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Enhance Bandwidth of Design Rectangular Microstrip Patch [MSP] Antenna using a compact L Slots Technique for Broadband Applications

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ABSTRACT

In this paper, the bandwidth enhancement of microstrip patch [MSP] antenna is done by cutting a compact L slots into dimension calculated rectangular patch. The design antenna is suitable for the use of many broad band applications at broadband operating frequency range of 1.605-3.381GHz and antenna successfully obtained the bandwidth of 1776MHz (71.24% fractional bandwidth), efficiency (100%), VSWR (1.286) and gain 3.616dB at calculated resonant frequency of 2.03GHz. The designed structure and performance of microstrip patch [MSP] antenna is simulated using IE3D Zealand simulation software. The antenna is fed by 50Ωmicrostrip line feed.

Key words: Calculated ground plane, Calculated microstrip patch [MSP], Enhance bandwidth, IE3D simulator, L-slots shape, 50Ωmicrostrip line feed.

1. INTRODUCTION

Broadband devices is mainly operated in our daily lives such like mobile phone, radio, laptop with wireless connection and MSP antennas play a important role of these devices [17].

In this paper the purpose of new design antenna presents to enhance the bandwidth of a compact L slot shape MSP antenna for many broadband applications such as military, wireless communication, satellite communication, global positioning system (GPS), RF devices, WLAN/WI -MAX application [8], [11]. The major drawbacks of MSP antennas in basic form are narrow bandwidth and low gain [7]. Then many techniques are used to enhance bandwidth and gain of MSP antennas. By using thick substrate with low dialectic constant and compact slotted patch can enhance the bandwidth and gain of antennas [16]. The MSP antenna have some good features such as low cost, low profile, light weight, high efficiency, simply manufacture and easy to implement with circuits [8], [10], [16].The design structure components of antenna become small in size and have low processing cost [11].

In this paper transmission line method are used to analysis the rectangular MSP antenna. The design resonant frequency of rectangular MSP antenna is 2.5GHz with 50Ωmicrostrip line feed. MSP antenna is characterized by using thickness (H), dialectic constant (ε_r), and length (L_g, L), width (W_g, W) of ground plane and patch. The performances of design MSP antenna such as radiation pattern, return loss, directivity, VSWR and gain are simulated by using IE3D software.

2. MATHEMATICAL FORMULAS TO CALCULATE THE DIMENSIONS OF MICROSTRIP PATCH [MSP] ANTENNA

The mathematical formula is used to calculate the dimensions of ground plane and micro strip patch in the form of length and width.

2.1 Width Formula of Rectangular MSP Antenna [1], [8].

$$W=\left(\frac{c}{2f_r}\right)\left(\frac{\varepsilon_r+1}{2}\right)^{-.5}$$

Where c = 3×10^8 ms^{-1}, ε_r =4.2, f_r =2.5GHz

2.2 Formula of Effective Dielectric Constant [4], [15].

$$\varepsilon_{eff}=\left(\frac{\varepsilon_r+1}{2}\right)+\left(\frac{\varepsilon_r-1}{2}\right)\left(1+\frac{12W}{H}\right)^{-.5}$$

At H=1.6mm

2.3 Formula of Length Extension of Antenna [1], [4].

$$\Delta L=.412H\left(\frac{\varepsilon_{eff}+.3}{\varepsilon_{eff}-.258}\right)\left(\frac{\left(\frac{W}{H}\right)+.264}{\left(\frac{W}{H}\right)+.8}\right)$$

2.4 Length Formula of Rectangular MSP Antenna [5], [8].

$$L = \left(\frac{c}{2 f_r \sqrt{\varepsilon_{eff}}} \right) - 2\Delta L$$

2.5 Length and Width Formula of the Ground Plane of Antenna [1], [11].

$$L_g = L + 6H$$

$$W_g = W + 6H$$

3. ANTENNA DESIGN SPECIFICATION

Calculated dimensions of ground plane is constructed by using resonant frequency (f_r), dielectric constant (ε_r), substrate thickness (*H*) and loss tangent (*tan* δ) and 50Ωmicrostrip line feed is fed into patch. Calculated dimensions are obtained by formula and a compact L slots cut into the rectangular patch.

Table 1: Antenna Design Specifications

S. NO	Antenna Parameter	Data
1.	Resonant frequency (f_r)	2.5GHz
2.	Substrate thickness (*H*)	1.6mm
3.	Dielectric constant (ε_r)	4.2
4.	Loss Tangent (*tan* δ)	.0013

4. ANTENNA DESIGN PROCEDURE

Using the above equations and geometrical parameters, dimensions of antenna is calculated. In the design of antennas first calculate the dimensions of ground plane and patch then antenna is constructed by using dimensions after that slots cut into the microstrip patch.

Table 2: Calculated Antenna Dimensions

S. NO	Antenna Dimension	Data
1.	Ground plane width (W_g)	46.8 mm
2.	Ground plane Length (L_g)	37.4 mm
3.	Patch width (*W*)	37.2 mm
4.	Patch length (*L*)	27.8 mm

The calculated design of a compact L slots microstrip patch antenna is shown in Figure 1.

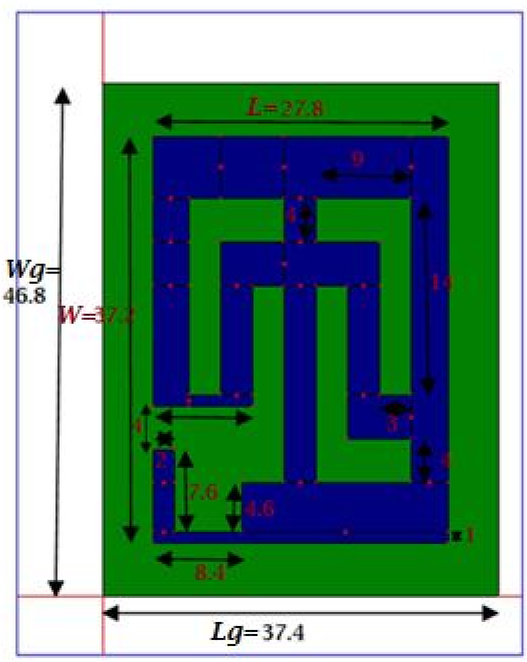

Figure 1: Geometry of Design Antenna and All Dimensions in mm

5. SIMULATION RESULT AND DISCUSSION

The simulation performance of design MSP antenna is analyzed by using IE3D software at define resonant frequency of 2.5GHz and antenna successfully obtained 2.03GHz resonant frequency at peak point of return loss.

The plot graph of return loss Vs frequency is taken at the maximum frequency of 3.5GHz which is shown in Figure 2,The enhances bandwidth 1776MHz (71.24% fractional bandwidth) of design antenna is obtained at calculated resonant frequency of 2.03GHz.

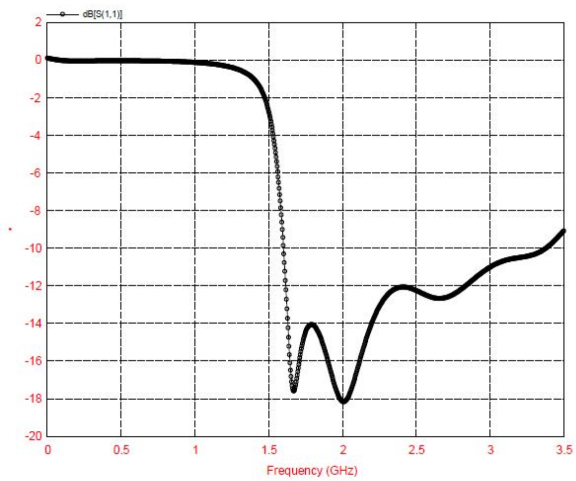

Figure 2: Return Loss vs. Frequency Graph

In Figure 3, the plot graph of Gain Vs Frequency shows the total field gain of the MSP antenna and obtain maximum gain of antenna is 3.616 dB at resonant frequency 2.03GHz.

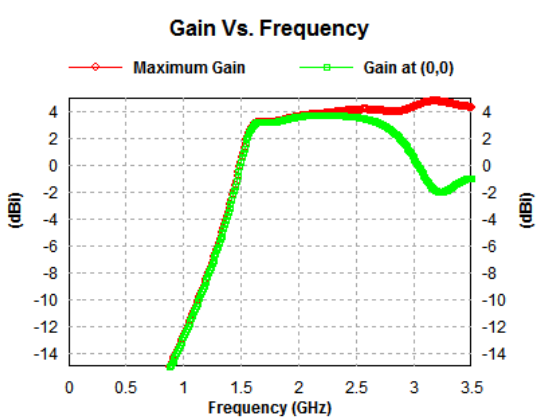

Figure 3: Gain vs. Frequency Plot

In Figure 4, the plot graph of Efficiency Vs Frequency represents radiating efficiency and antenna efficiency. The obtain percentage antenna efficiency is 100 at 2.03GHz

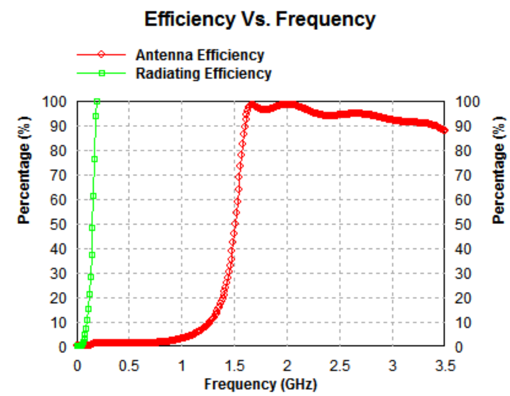

Figure 4: Efficiency vs. Frequency Plot

In Figure 5, the plot graph of VSWR Vs Frequency represents that the bandwidth of design antenna is useful or not. The obtain VSWR is 1.286 at resonant frequency of 2.03GHz.

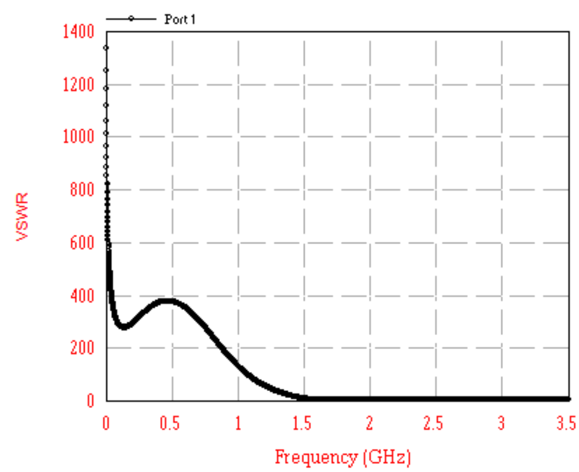

Figure 5: VSWR vs. Frequency Plot

In Figure 6, the plot graph of 2D radiation pattern of antenna represents radiating all power in one direction therefore design antenna has unidirectional radiation pattern. 2D radiation pattern of antenna is shown at resonant frequency 2.03GHz and phi=0(deg), phi=90(deg).

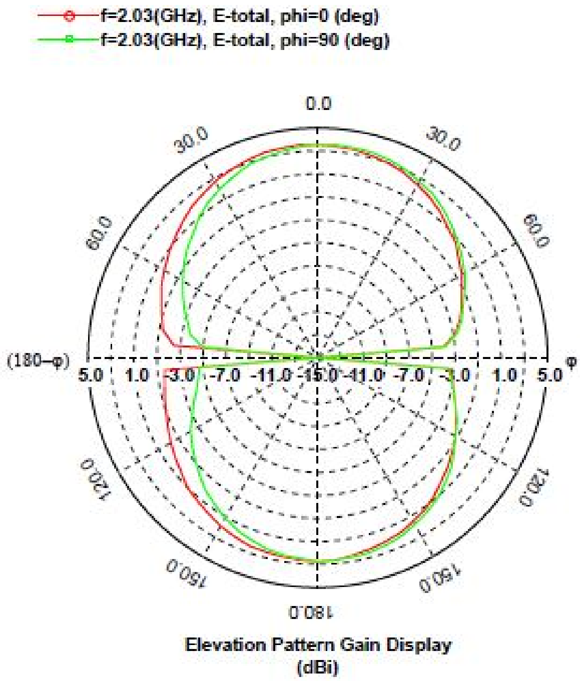

Figure 6: 2D Radiation Pattern of Antenna

In Figure 7, the plot graph of total field Directivity Vs Frequency represents the ratio of radiation intensity in a given direction from the antenna to the radiation intensity averaged over all direction [14]. The obtain directivity of antenna is 3.94 dB at resonant frequency 2.03GHz.

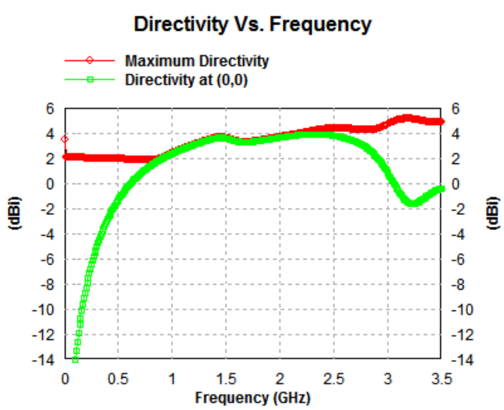

Figure 7: Directivity vs. Frequency Plot

In Figure 8, the plot graph of Axial-Ratio Vs Frequency represents the ratio of the major axis to the minor axis of the polarization ellipse and the resulting pattern shows an oscillating pattern [9].

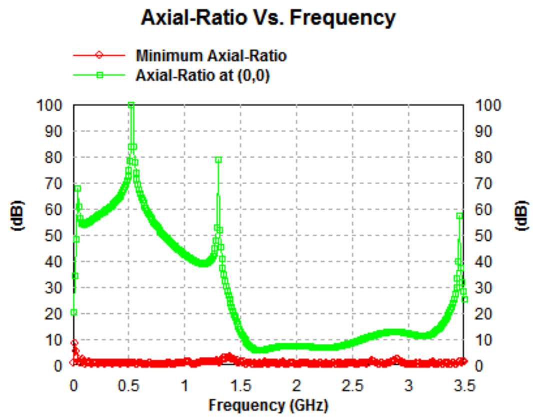

Figure 8: Axial-Ratio vs. Frequency Plot

6. CONCLUSION

In this paper a compact L slots rectangular microstrip patch [MSP] antenna with 50Ωmicristrip line feed has been designed. The enhance bandwidth of design antenna is 1776MHz (71.24% fractional bandwidth), operating frequency range 1.605-3.381GHz and gain (4.04dB), efficiency (100%), return loss (-18.06dB) and VSWR (1.286) is obtained at resonant frequency of 2.03GHz. The simulated result of design antenna shows good performance and thus can be used as various broadband applications such as missile, wireless, satellite, mobile communication, and military.

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