereas,the magnetic field follow the same direction in the both lines. Hence the directions of power density flow P = E×H in the two lines are opposite. Therefore the coupled power flow is backward compared to forward power flow in input line. Hence this coupler is called backward coupler where port 4 is ideally isolated. The main properties of the microstrip coupler can be analysed by decomposing the actual excitation into even and odd symmetry modes. The characteristic impedances of these modes are different, denoted by Zoe and Zoo.These impedances are the major design parameters for the design of microstrip coupler and are obtained in terms of coupling C and the single line terminating characteristic impedance Zo.

CHAPTER 2

DESIGN OF MICROSTRIP COUPLER

DESIGN EQUATIONS:

In the design of coupled lines, we consider following parameters: w/h, s/h, εr, εeff , Zoo, Zoe, Zo and Coupling.By using even and odd mode excitation , we find even and odd mode impedances Zoe and Zoo.

In design of coupled transmission lines when finding Zoo and Zoe we use the following approximate synthesis technique.

Firstly,with given Zo (single line characteristic impedance), εr(relative dielectric constant of the substrate) and C(coupling of the coupled lines) determining shape ratios for equivalent single microstrip lines.

Secondly, finding the shape ratio w/h and the spacing ratio s/h for the desired coupled microstrip by using the single line shape ratios found in first step.

Since we have in hand C(in dB) and Zo(impedance) we can find Zoe and Zoo as follows:

$$c = 10^{-C/20}$$

as c is the coupling coefficient. Now, Zoo and Zoe are:-

$$Z_{oe} = Z_o\sqrt{\frac{1+c}{1-c}} \quad \text{and} \quad Z_{oo} = Z_o\sqrt{\frac{1-c}{1+c}}$$

Using Zoe and Zoo if we consider Zoe and Zoo for single line as Zose and Zoso;

$$Z_{ose} = \frac{Z_{oe}}{2} \quad \text{and} \quad Z_{oso} = \frac{Z_{oo}}{2}$$

Now we find (w/h)se and (w/h)so from Zose and Zoso. For this we use single line equations:

$$\frac{W}{h} = \begin{cases} \dfrac{8e^{A}}{e^{2A}-2} & \text{for W/h} < 2 \\ \dfrac{2}{\pi}\left[B-1-\ln(2B-1)+\dfrac{\varepsilon_{r-1}}{2\varepsilon_r}\left\{\ln(B-1)+0.39-\dfrac{0.61}{\varepsilon_r}\right\}\right] & \text{for W/h} > 2 \end{cases}$$

where

$$A = \frac{Z_0}{60}\sqrt{\frac{\varepsilon_r+1}{2}} + \frac{\varepsilon_r-1}{\varepsilon_r+1}\left(0.23+\frac{0.11}{\varepsilon_r}\right)$$

$$B = \frac{377\pi}{2Z_0\sqrt{\varepsilon_r}}$$

At this point, we are able to find (w/h)se and (w/h)so by applying Zose and Zoso (as Zo)to the single line microstrip equations. Now we can come to a point where we reach the w/h and s/h for the desired coupled microstrip line using a family of approximate equations as following:

$$\frac{s}{h} = \frac{2}{\pi}\cosh^{-1}\left[\frac{\cosh\{(\pi/2)(w/h)_{se}\} + \cosh\{(\pi/2)(w/h)_{so}\} - 2}{\cosh\{(\pi/2)(w/h)_{so}\} - \cosh\{(\pi/2)(w/h)_{se}\}}\right]$$

$$\left(\frac{w}{h}\right)_{se} = \frac{2}{\pi}\cosh^{-1}\left(\frac{2d - g + 1}{g + 1}\right)$$

$$\left(\frac{w}{h}\right)_{so} = \frac{2}{\pi}\cosh^{-1}\left(\frac{2d - g - 1}{g - 1}\right) + \frac{4}{\pi(1 + \varepsilon_r/2)}\cosh^{-1}\left(1 + 2\frac{w/h}{s/h}\right) \qquad \varepsilon_r \le 6$$

$$\left(\frac{w}{h}\right)_{so} = \frac{2}{\pi}\cosh^{-1}\left(\frac{2d - g - 1}{g - 1}\right) + \frac{1}{\pi}\cosh^{-1}\left(1 + 2\frac{w/h}{s/h}\right) \qquad \varepsilon_r \ge 6$$

$$g = \cosh\left(\frac{\pi s}{2h}\right) \qquad d = \cosh\left(\pi\frac{w}{h} + \frac{\pi}{2}\frac{s}{h}\right)$$

As a result, we began from parameters C, Zo and εr and at the end find w/h and s/h.

$\lambda = \upsilon_p / f$ and $\upsilon_p = c/\sqrt{\varepsilon_{eff}}$, here c is the speed of light, $3.10^8 m/s$

SIMULATION:

Firstly a basic microstrip coupler is designed with a coupling of -15dB, frequency of 5GHz and characteristic impedance Zo of 50 ohms. Simulation of this coupler is done with the help of CST microwave studio software . Two different basic microstrip couplers are designed with substrate of relative permittivities 9.9 and 2.2. After this length, width and spacing between two coupled microstrip lines are calculated for characteristic impedance of 50 ohms for substrates of different relative permittivities using the design equations given above. Simulation is started by making a substrate of particular relative permittivity.A ground plane is made below substrate. The input microstrip line of calculated length and width is made on substrate. Then coupled microstrip line of calculated width is made adjacent to input line. Then four discrete ports are made on edges of microstrip lines.Port1 is the input port , port2 is the output port, port 3 is the coupled port and port 4 is the isolated port. Energy is coupled from port 1 to port 3.Then transient analysis is done and we get the plots of S parameters magnitude in dB with frequency. We get plots for S(1,1),S(2,1),S(3,1),S(4,1) with frequency.

CHAPTER 3

GROUND PLANE APERTURE

A vacuum is created in ground plane below the substrate of the basic coupler.The width of vacuum created is gradually increased from 1mm to 5mm in increments of 0.5 mm.
At every width of vacuum created transient analysis is done and we get plots of S parameters S(1,1),S(2,1),S(3,1),S(4,1) magnitude in dB with frequency. The plots are compared and the changes are noted down in plots of basic microstrip coupler and coupler with different widths of vacuum.

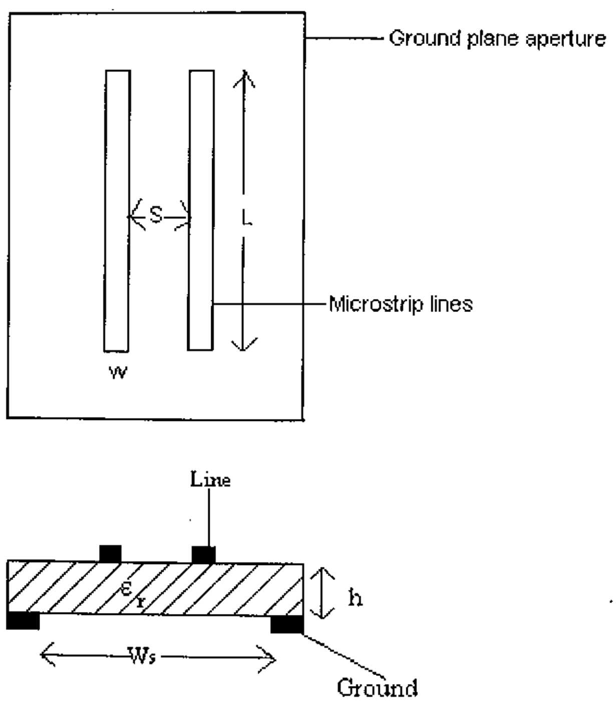


Fig1: Basic Schematic of Coupler with Ground plane aperture

CHAPTER 4

RESULTS

Graphs for Basic microstrip coupler:

Material: Alumina(99.5% lossfree)

Epsilon: 9.9

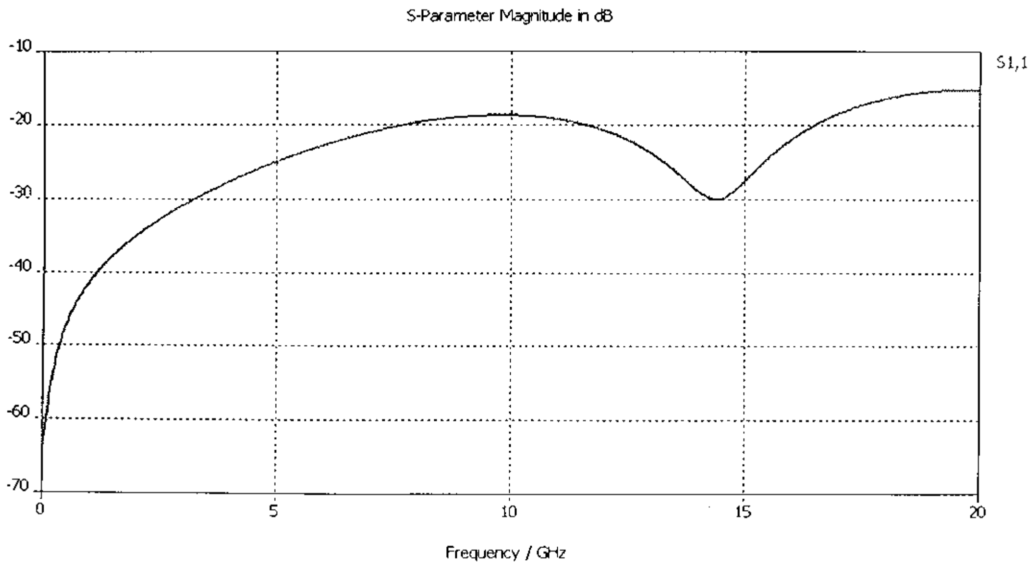
Length of microstrip lines: 5mm

Width of microstrip lines: 0.42mm

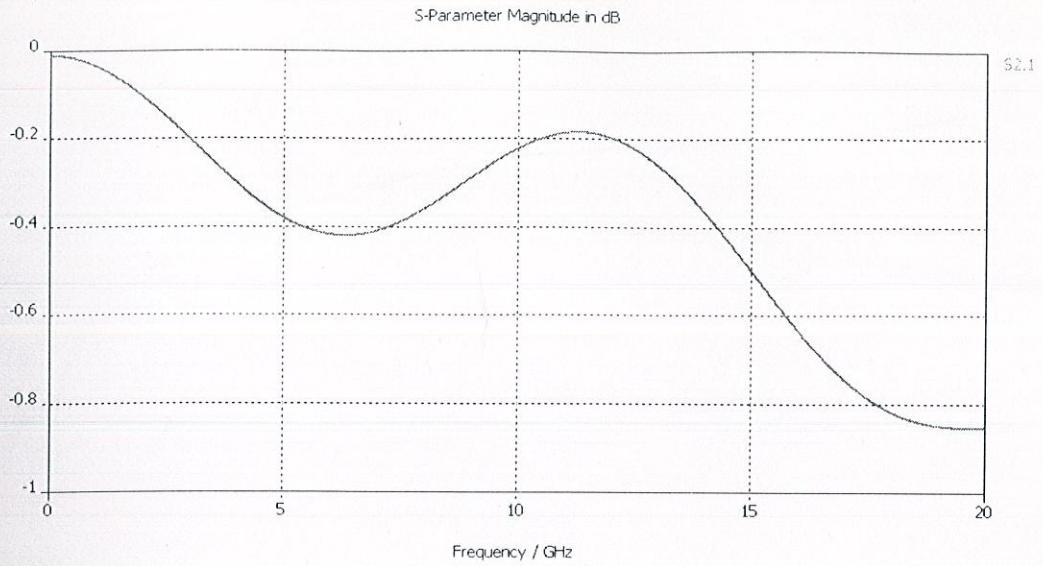
Height of microstrip lines:0.022mm

Spacing between two coupled microstrip lines: 0.4mm

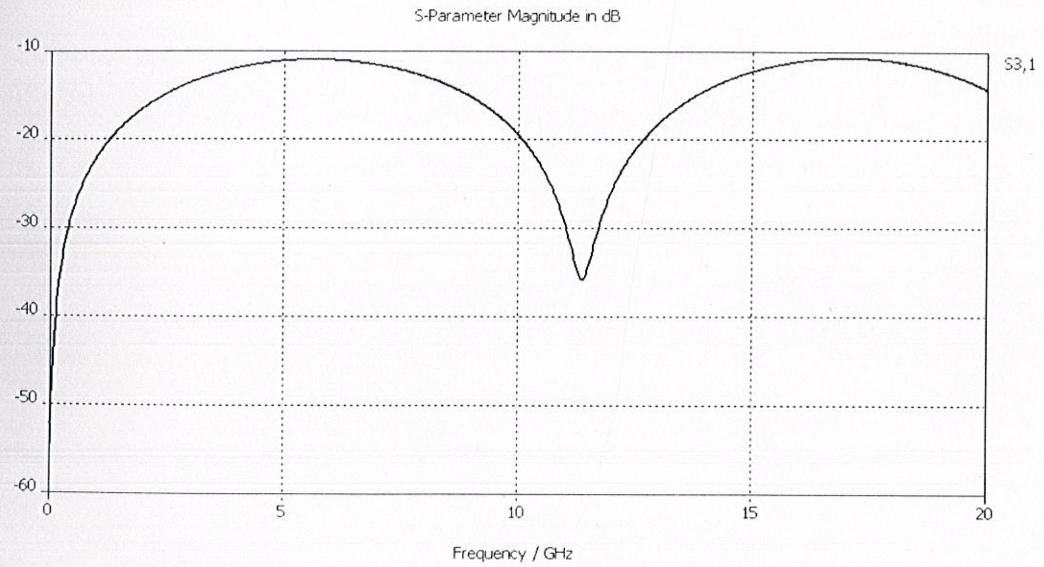
Height of substrate:0.508mm



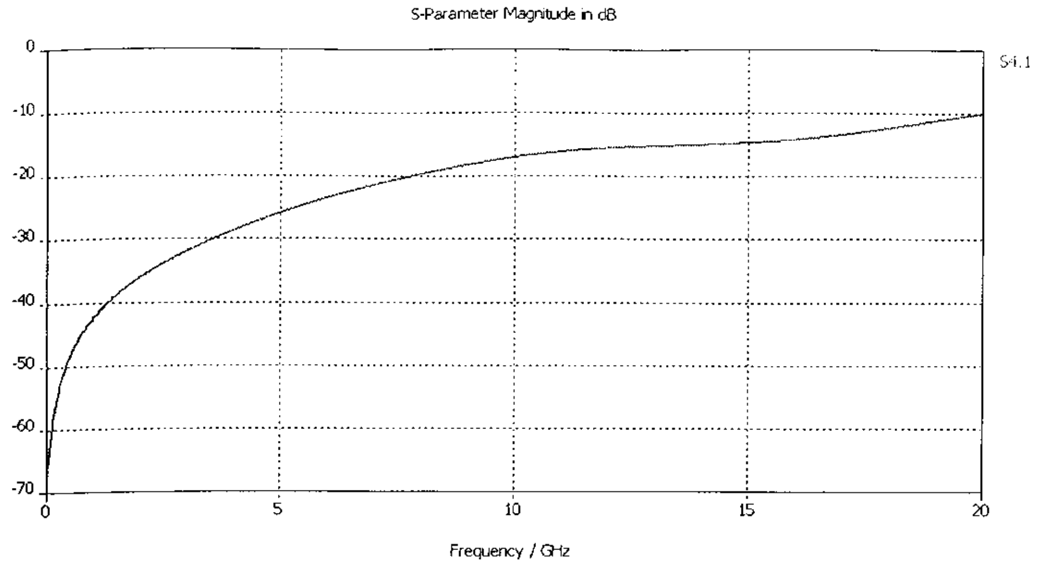
Plot for S1,1



Plot for S2,1



Plot for S3,1


S-Parameter Magnitude in dB
S4,1
0
-10
-20
-30
-40
-50
-60
-70
0
5
10
15
20
Frequency / GHz

Plot for S4,1

Graphs for basic microstrip coupler with ground plane aperture:

Material: Alumina (99.5% loss free)

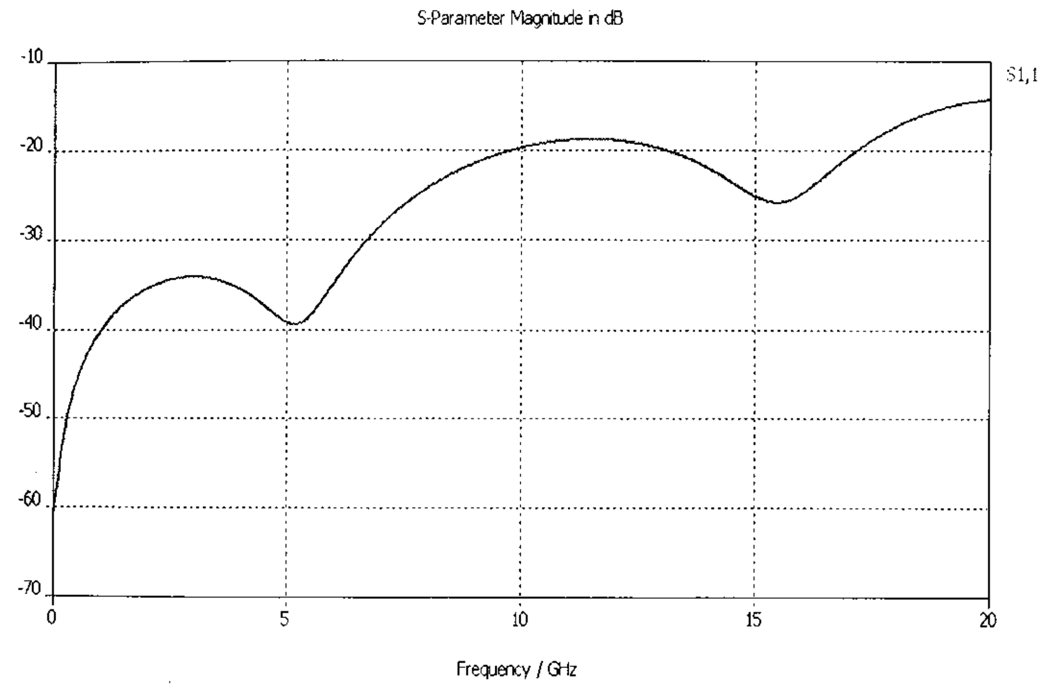
Length of microstrip lines: 5mm

Width of microstrip lines: 0.42mm

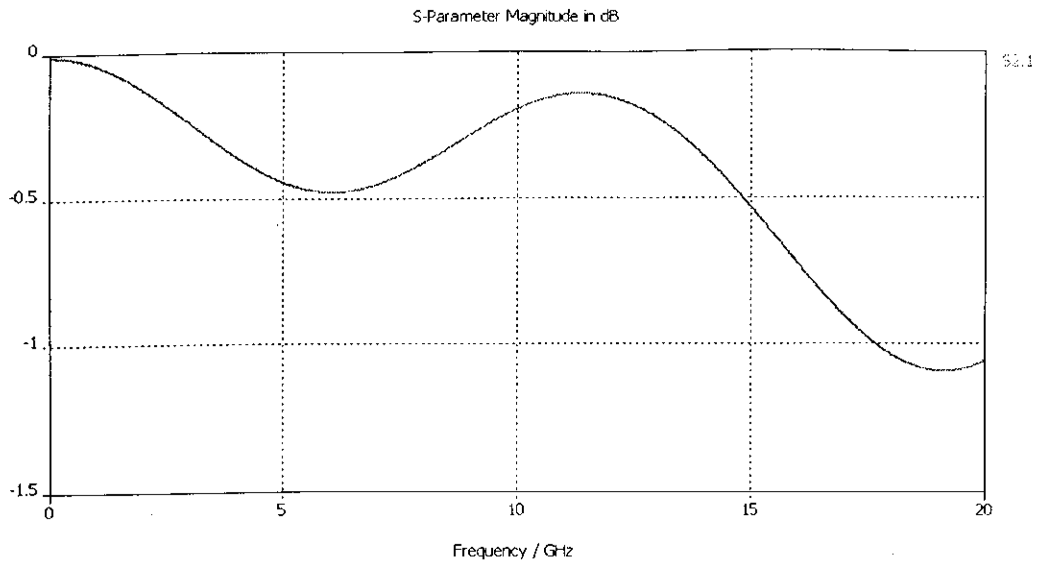
Height of microstrip lines:0.022mm

Spacing between two coupled microstrip lines: 0.4mm

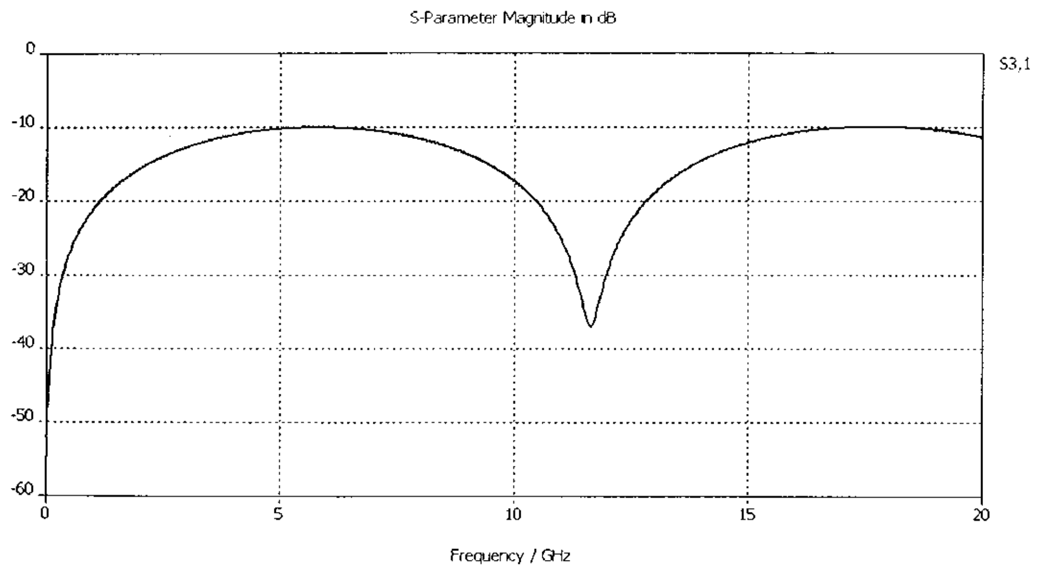
Height of substrate: 0.508mm



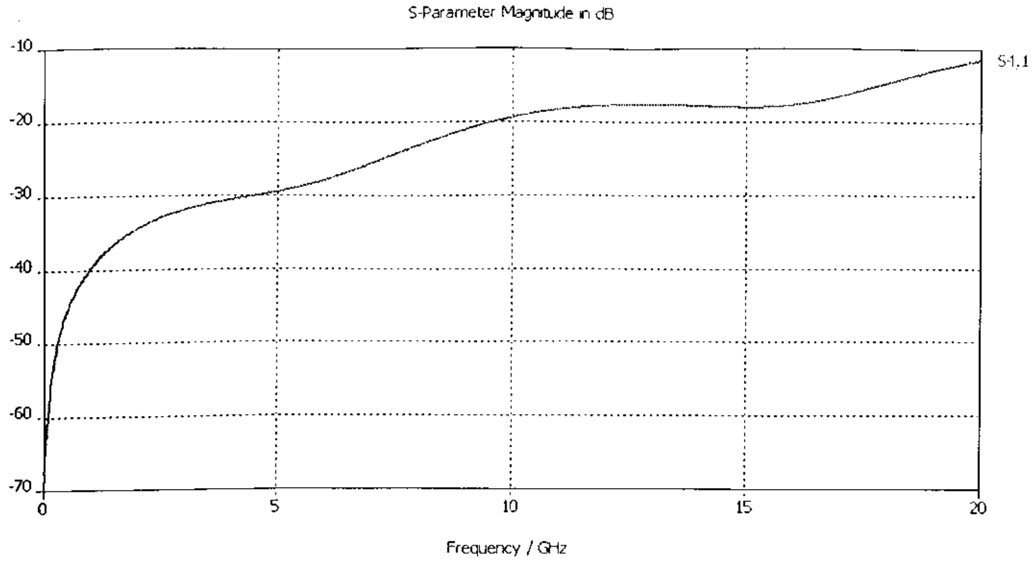
Plot for S1,1



Plot for S2,1



Plot for S3,1



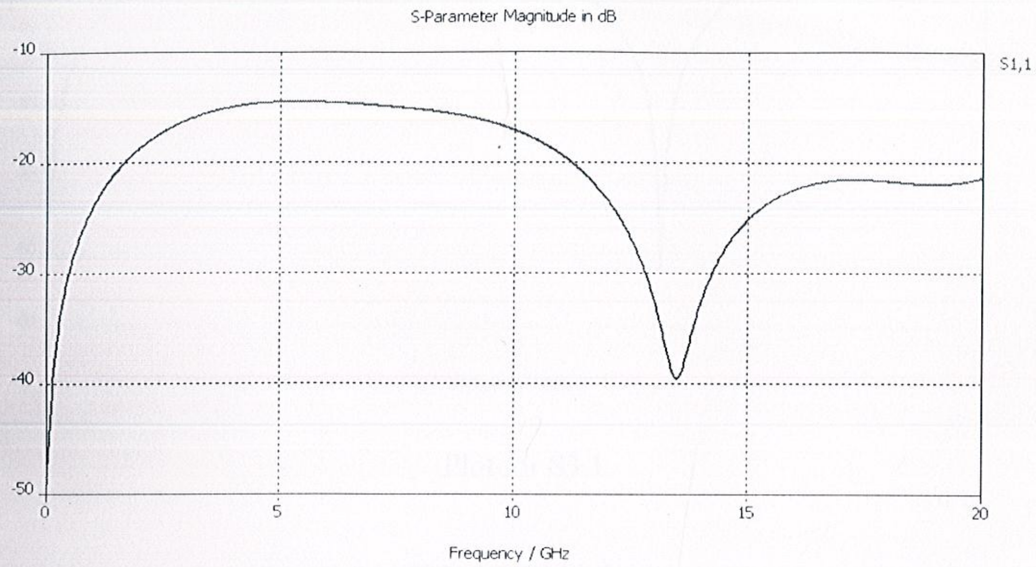
Plot for S4,1

Ground plane aperture dimensions:

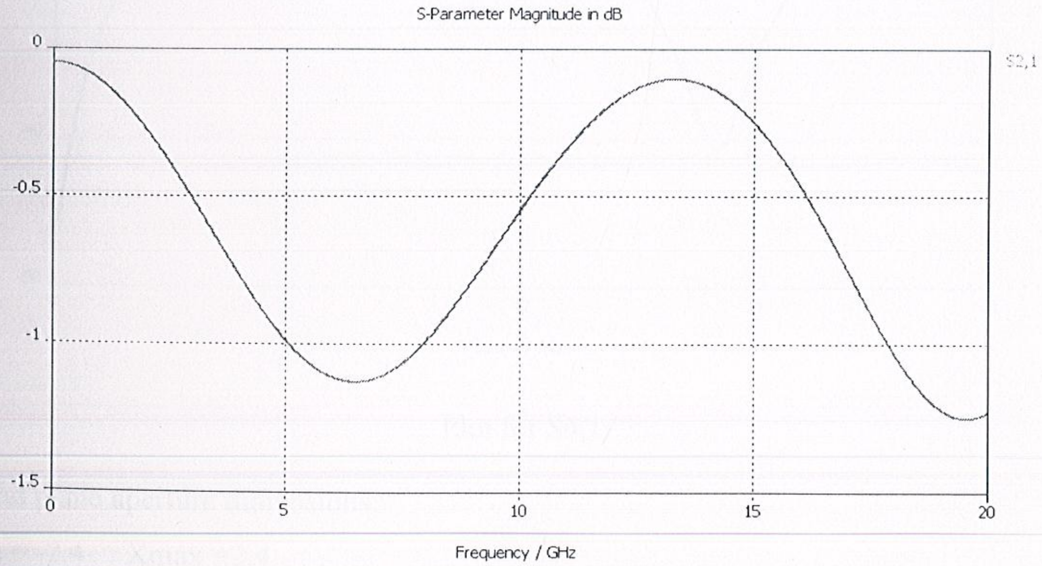
Xmin = -2.4   Xmax =2.4

Ymin = -0.5   Ymax =0.5 (total = 1mm)

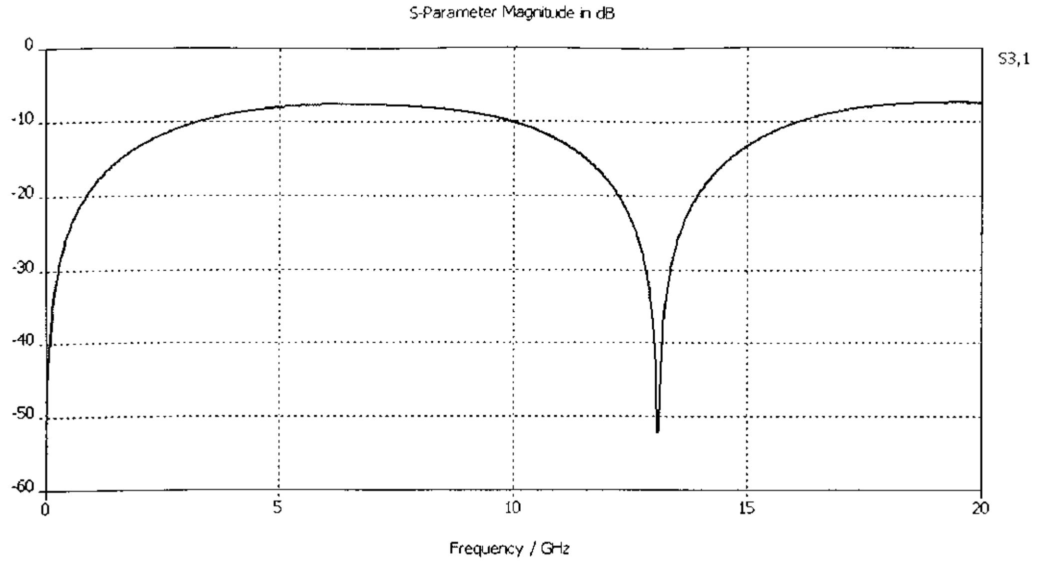
Zmin = -1   Zmax = 0



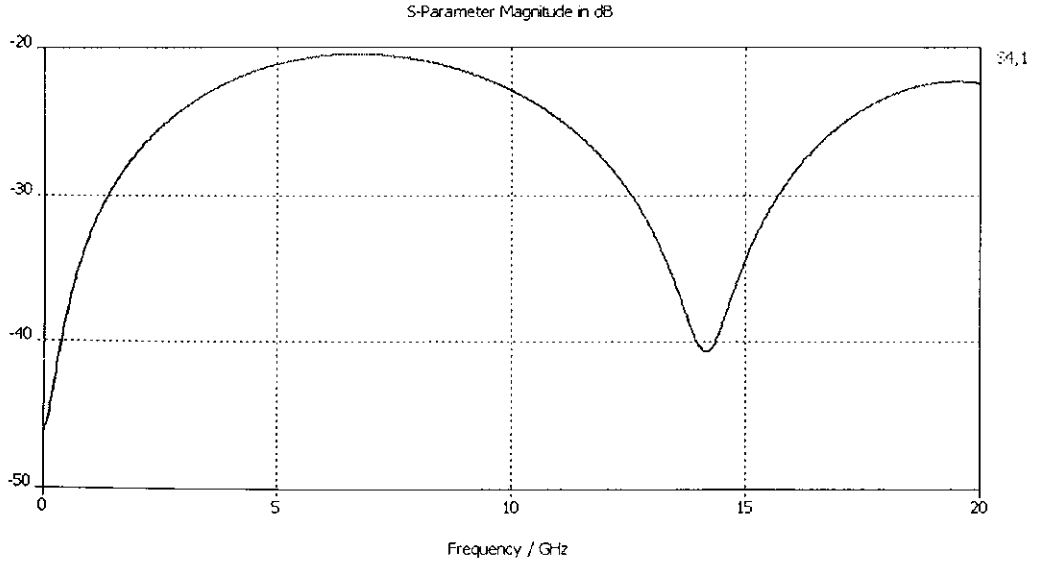
Plot for S1,1



Plot for S2,1



Plot for S3,1



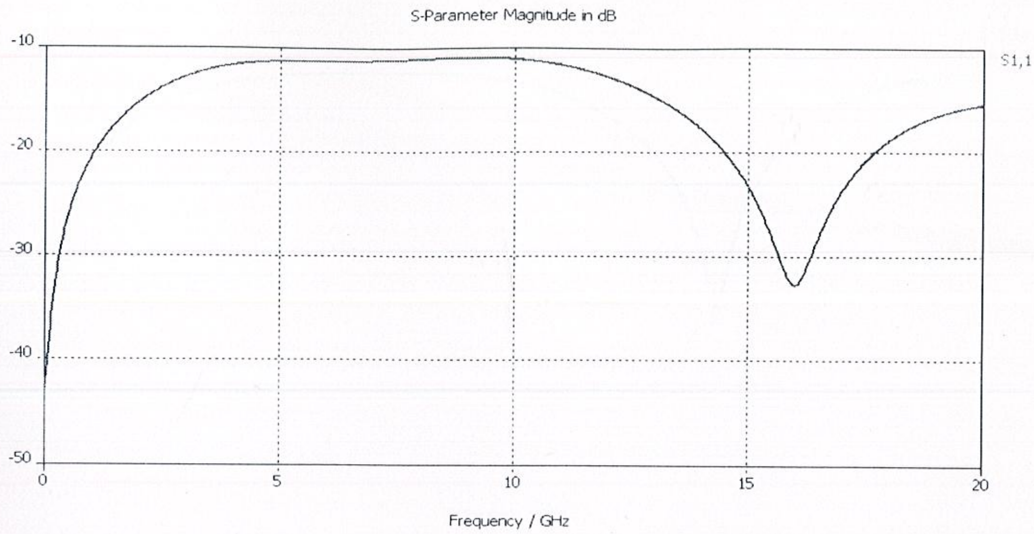
Plot for S4,1

Ground plane aperture dimensions:

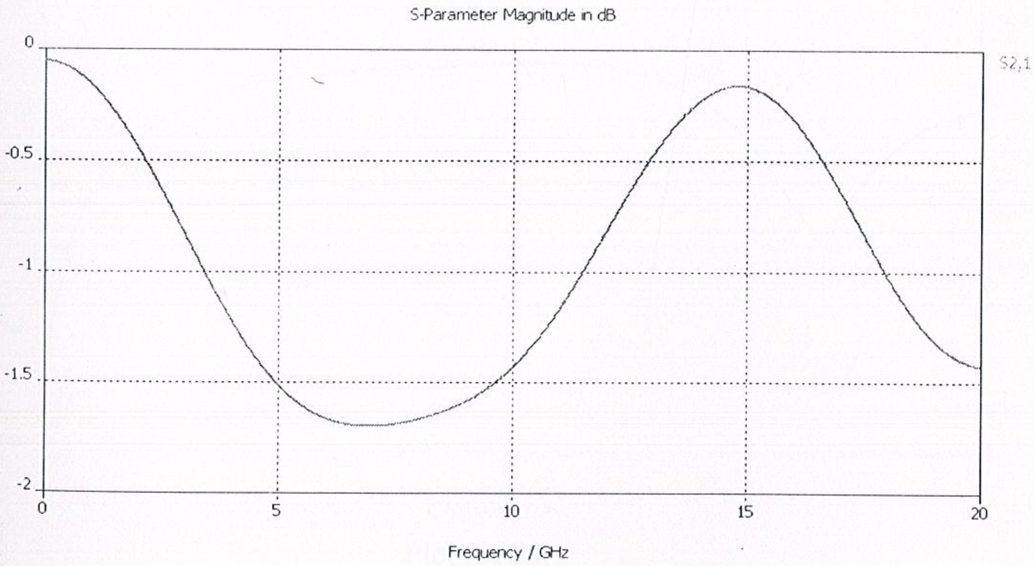
Xmin = -2.4 Xmax =2.4

Ymin = -1 Ymax = 1 (total = 2mm)

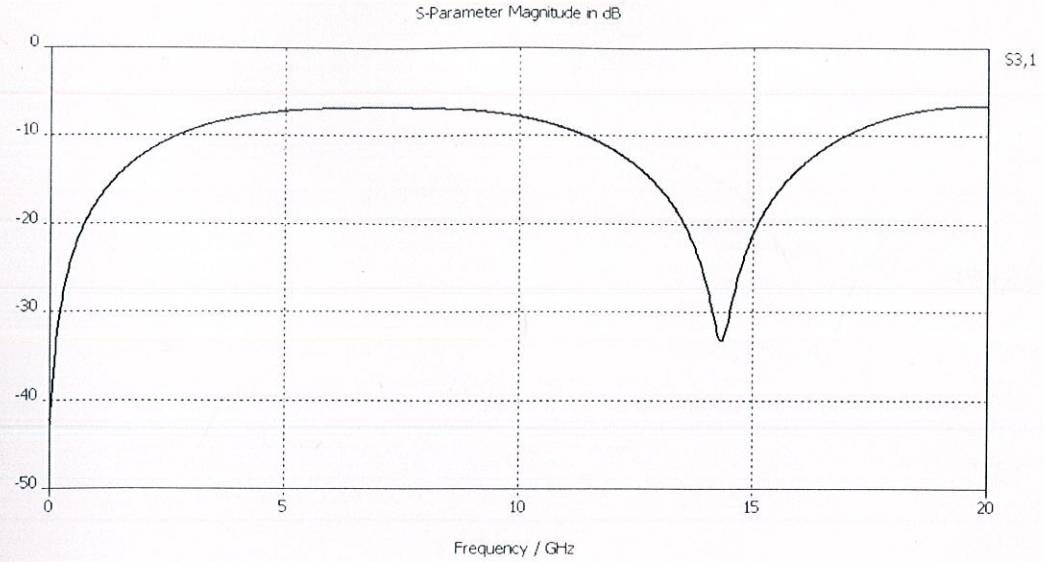
Zmin = -1 Zmax = 0



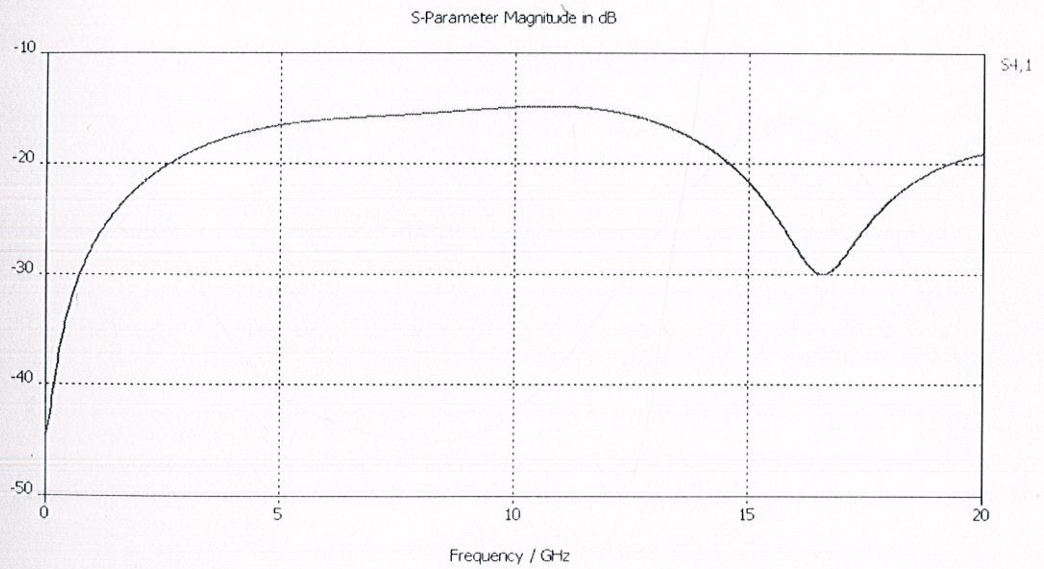
Plot for S1,1



Plot for S2,1



Plot for S3,1



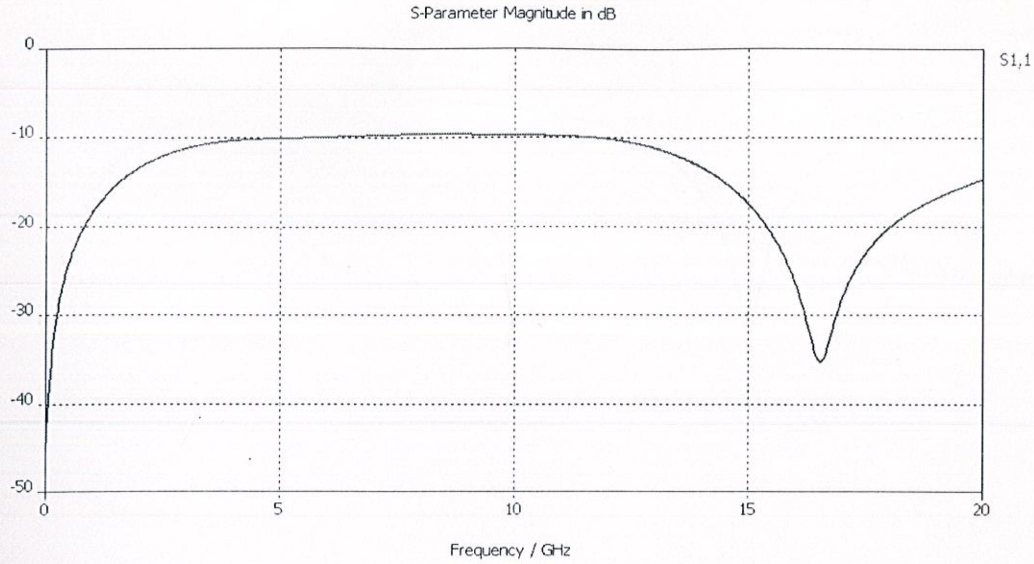
Plot for S4,1

Ground plane aperture dimensions:

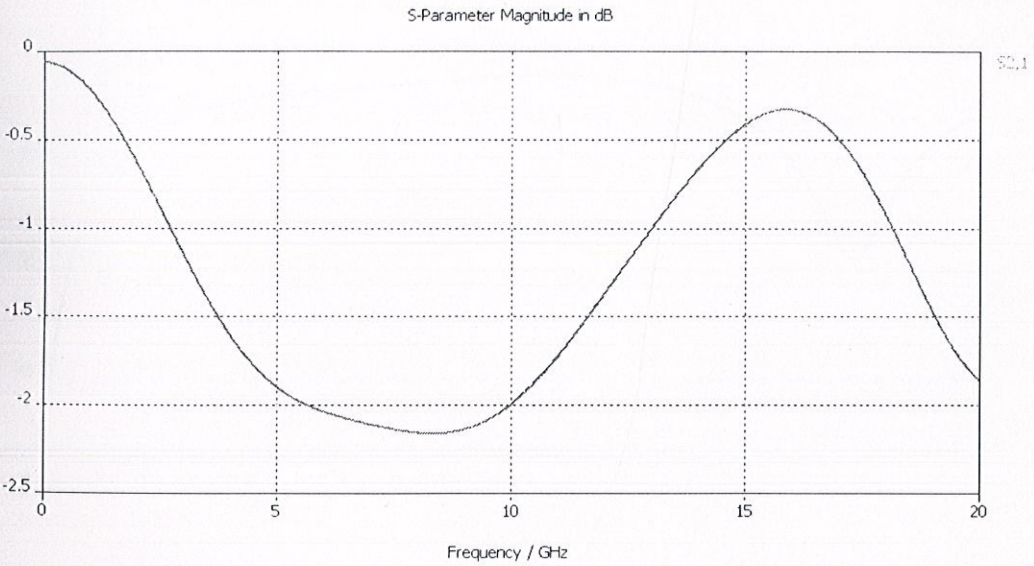
Xmin = -2.4   Xmax =2.4

Ymin = -1.5   Ymax =1.5 (total = 3mm)

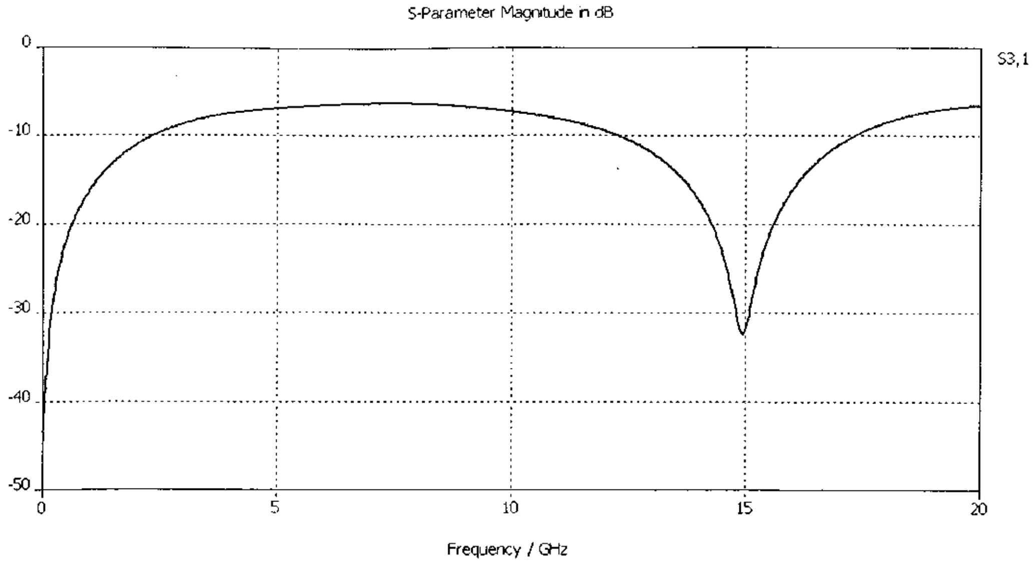
Zmin = -1   Zmax = 0



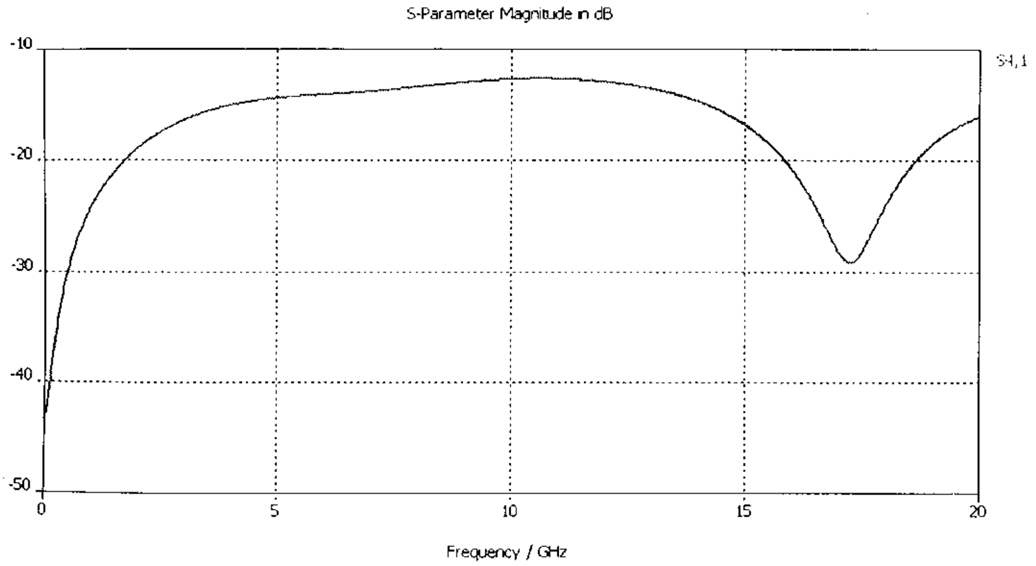
Plot for S1,1



Plot for S2,1



Plot for S3,1



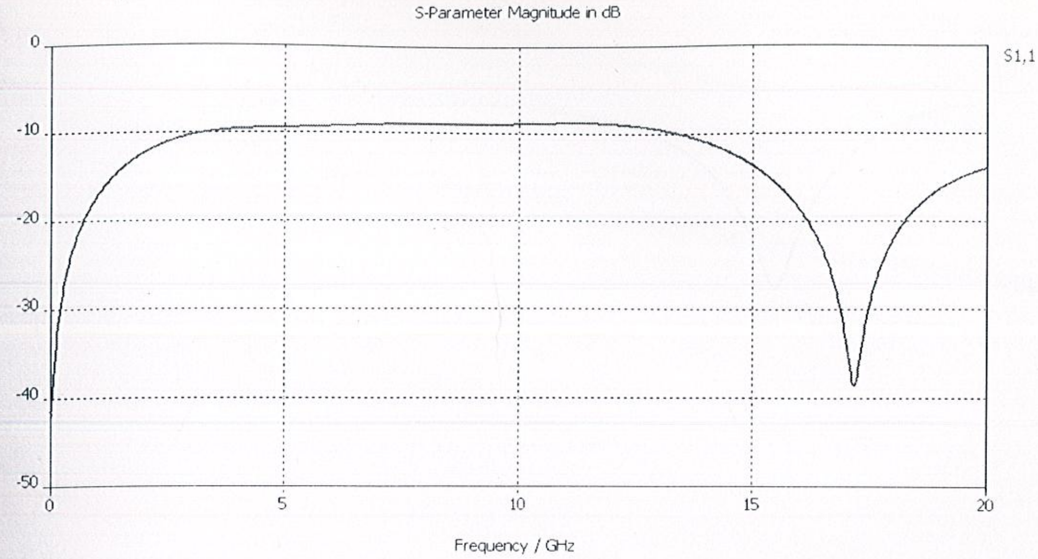
Plot for S4,1

Ground plane aperture dimensions:

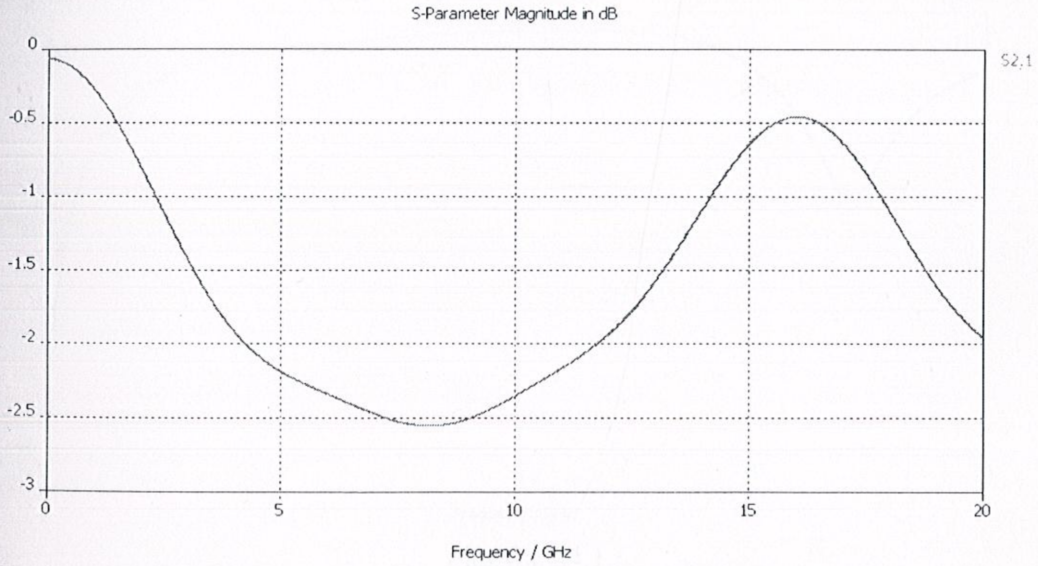
Xmin = -2.4 Xmax =2.4

Ymin = -2 Ymax =2 (total =4mm)

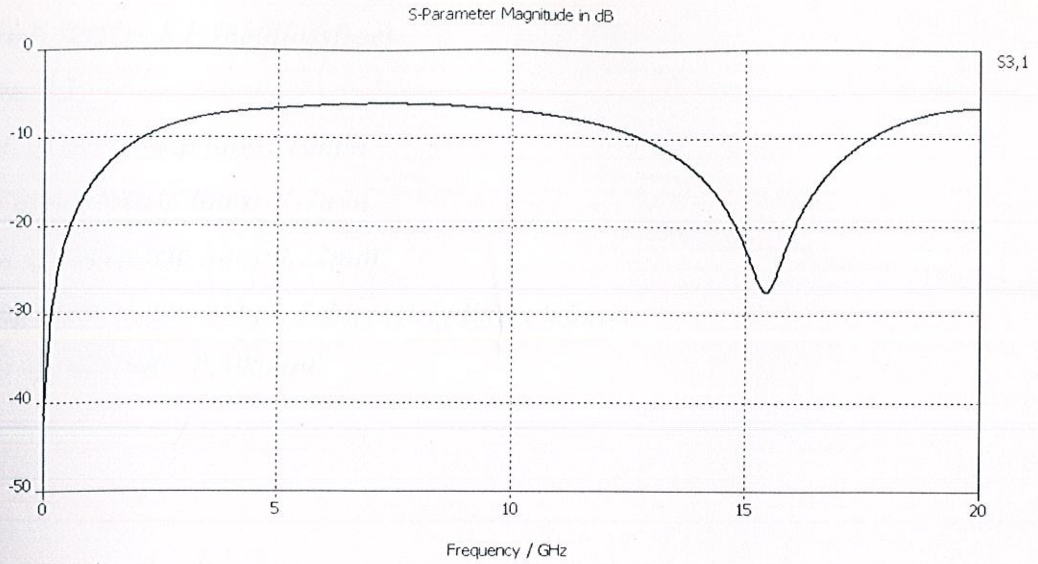
Zmin = -1 Zmax = 0



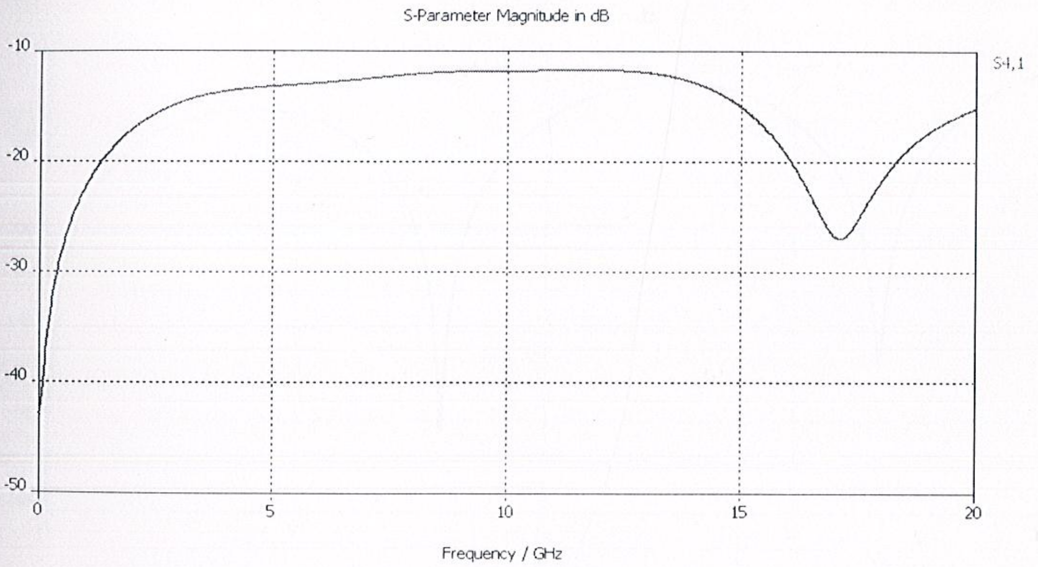
Plot for S1,1



Plot for S2,1



Plot for S3,1



Plot for S4,1

Ground plane aperture dimensions:

Xmin = -2.4   Xmax =2.4

Ymin = -2.5   Ymax =2.5 (total = 5mm)

Zmin = -1   Zmax = 0

Graphs for Basic microstrip coupler:

Material: Rogers RT 5880(lossfree)

Epsilon:2.2

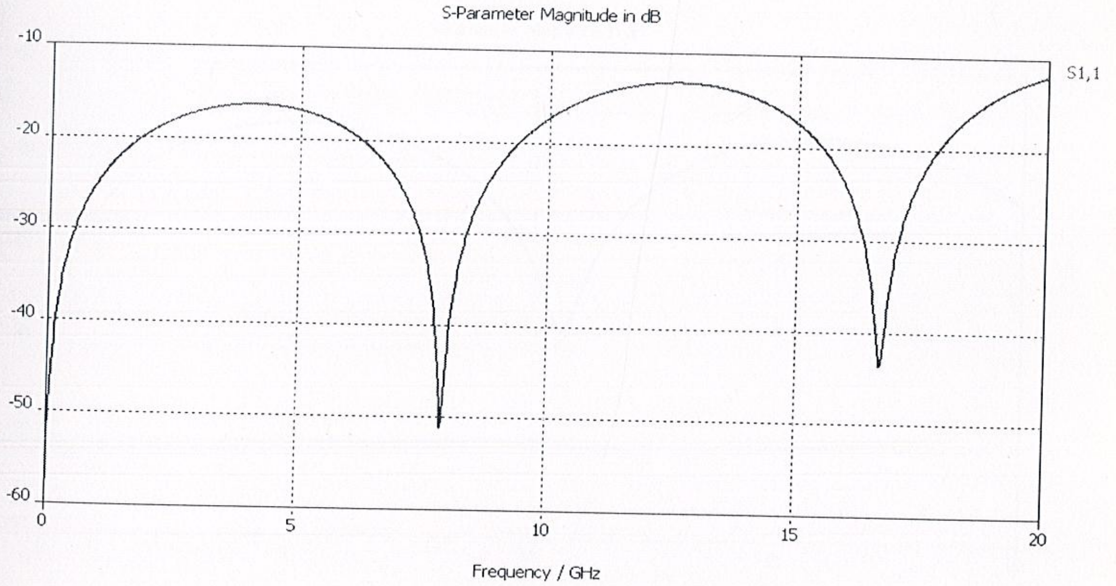
Length of microstrip lines: 10mm

Width of microstrip lines: 1.2mm

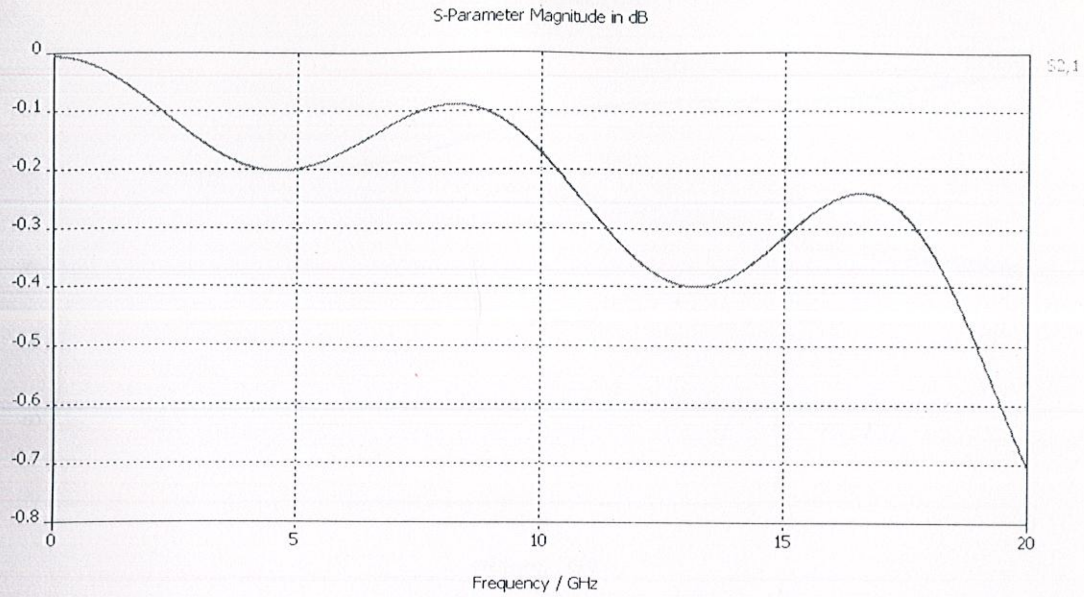
Height of microstrip lines:0.22mm

Spacing between two coupled microstrip lines: 0.6mm

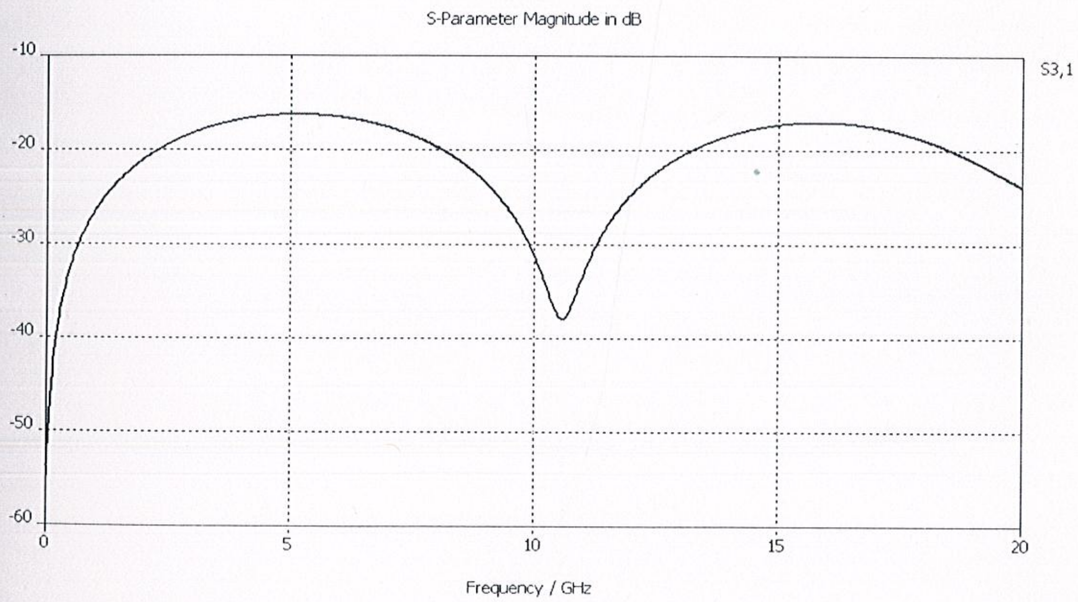
Height of substrate :0.508mm



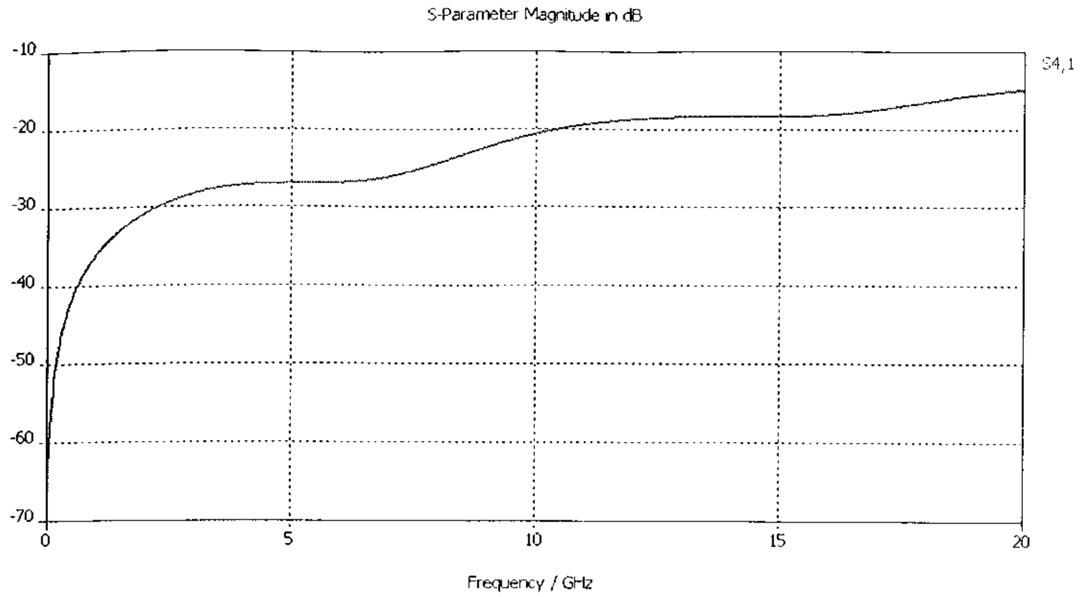
Plot for S1,1



Plot for S2,1



Plot for S3,1


S-Parameter Magnitude in dB
S4,1
-10
-20
-30
-40
-50
-60
-70
0
5
10
15
20
Frequency / GHz

Plot for S4,1

Graphs for basic microstrip coupler with ground plane aperture:

Material: Rogers RT 5880(lossfree)

Epsilon = 2.2

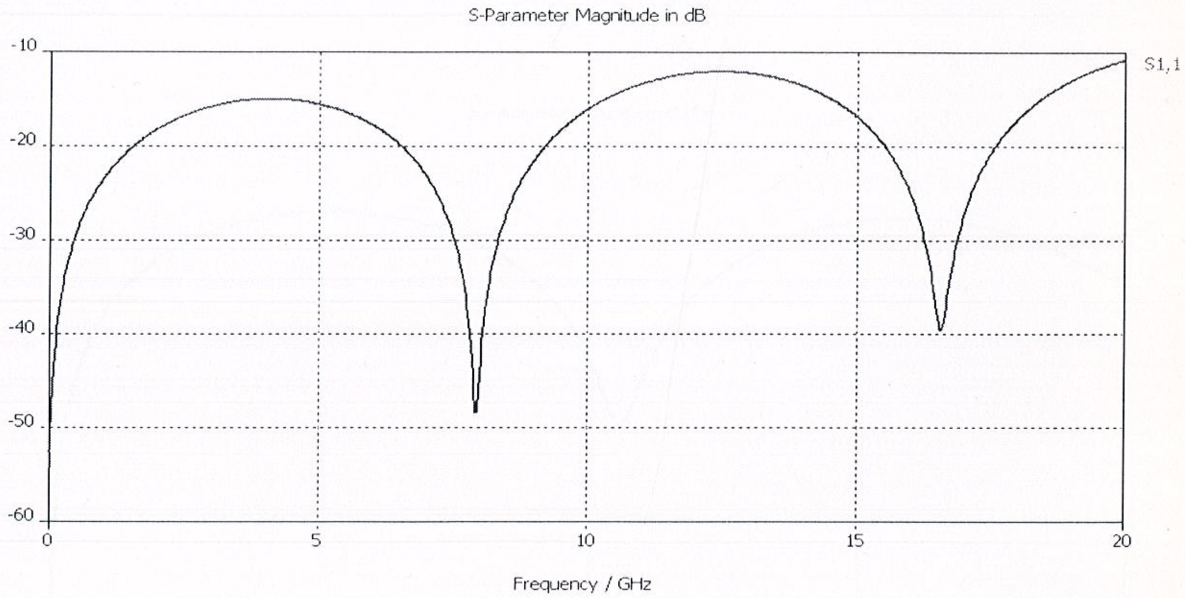
Length of microstrip lines: 10mm

Width of microstrip lines: 1.2mm

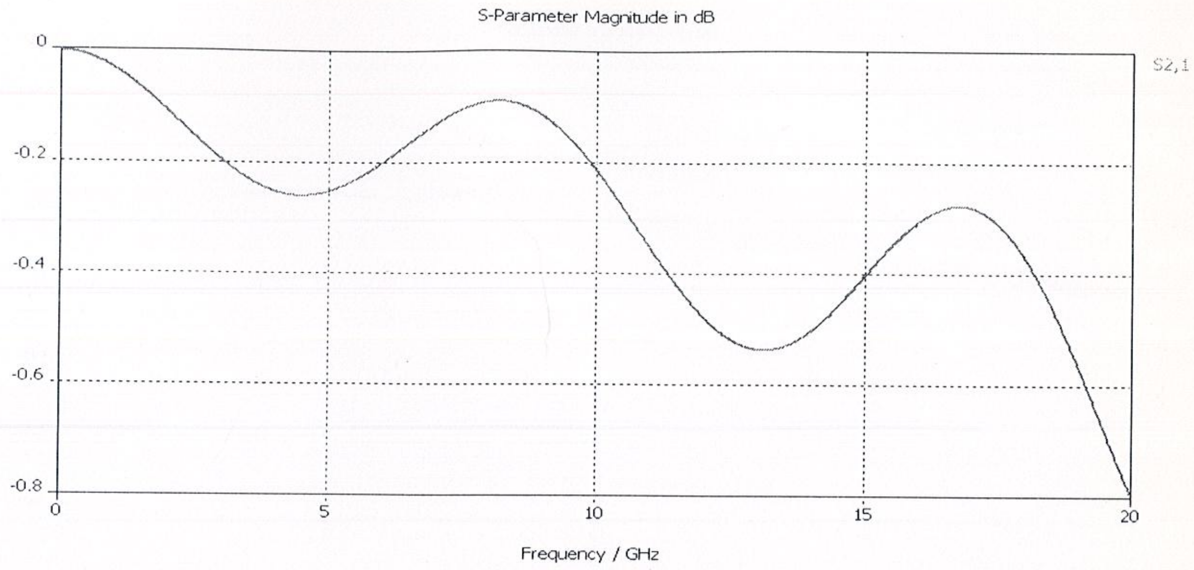
Height of microstrip lines:0.22mm

Spacing between two coupled microstrip lines: 0.6mm

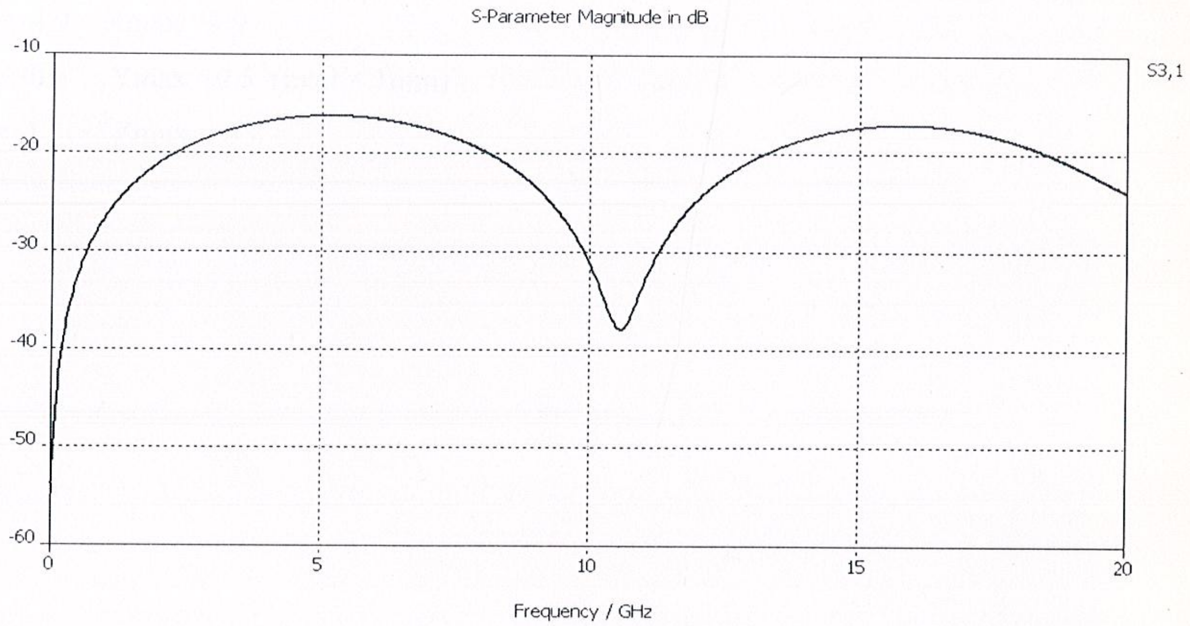
Height of substrate:0.508mm



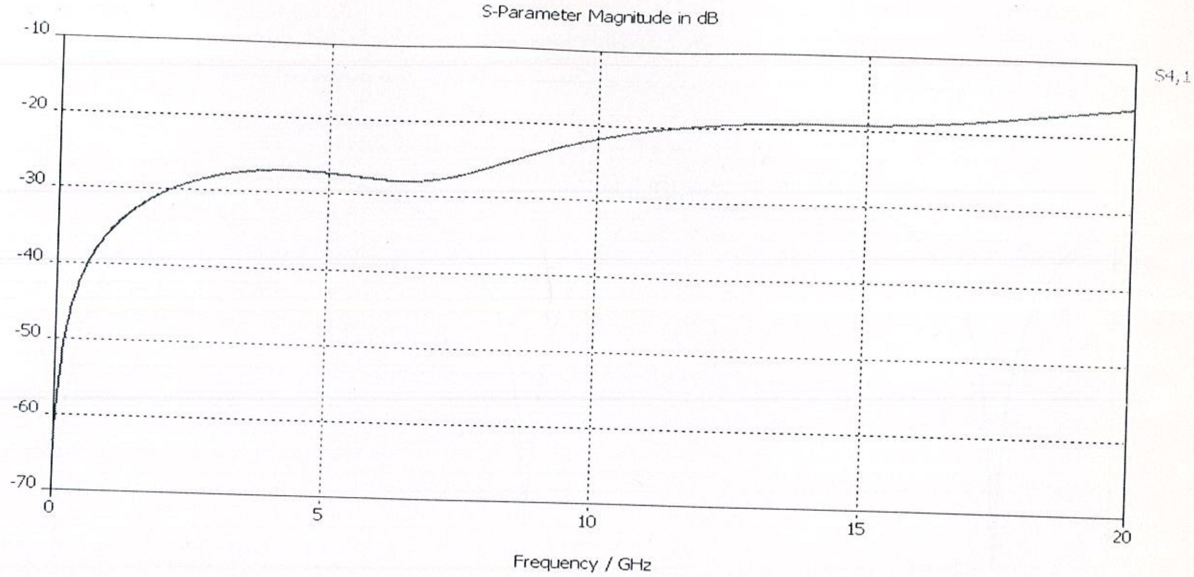
Plot for S1,1



Plot for S2,1



Plot for S3,1



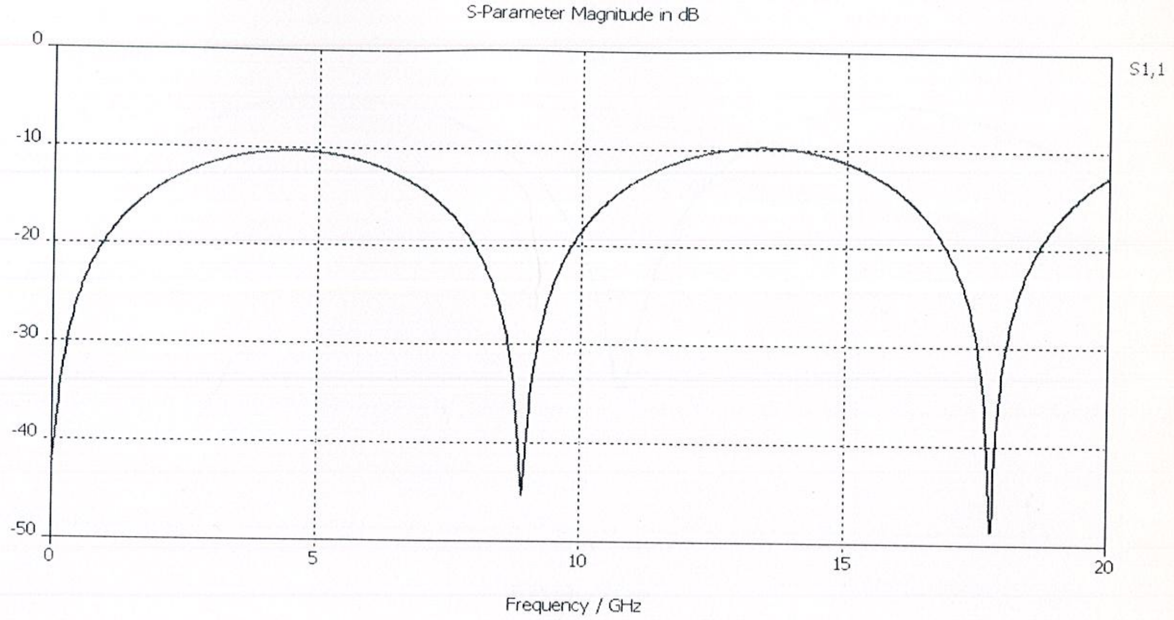
Plot for S4,1

Ground plane dimensions:

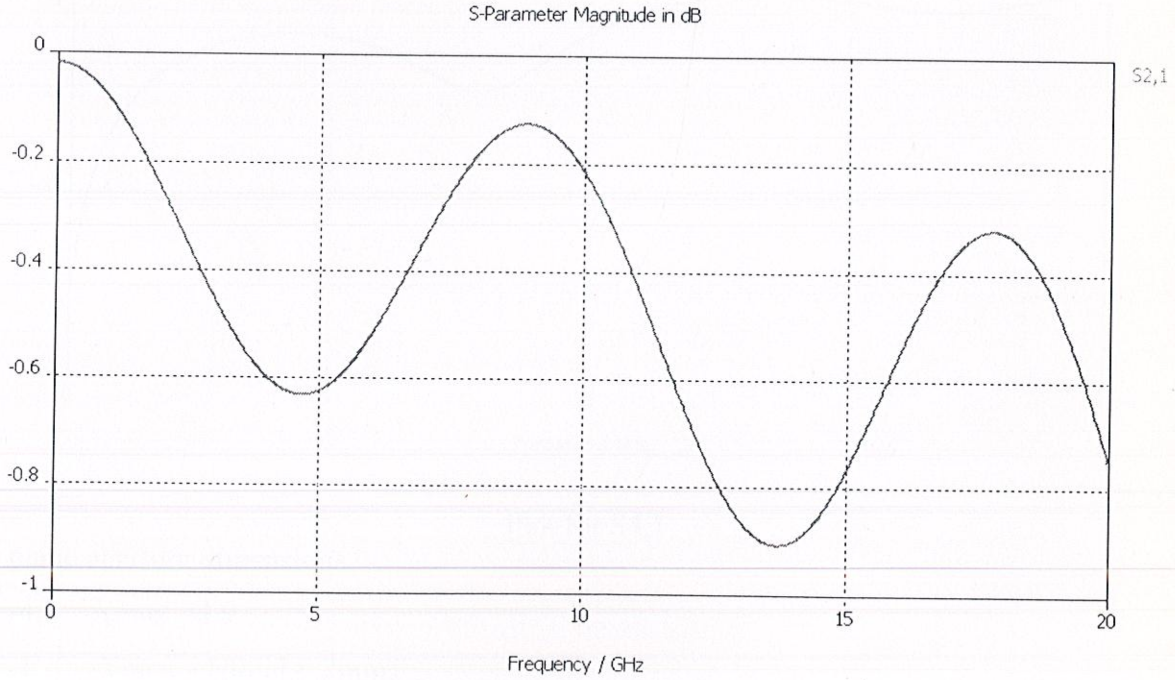
Xmin = -4.9   Xmax =4.9

Ymin = -0.5   Ymax =0.5 (total = 1mm)

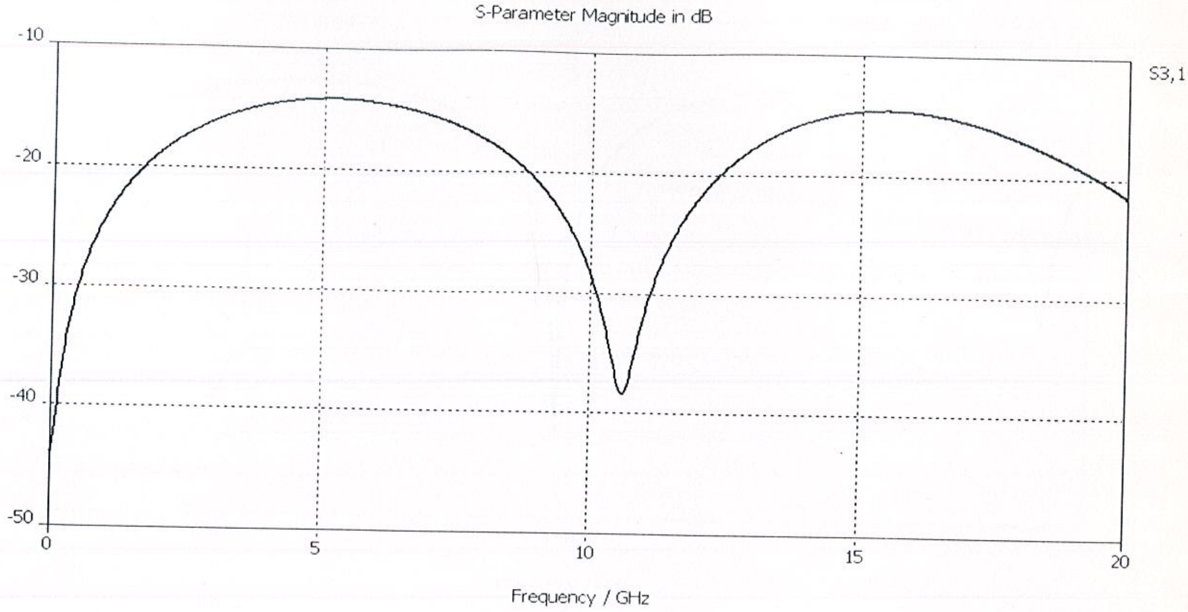
Zmin = -1   Zmax = 0



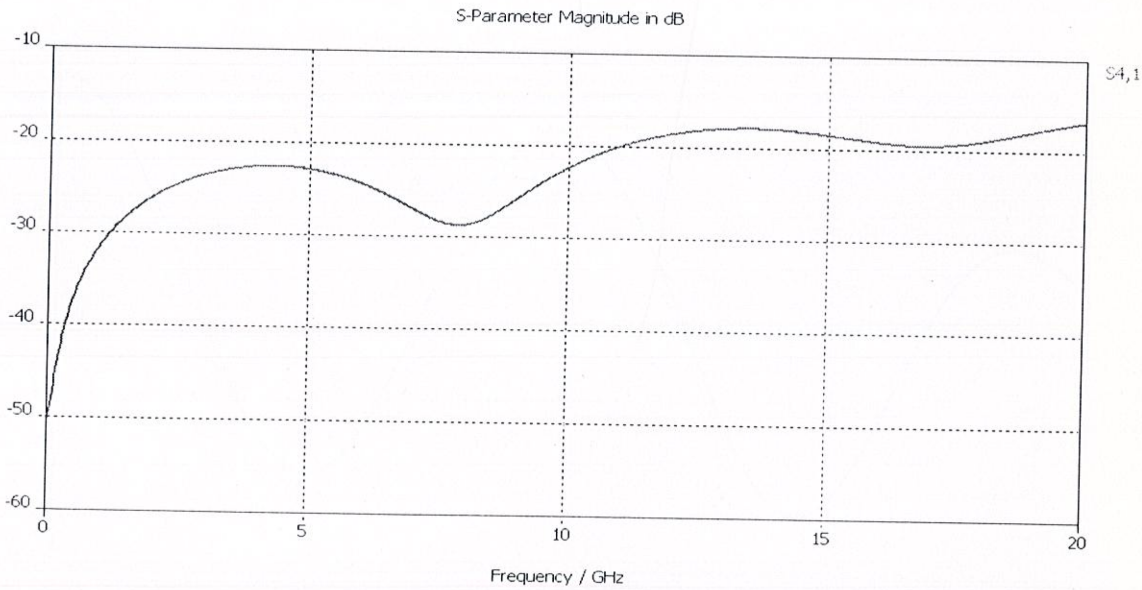
Plot for S1,1



Plot for S2,1



Plot for S3,1



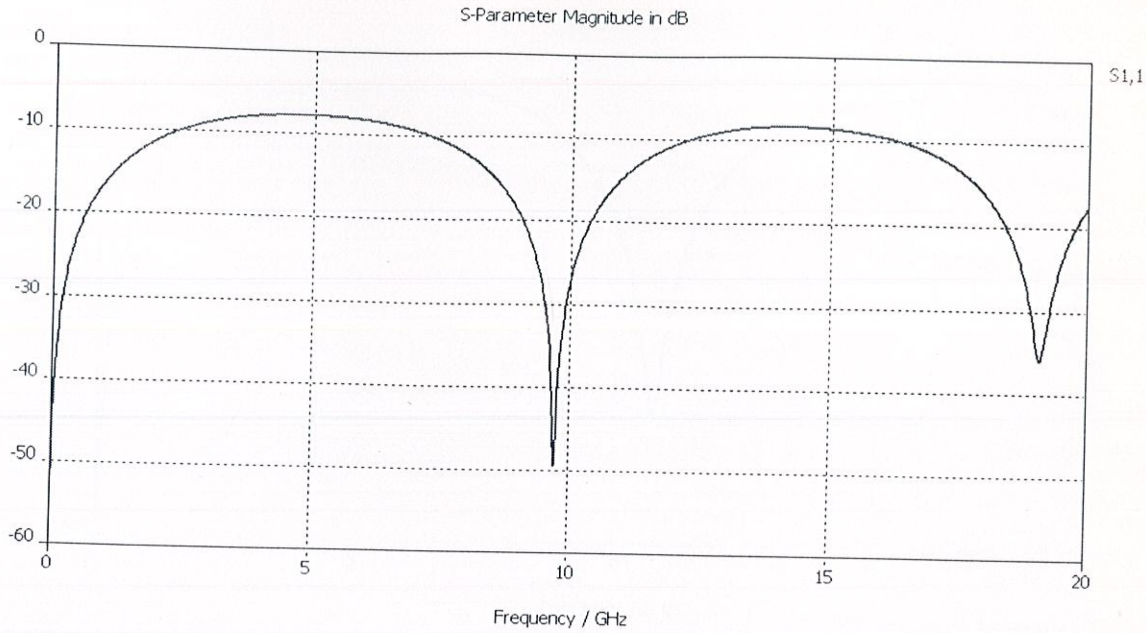
Plot for S4,1

Ground plane aperture dimensions:

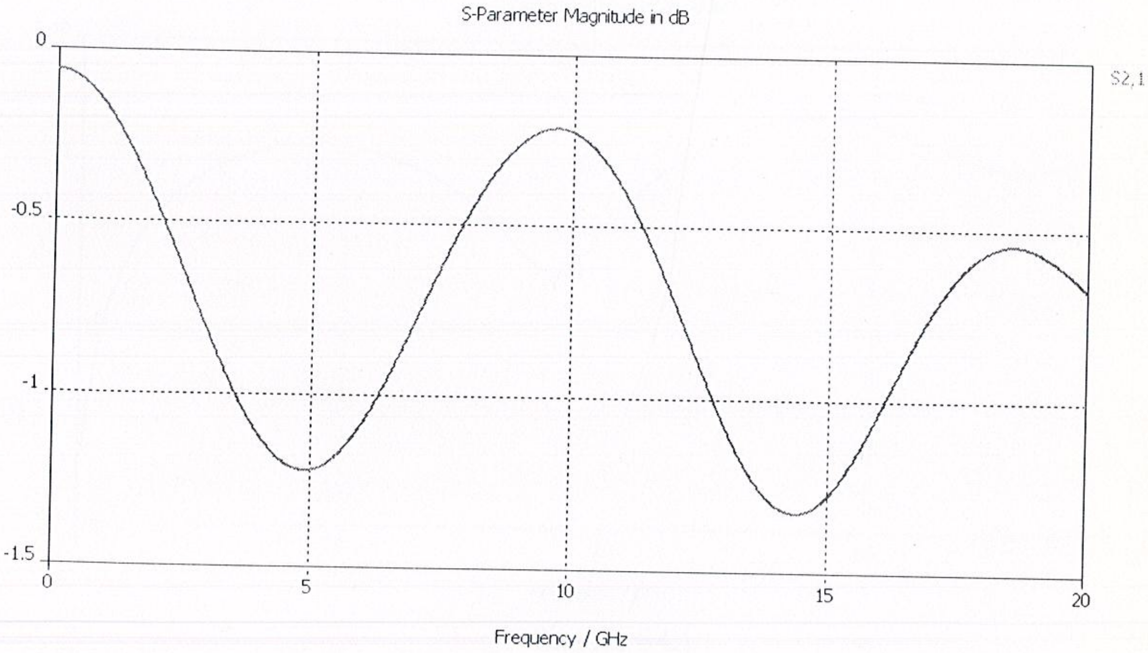
Xmin = -4.9   Xmax =4.9

Ymin = -1   Ymax =1(total = 2mm)

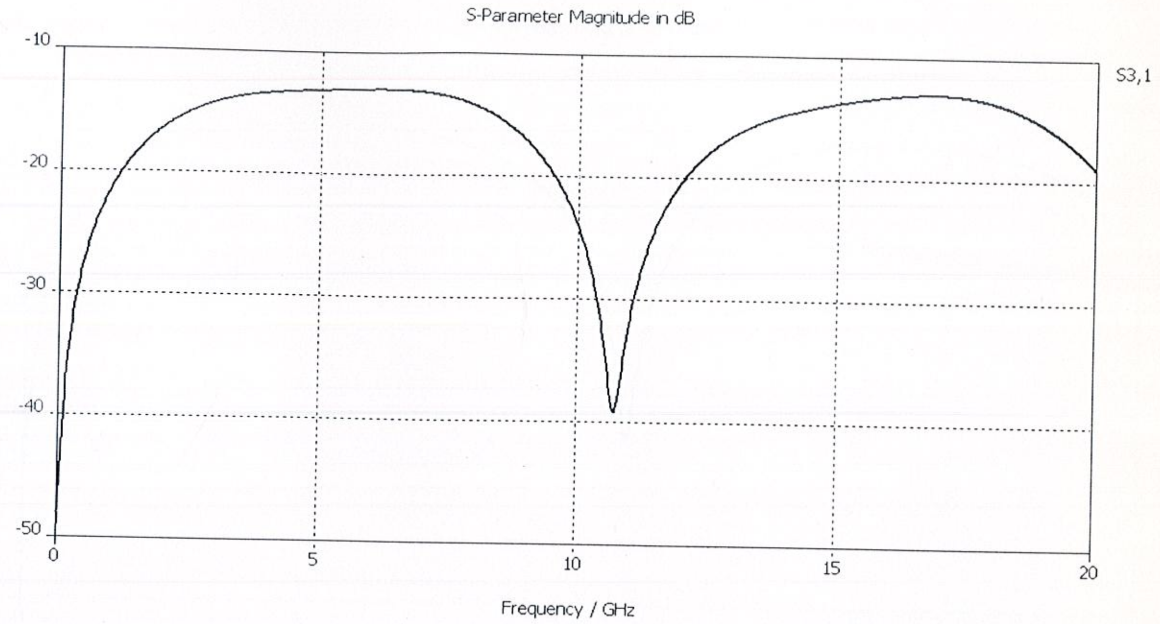
Zmin = -1   Zmax = 0



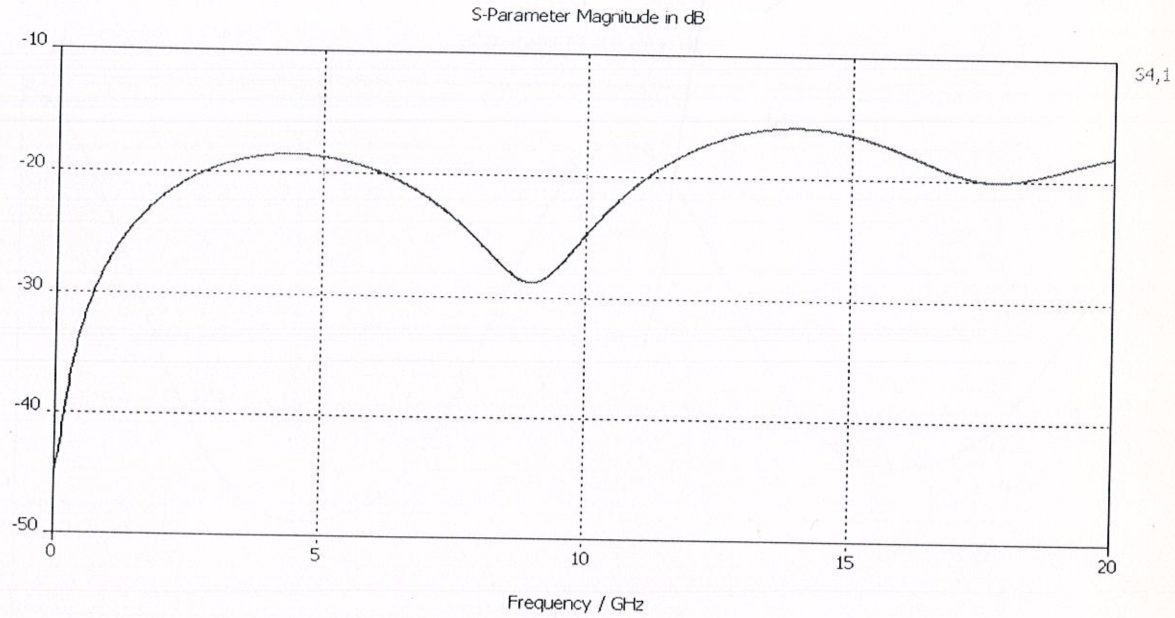
Plot for S1,1



Plot for S2,1



Plot for S3,1



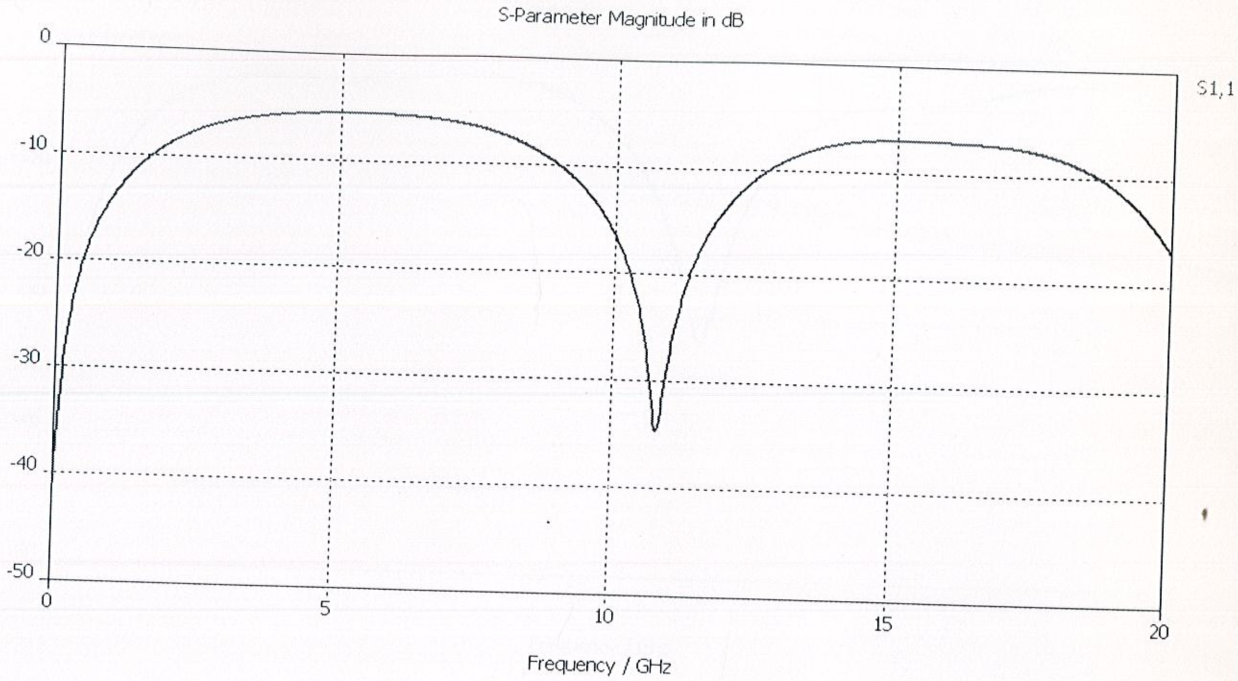
Plot for S4,1

Ground plane aperture dimensions:

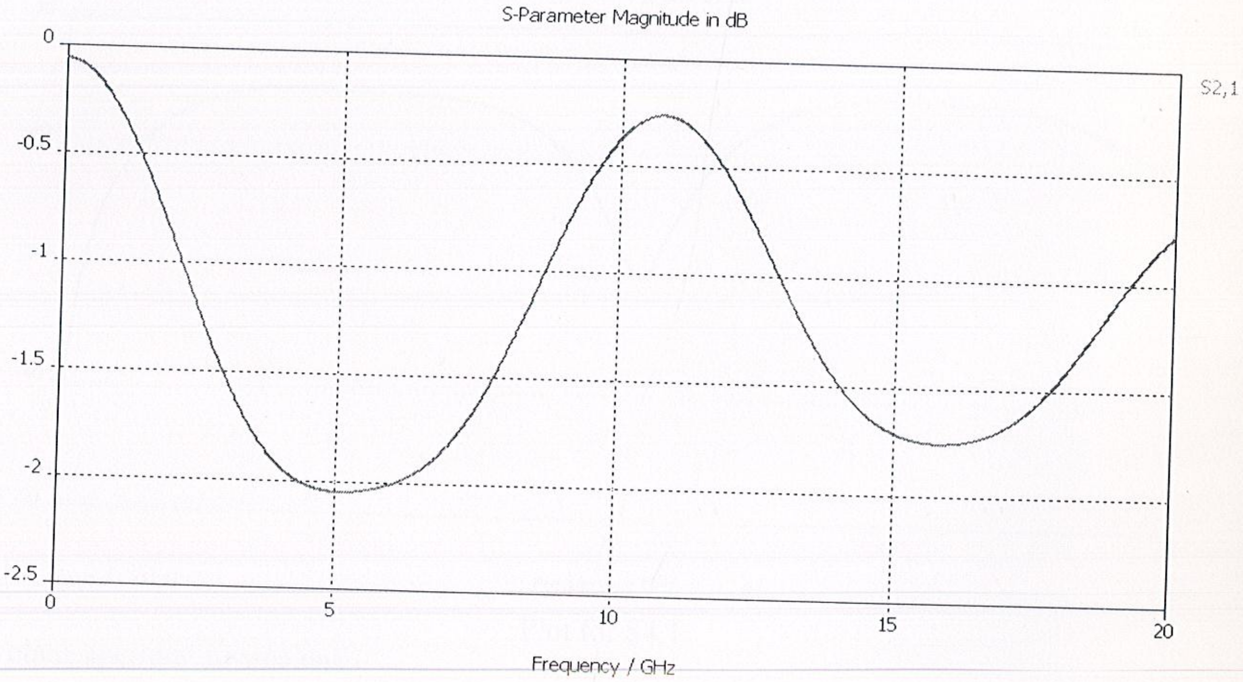
Xmin = -4.9 Xmax =4.9

Ymin = -1.5 Ymax =1.5(total = 3mm)

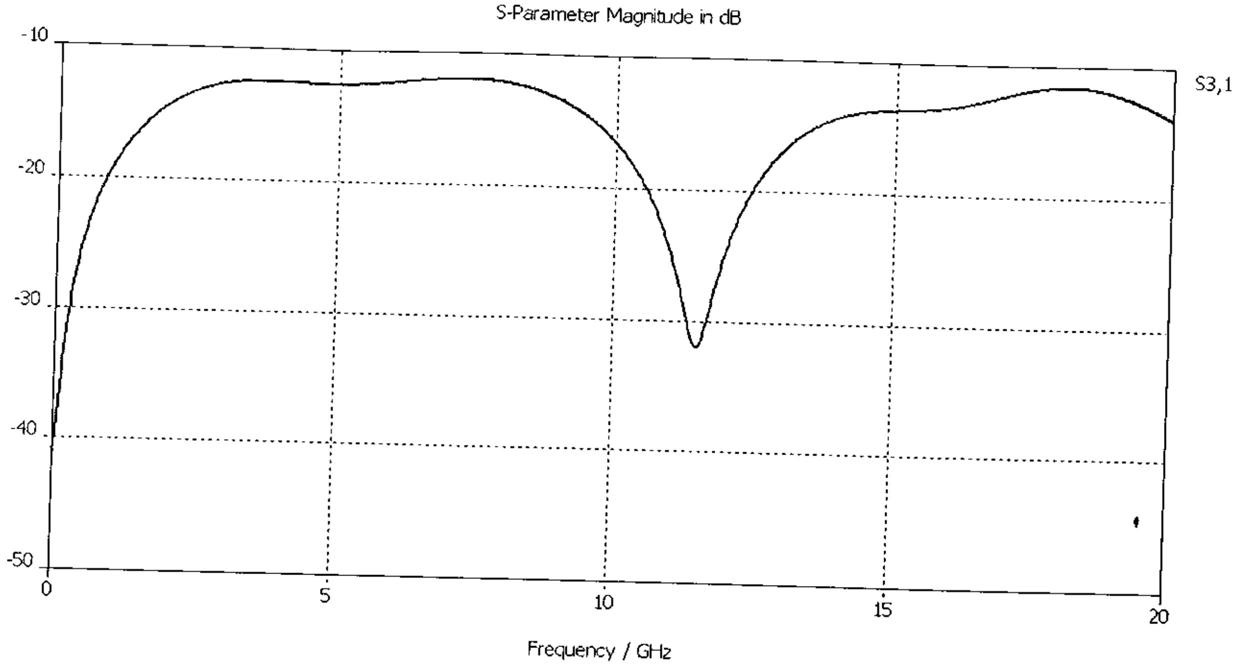
Zmin = -1 Zmax = 0



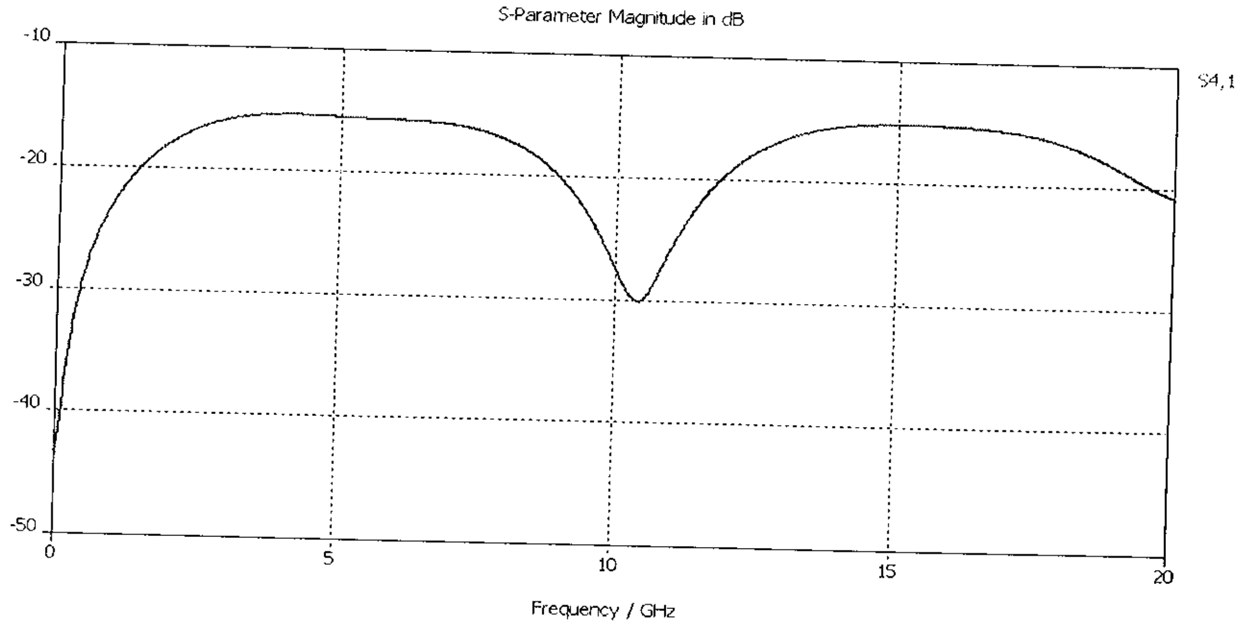
Plot for S1,1



Plot for S2,1



Plot for S3,1



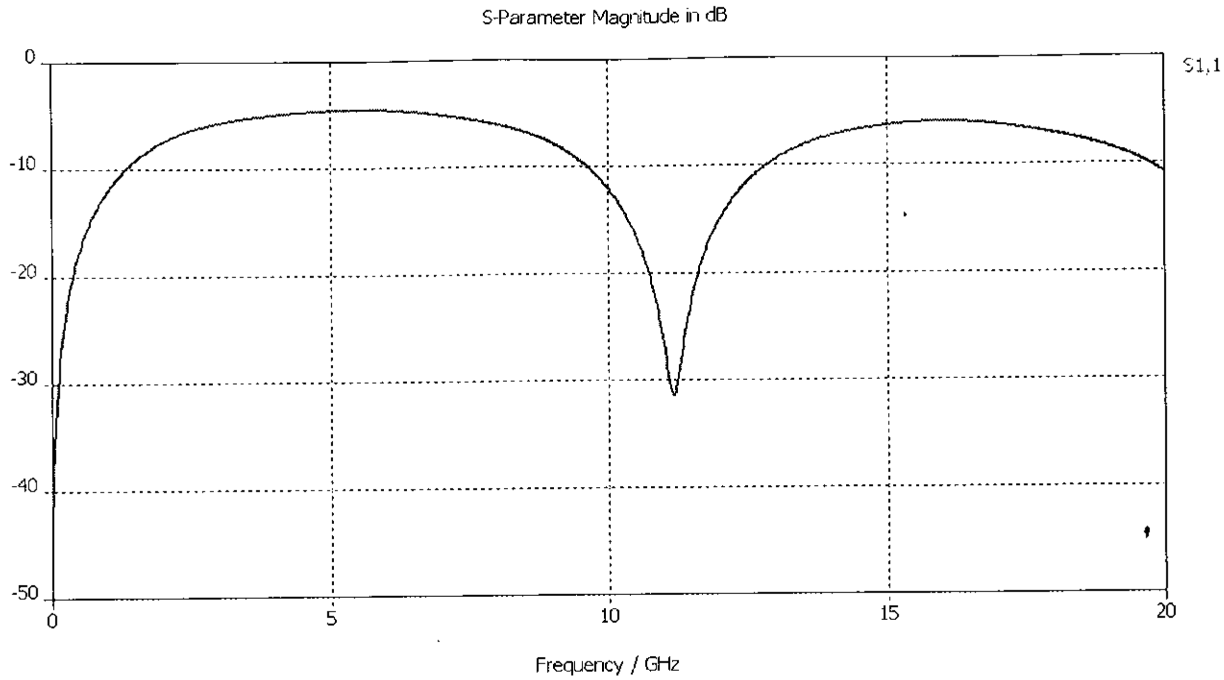
Plot for S4,1

Ground plane aperture dimensions:

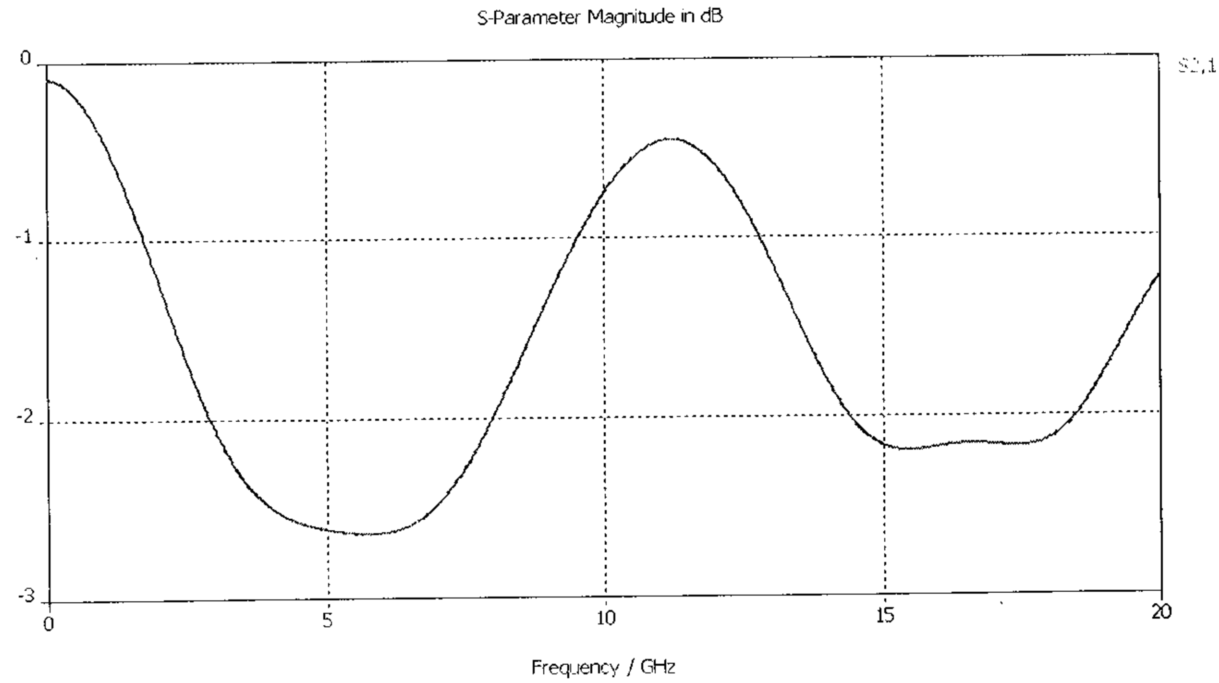
Xmin = -4.9 Xmax=4.9

Ymin = -2 Ymax =2(total 4mm)

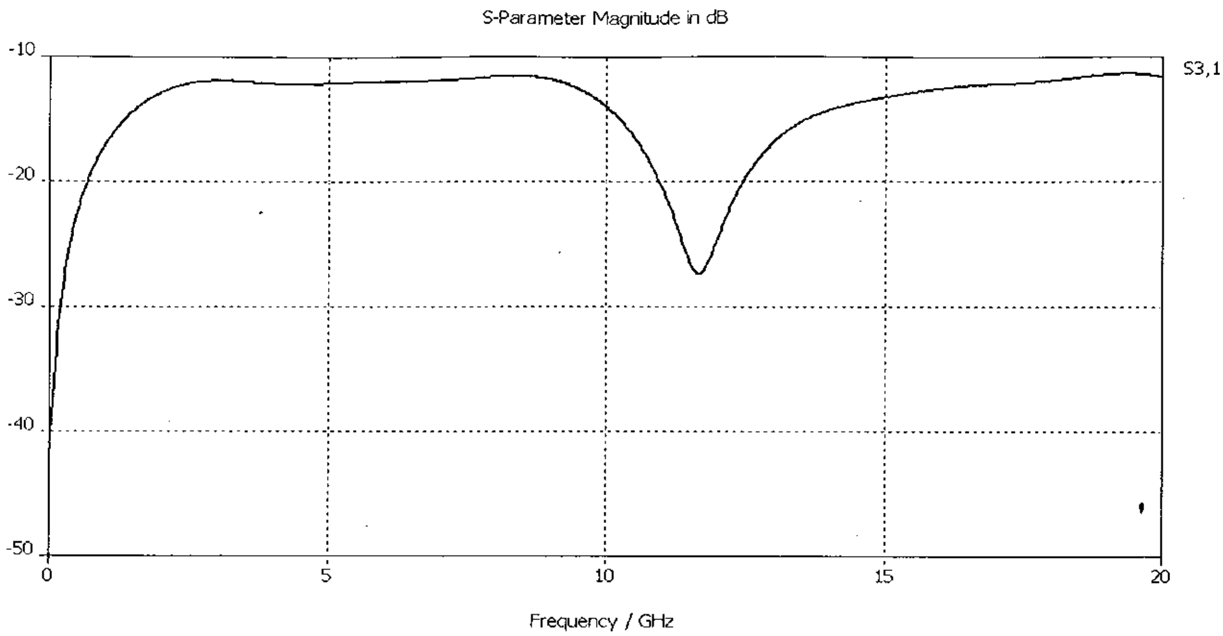
Zmin = -1 Zmax = 0



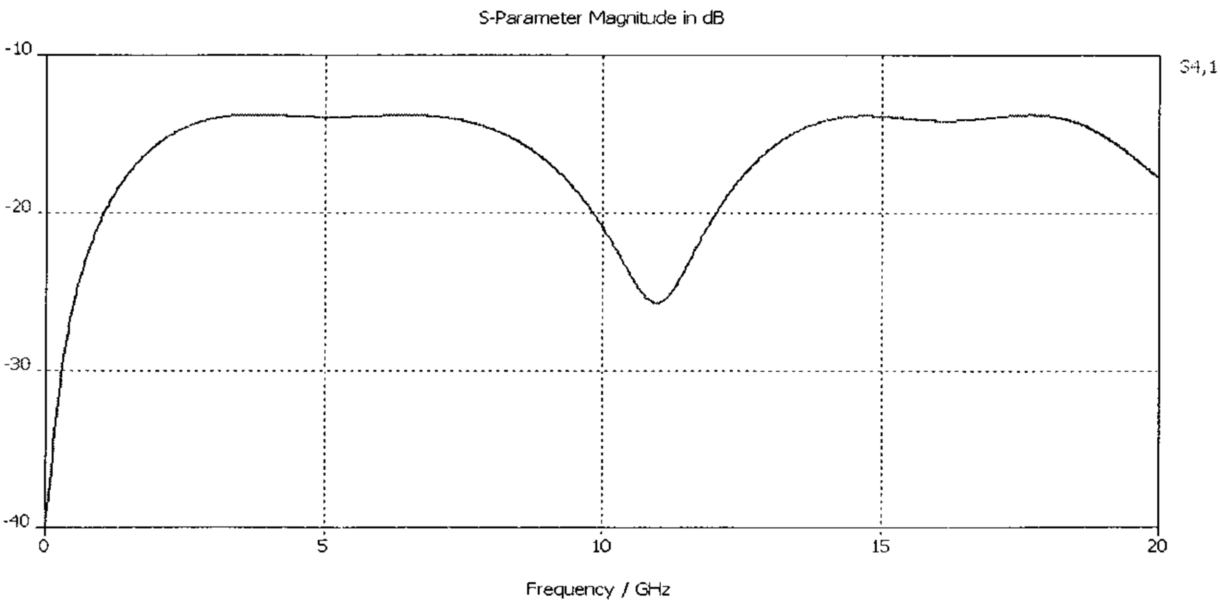
Plot for S1,1



Plot for S2,1



Plot for S3,1



Plot for S4,1

Ground plane aperture dimensions:

Xmin = -4.9 Xmax =4.9

Ymin = -2.5 Ymax =2.5(5mm)

Zmin = -1 Zmax = 0

SUMMARIZATION OF RESULTS

OBSERVATION FOR:

Material: Alumina (99.5% loss free)

Epsilon = 9.9

	Basic Coupler	Ws = 1mm	Ws = 1.5mm	Ws = 2mm	Ws = 2.5mm	Ws = 3mm	Ws = 3.5mm	Ws = 4mm	Ws = 4.5mm	Ws = 5mm
S1,1	-25.00 (dB)	-39.25 (dB)	-20.74 (dB)	-14.48 (dB)	-12.39 (dB)	-11.23 (dB)	-10.55 (dB)	-10.01 (dB)	-9.672 (dB)	-9.367 (dB)
S2,1	-0.38 (dB)	-0.4461 (dB)	-0.6383 (dB)	-0.9872 (dB)	-1.261 (dB)	-1.514 (dB)	-1.71 (dB)	-1.9 (dB)	-2.033 (dB)	-2.183 (dB)
S3,1	-11.00 (dB)	-10.15 (dB)	-8.936 (dB)	-8.003 (dB)	-7.531 (dB)	-7.138 (dB)	-7.001 (dB)	-6.832 (dB)	-6.675 (dB)	-6.572 (dB)
S4,1	-26.00 (dB)	-29.42 (dB)	-27.48 (dB)	-21.1 (dB)	-18.33 (dB)	-16.51 (dB)	-15.35 (dB)	-14.39 (dB)	-13.79 (dB)	-13.18 (dB)

Readings taken at frequency of 5GHz.Here Ws is the width of vacuum created in the ground plane. Here Ws is the width of ground plane aperture.

	Basic Coupler Freq. Range In GHz	ForWs = 1mm Freq. Range In GHz	Ws = 1.5mm Freq. Range In GHz	Ws = 2mm Freq. Range In GHz	Ws = 2.5mm Freq. Range In GHz	Ws = 3mm Freq. Range In GHz	Ws = 3.5mm Freq. Range In GHz	Ws = 4mm Freq. Range In GHz	Ws = 4.5mm Freq. Range In GHz	Ws = 5mm Freq. Range In GHz
S3,1	3.9257 to 7.41	4.0186 to 7.5494	4.2044 to 7.921	4.2741 to 7.921	4.2276 to 9.5006	4.1347 to 9.9642	4.3438 to 9.8955	4.2509 to 10.035	4.2276 to 10.151	4.158 to 10.221
S4,1	11.8 to 16.725	10.755 to 15.285	12.892 to 18.002	4.6225 to 8.8502	4.9013 to 11.591	6.6899 to 12.706	7.39 to 12.846	7.3403 to 13.148	6.7131 to 13.844	6.4596 to 13.914

Frequency range with coupling ratio of ±1dB.Here Ws is the width of ground plane aperture.

OBSERVATION FOR:

Material: Rogers RT 5880(lossfree)

Epsilon: 2.2

	Basic Coupler	Ws = 1mm	Ws = 1.5mm	Ws = 2mm	Ws = 2.5mm	Ws = 3mm	Ws = 3.5mm	Ws = 4mm	Ws = 4.5mm	Ws = 5mm
S1,1	-16.83 (dB)	-15.55 (dB)	-13.23 (dB)	-10.47 (dB)	-9.329 (dB)	-7.75 (dB)	-6.283 (dB)	-5.483 (dB)	-4.88 (dB)	-4.551 (dB)
S2,1	-0.1988 (dB)	-0.2505 (dB)	-0.3704 (dB)	-0.6222 (dB)	-0.848 (dB)	-1.217 (dB)	-1.645 (dB)	-2.045 (dB)	-2.361 (dB)	-2.618 (dB)
S3,1	-16.97 (dB)	-16.2 (dB)	-15.27 (dB)	-14.14 (dB)	-13.65 (dB)	-13.1 (dB)	-12.8 (dB)	-12.54 (dB)	-12.22 (dB)	-12.10 (dB)
S4,1	-26.9 (dB)	-27.24 (dB)	-25.77 (dB)	-22.87 (dB)	-21.11 (dB)	-18.72 (dB)	-16.92 (dB)	-15.52 (dB)	-14.6 (dB)	-13.92 (dB)

Readings taken at frequency of 5GHz.Here Ws is the width of ground plane aperture.

	Basic Coupler Freq. Range In GHz	ForWs = 1mm Freq. Range In GHz	Ws = 1.5mm Freq. Range In GHz	Ws = 2mm Freq. Range In GHz	Ws = 2.5mm Freq. Range In GHz	Ws = 3mm Freq. Range In GHz	Ws = 3.5mm Freq. Range In GHz	Ws = 4mm Freq. Range In GHz	Ws = 4.5mm Freq. Range In GHz	Ws = 5mm Freq. Range In GHz
S3,1	3.5772 to 6.6434	3.6005 to 6.7596	3.554 to 6.713	3.554 to 6.806	3.3682 to 7.41	3.1359 to 7.8281	2.9268 to 8.3391	2.6713 to 8.7573	2.2997 to 9.338	4.158 to 10.221
S4,1	11.01 to 17.05	11.243 to 17.236	11.22 to 15.912	11.73 to 15.494	12.102 to 15.261	12.544 to 15.401	12.683 to 16.91	13.217 to 17.7	13.38 to 18.537	13.473 to 18.908

Frequency range with coupling ratio of ±1dB. Here Ws is the width of ground plane aperture.

CHAPTER 5

CONCLUSION

With the introduction of ground plane aperture, the bandwidth (considering the coupling ratio ±1dB) is increased resulting in a broadband operation using a single edge coupled section.The plots show that the coupling increases resulting in increase of insertion loss and decrease of directivity.

APPENDIX A

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APPENDIX B

WEB RESOURCES

Most of the research and comparisons were made online.
Here 's the list of websites that were really helpful in gaining understanding and for implementation.

- www.ieeexplore.ieee.org
- www.google.com
- www.search.com
- www.circuitsage.com

self care as he has reduced it a lot. As I told him the benefits of the hygiene. Told him to try to be socially adaptable as he is become a lot reduced socially. Try to motivate him to work and earn on his own. Try to settle down in you life.

(c) Family Therapy : All the family members of the patient were told that they should be supportive, understanding, caring and affectionate co-operative and loving towards the patient. They were made understood that drug dependency was not an habit but actually it was an illness. They should help there patient so that he can be cured form the illness. I also told my patients relative that psychotic illness is not only related to the madness but it is an illness which can be cured and the family needs to be very supportive and the medication of the patient should be done in a regular process as it is required. The behaviour should be very normal toward the patient.

Session-VI

Psycho education sessions.

(a) Education regarding the illness of drug dependency and Psychotic illness in four sessions :

(i) Drug dependency as and illness.

(ii) Recurrent illness.

(iii) Its harmful effects.

(iv) Psychotic illness is curable and patient can had a normal life. Should not be treated badly or differently by family.

(b) Regarding Relapse Prevention : The patient was motivated to make a voluntary decision to change; for this he was told to encourage a sense of control over his behaviour i.e. to control his drug dependency.