CHAPTER SIX

MULTILAYER OR INCREASED SUBSTRATE HEIGHT WIDEBAND MICROSTRIP PATCH ANTENNA

In this chapter multilayer patch antenna or increased substrate height, reduced size microstrip antennas are designed and analyzed. These multilayer arrangements are suitable as array elements. Bandwidth may be improved if the compact rectangular microstrip patch antenna with increased substrate height is used. By configuring these designs, compact and wideband microstrip patch antenna may be realized, which is prime objective for many applications.

6.1 INTRODUCTION

In planar multiple resonator arrangement of patch antenna which have been discussed earlier, bandwidth of the antenna increases by using many planar- coupled resonators. These wideband arrangements are having some demerits. First and foremost, planar size of the antenna increases, as air gap coupled or directly coupled parasitic patches are positioned along radiating corners (edges) and non radiating corners (edges) of fed printed patch which makes it an unsuitable array element. Second, the radiation pattern changes over the BW in many cases. Instead of using the planar-coupled method, any number of patches can be placed on separate dielectric substrates and they can be connected to each other. This technique increases the patch antenna height but the dimension along planar direction is similar as that of the single printed patch antenna. Depending on the coupling mechanism, these arrangements are known as electromagnetically coupled patch antenna or aperture coupled microstrip antenna. In electromagnetically coupled patch antenna the lower patch is fed with a coaxial line and the upper parasitic patch is excited due to electromagnetically coupling with the lower patch. The patches can be printed on separate substrates and an air gap or foam material can be introduced between these substrate layers to increase the bandwidth [31]. The bandwidth enhancement can be achieved due to an increase in the overall height (h) of the printed patch antenna.

6.2 INCREASED SUBSTRATE HEIGHT WIDEBAND MICROSTRIP ANTENNA DESIGN-1

In the antenna design-1, bandwidth has been enhanced if the truncated gap coupled reduced size rectangular microstrip patch antenna with increased dielectric substrate height (h) is introduced.

Figure 6.1 presents the truncated gap coupled reduced size rectangular printed patch antenna design-1. In this antenna design-1, an air gap of 0.625 mm is introduced 0.675 mm below the centre horizontal axis. Antenna is designed for S-band of frequency range with center frequency f_0 = 2.55 GHz, within the frequency range 2 GHz to 3 GHz, step of frequency selected to be 0.01 GHz, In this antenna design-1, the patch length L = 30 mm**,** the patch width W = 55 mm, with two side corners are truncated, height of the dielectric substrate 3.18 mm, feed point positions on the patch is (-9.775, -0.175). Microstrip patch antenna design considered is printed on inexpensive FR4 (copper-cladded plate) having dielectric constant (Єr) of 4.4, loss tangent tan δ = 0.02. The coaxial probe feed having 50-ohm impedance is used for feeding the patch. Figure 6.2 shows the graph between return loss (in dB) and frequency (in GHz) for antenna design-1; maximum return loss is – 41 dB within this frequency range, impedance bandwidth can be taken below – 10 dB return loss. Figure 6.3 shows the graph between directivity (in dBi) and frequency (in GHz) for antenna design-1. For the antenna design-1, directivity (in dBi) for the operating frequency is coming between 5-8 dBi. Figure 6.4 shows the radiation pattern (2-D elevation pattern) for antenna design-1 at the center frequency 2.55 GHz. Figure 6.5 shows the impedance loci for antenna design-1. At resonance frequency 2.55 GHz, the simulated input impedance of antenna design-1 is near to be matched with 50 ohm impedance. The impedance bandwidth is coming out to be **23.1 %** of the center frequency at 2.55 GHz with four resonant modes within the specified frequency range.

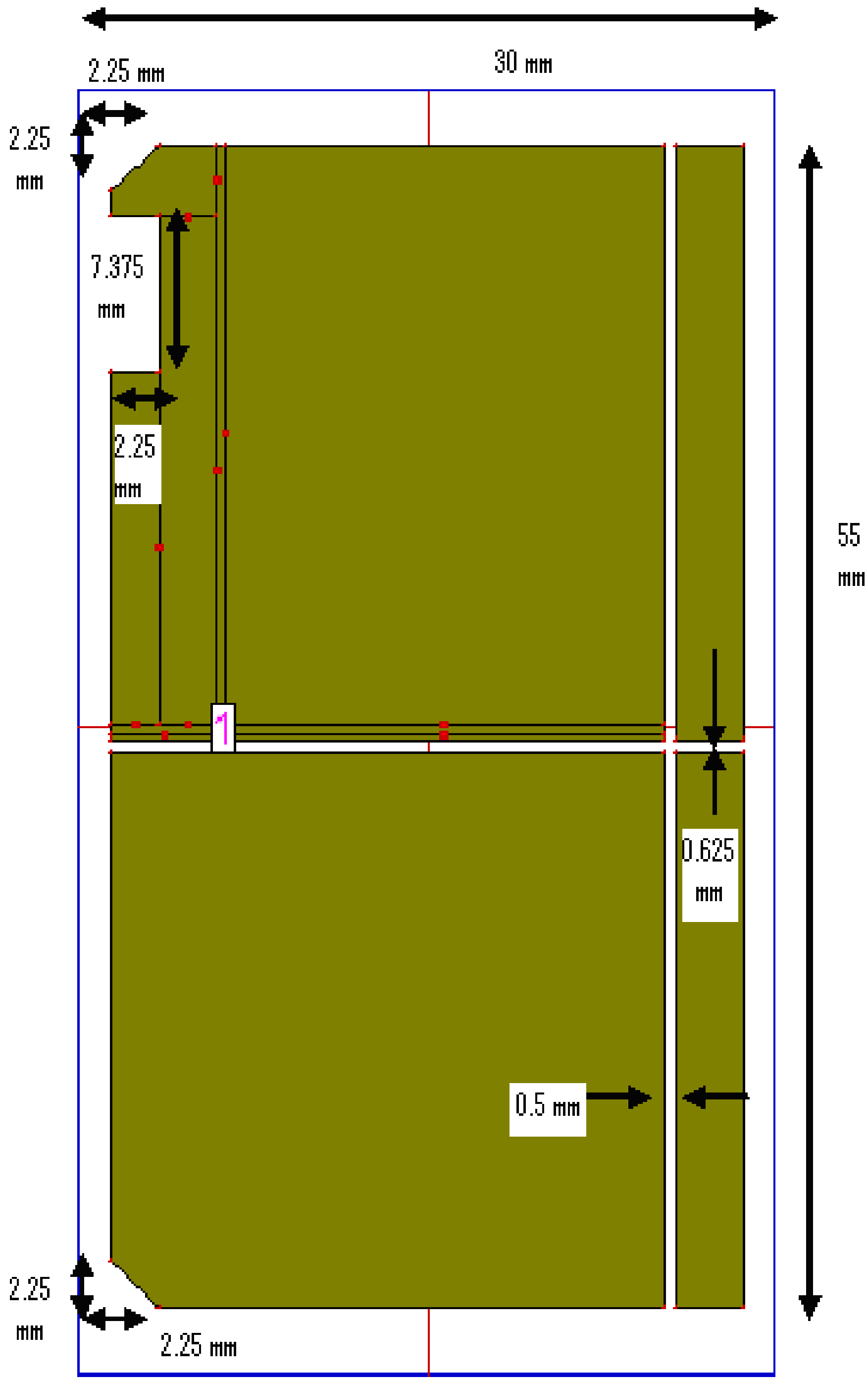

Figure 6.1: Increased substrate height rectangular microstrip antenna design-1

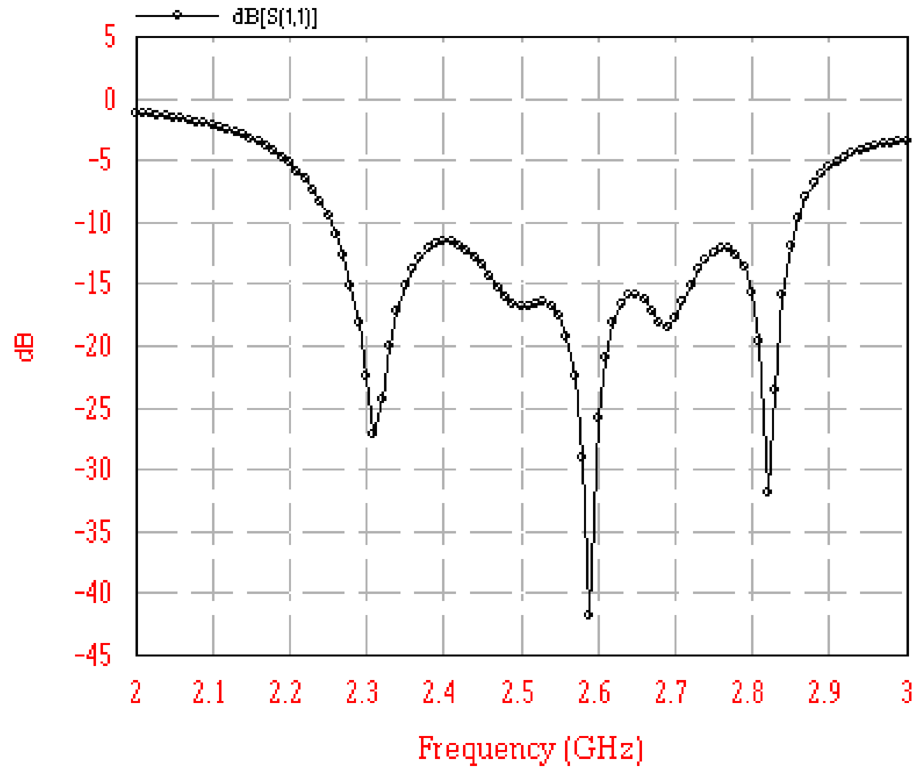

Figure 6.2 Graph between return loss and frequency for antenna design-1

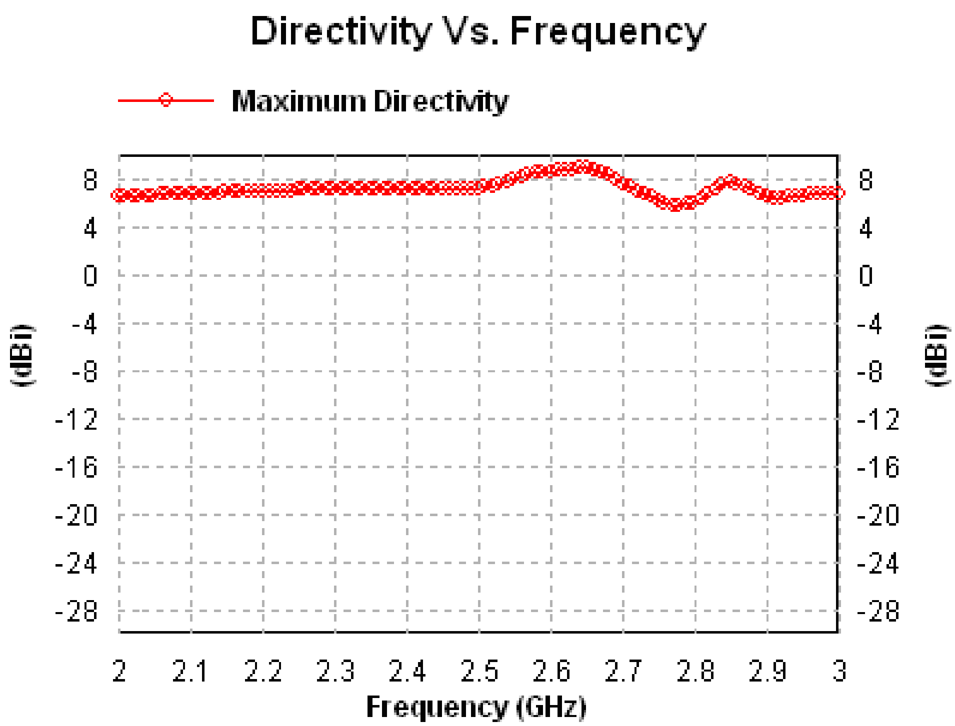

Figure 6.3 Graph between directivity and frequency for antenna design-1

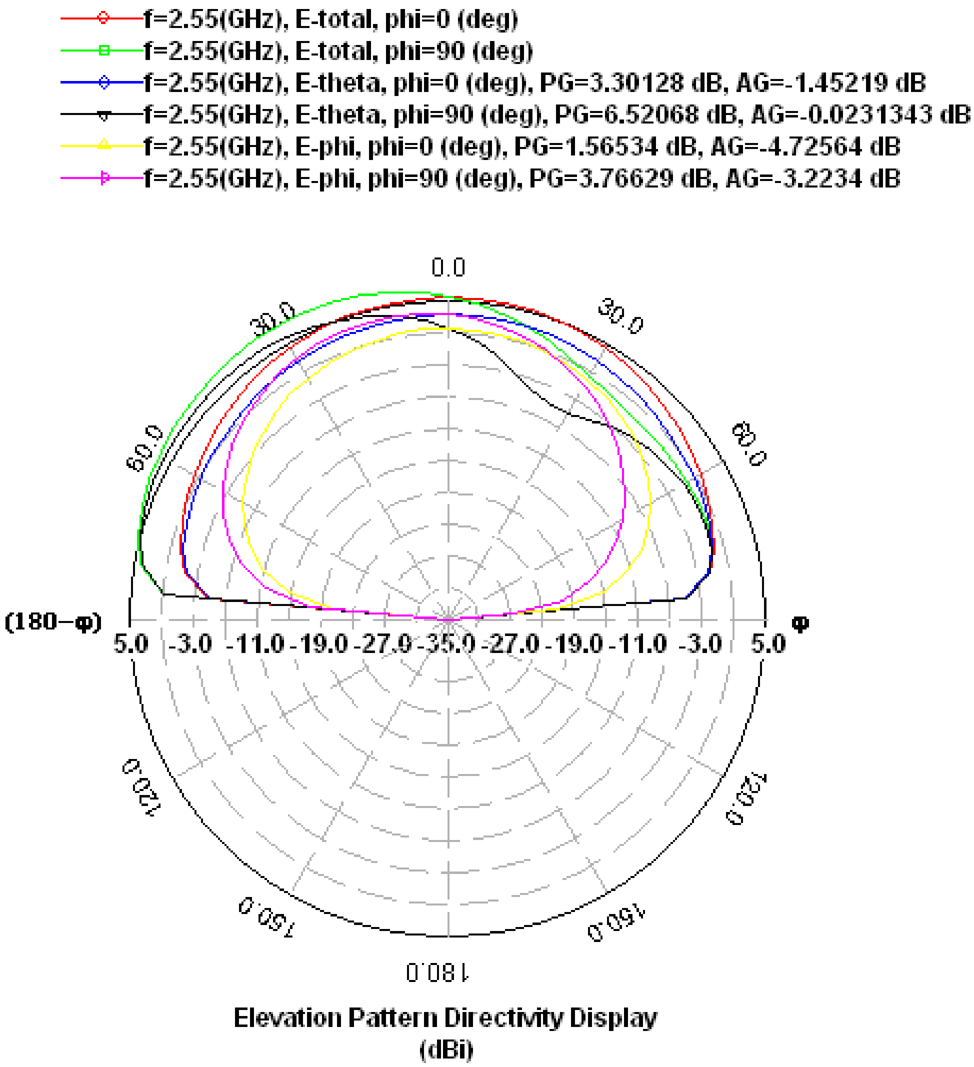

Figure 6.4 Radiation pattern for antenna design-1

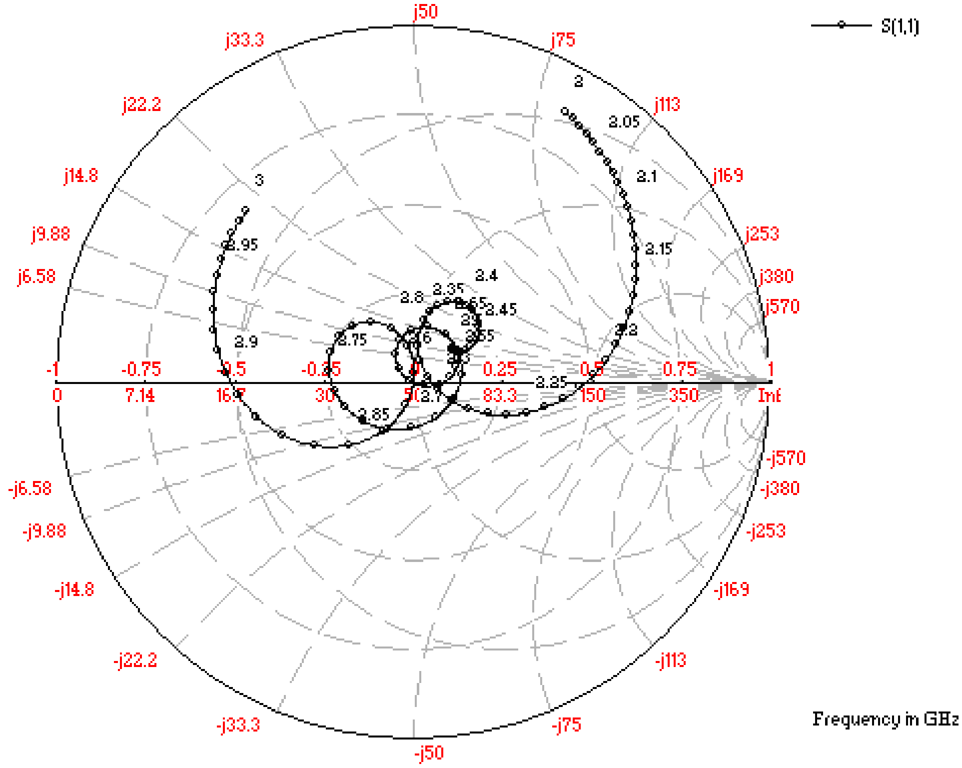

Figure 6.5 Impedance loci for antenna design-1

6.3 INCREASED SUBSTRATE HEIGHT WIDEBAND MICROSTRIP ANTENNA DESIGN-2

In this printed patch antenna design-2, triple band modified square microstrip patch antenna with wideband is achieved by inserting slits of different dimensions at the edges of the radiating patch having finite ground plane.

Figure 6.6 presents the modified square microstrip patch antenna with slits at the edges having finite ground plane of antenna design-2. Antenna is designed for different applications of wireless communication in S-band and C-band for for three operating frequencies at 2.18, 2.76 and 4.2 GHz, within the frequency range 2 GHz to 5 GHz, step of frequency selected to be 0.01 GHz, In this square patch antenna design-2, patch length L = 35 mm**,** patch width W = 35 mm with finite ground plane of the dimension L = 40 mm and W = 40 mm, height of the dielectric substrate (h) 3.18 mm and feed point positions at the patch is (-14, 14.475). Microstrip patch antenna design considered is printed on inexpensive FR4 (copper-cladded plate) having dielectric constant (Єr) of 4.4, loss tangent tan δ = 0.02. The coaxial probe feed having 50-ohm impedance is used for feeding the patch. Figure 6.7 shows the graph between return loss (in dB) and frequency (in GHz) for antenna design-2; maximum return loss is – 36 dB within this frequency range, impedance bandwidth can be taken below – 10 dB return loss. Figure 6.8 shows the graph between VSWR and frequency (in GHz) for antenna design-2, impedance bandwidth can be taken below VSWR < 2. Figure 6.9 shows the graph between directivity (in dBi) and frequency (in GHz) for antenna design-2. Figure 6.10 shows the impedance loci for antenna design-2. At the three operating frequencies, the simulated input impedance of antenna design-2 is near to be matched with 50 ohm impedance. Here due to modified square microstrip patch antenna with slits at the edges having finite ground plane of this antenna design-2; the obtained bandwidth for these operating frequencies are **6.42 %**, **4.35 %** and **27.38 %** respectively. The other radiation properties of the presented antenna design for third operating frequency is also coming out to be satisfactory.

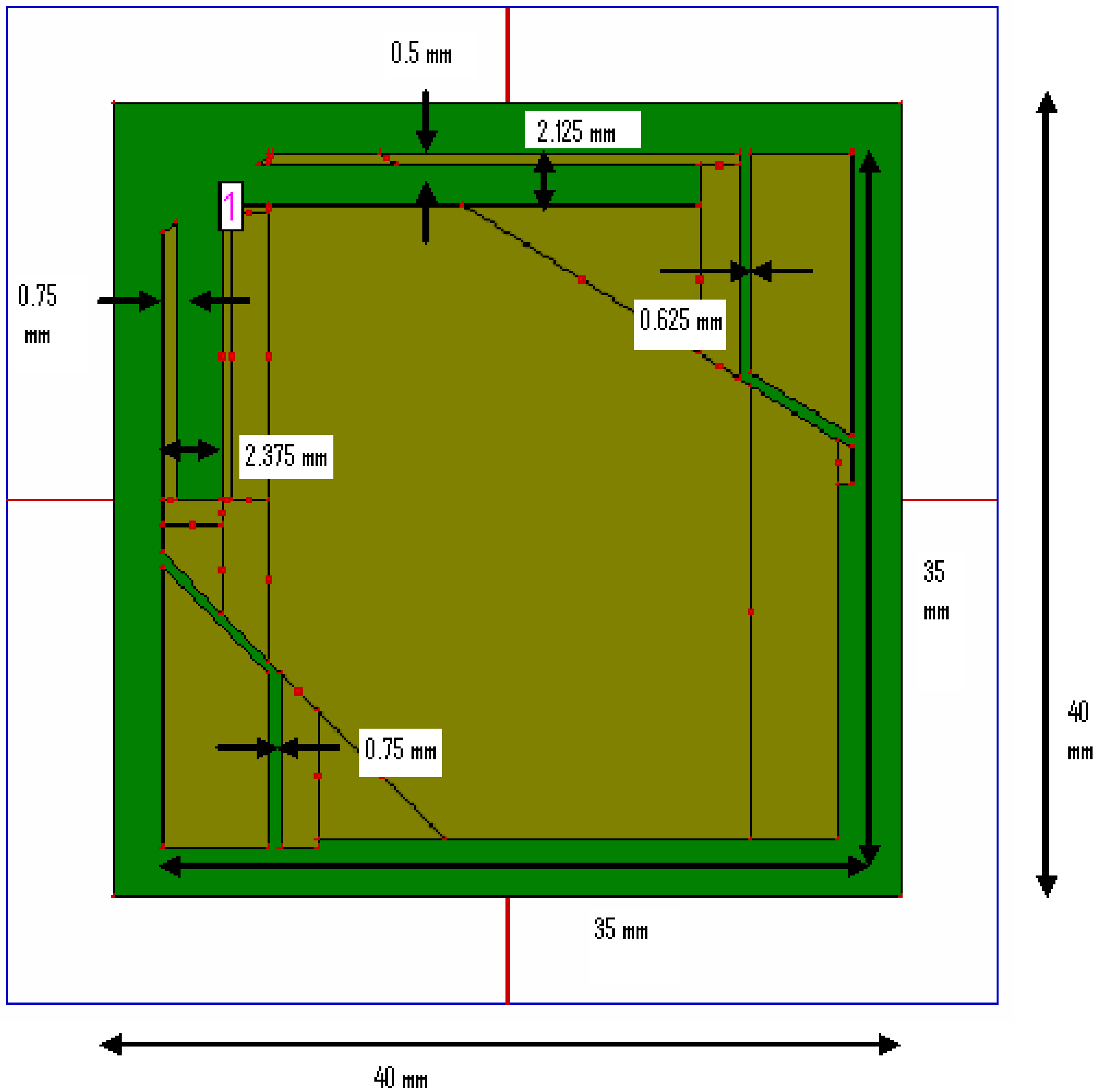

Figure 6.6 Front view of modified square microstrip patch antenna with slits at the edges and having finite ground

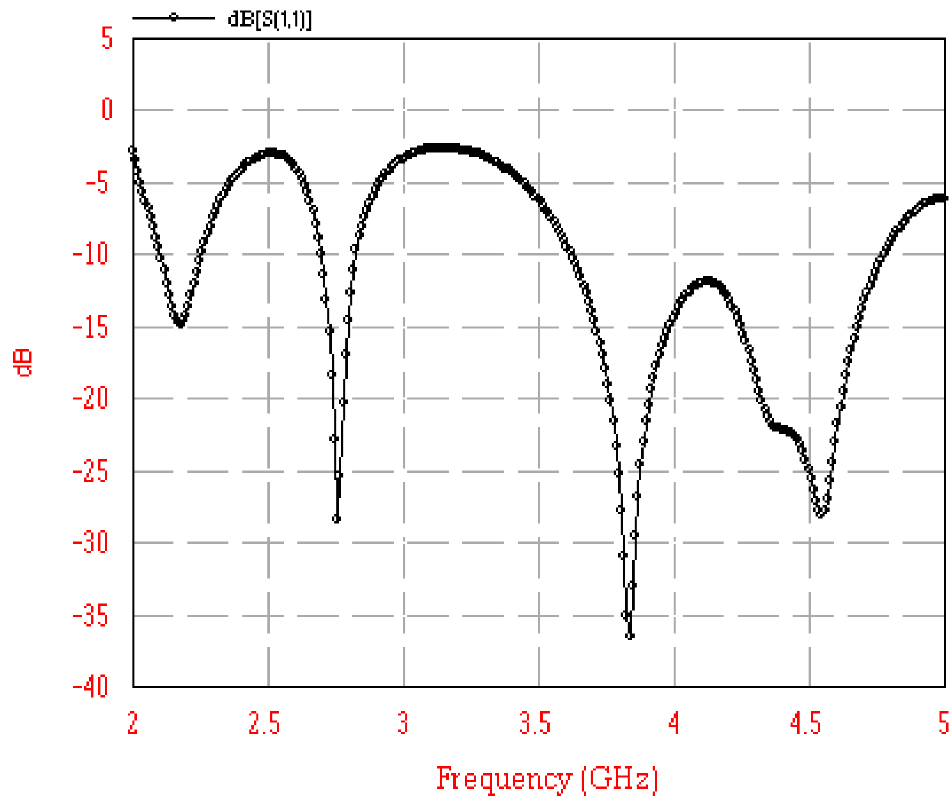

Figure 6.7 Graph between return loss and frequency for antenna design-2

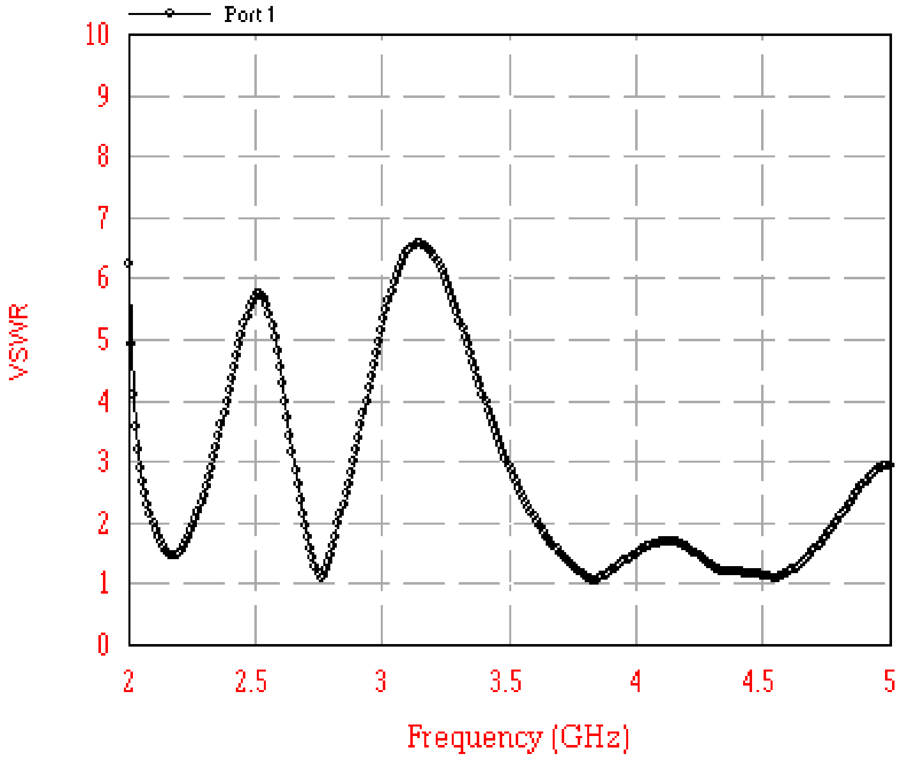

Figure 6.8 Graph between VSWR and frequency for antenna design-2

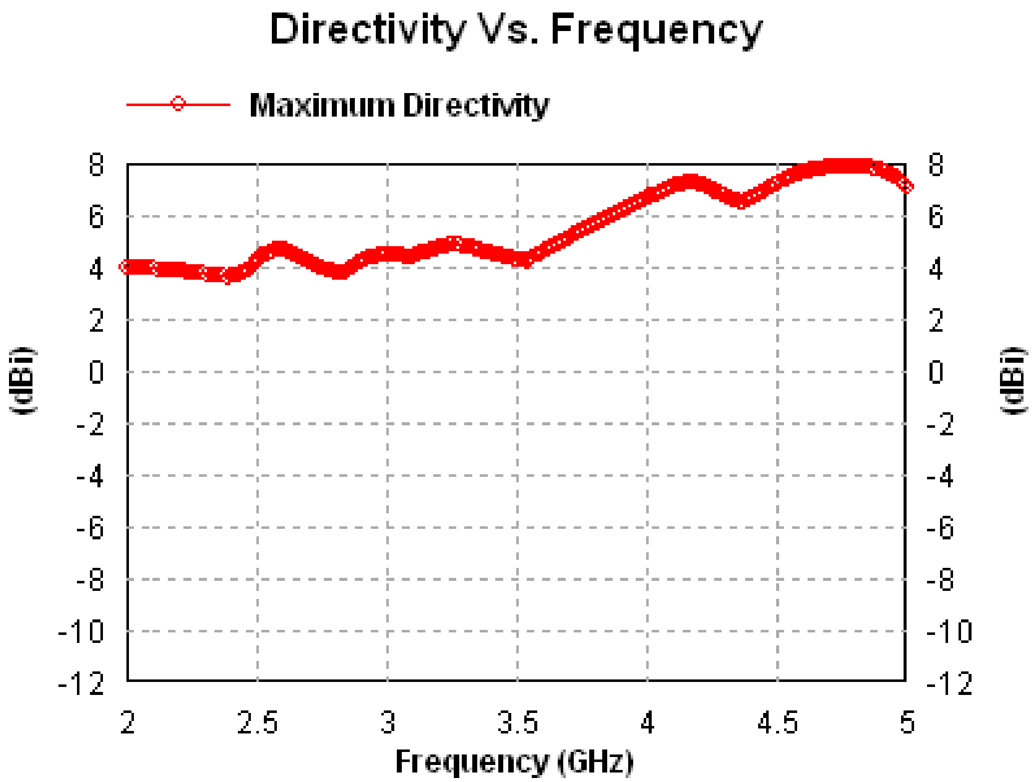

Figure 6.9 Graph between directivity and frequency for antenna design-2

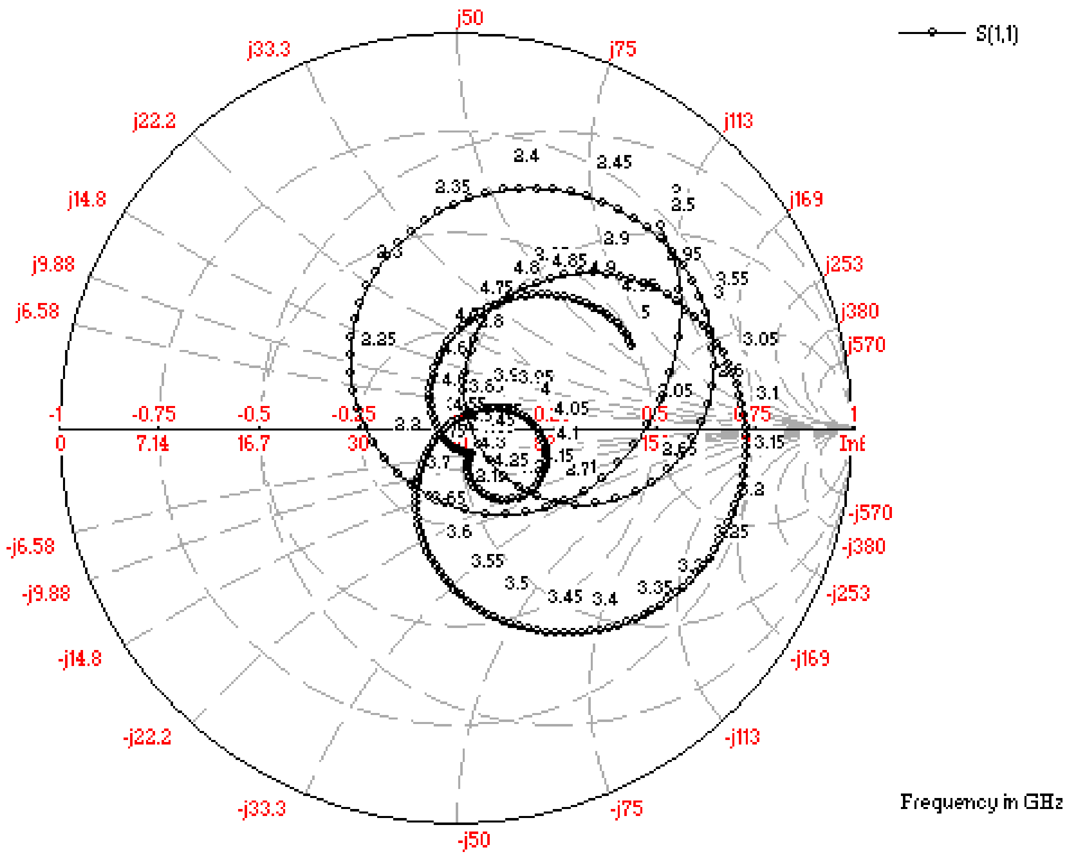

Figure 6.10 Impedance loci for antenna design-2

6.4 CONCLUSION

In this chapter, multilayer patch antenna or increased substrate height wideband microstrip patch antenna with modified reduced size antenna have been designed, which shows satisfactory radiation characteristics for the specified frequency range.