Design of a Microstrip Line fed Rectangular Slot Antenna and its Response under Slit Loading

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***Abstract*—A microstrip line fed rectangular slot antenna is comprising of a simple structure where the microstrip line couples the electromagnetic energy through the slot for radiation. In this paper, the design of a rectangular slot antenna ($0.155\lambda_0 \times 0.029\lambda_0$) fed by microstrip line is proposed. Later the short circuited narrow slot lines are introduced on both sides of the feed along the radiating segment of the slot antenna to provide slit loading. This affects the length and resonant frequency of the slot antenna to be reduced by 1.234% and 3.60% respectively. The simulations are performed with Ansoft High Frequency Structure Simulator (HFSS) version 11.**

Keywords--Slot antenna, microstrip line, slit, resonant frequency.

I. INTRODUCTION

Recent advancements in the field of science and technology are made keeping emphasis on miniaturized, reliable and power efficient systems [1]. Designing of slot antennas is a domain in which huge research work is going on and new developments are achieved. The basic methodologies of slot antenna design are discussed earlier with different resonant frequencies [2], [3]. The main advantages of radiating slots are wider bandwidth, better isolation and negligible radiation occurring from feeding network [4]. Microstrip lines are used to feed the slot radiators for several times in earlier experiments carried out by several researchers [2]-[4]. The slot antennas can be applied efficiently for ultrawideband and WLAN/WIMAX applications with proper accuracy [5], [6].

Miniaturization of slot antennas is very important for any compact design. Researchers are investigating on reducing the size of the slot antennas in different ways [7], [8]. The size reduction and increasing bandwidth using techniques like parasitic coupling and inductive loading are proposed earlier. The resonant frequency reduction and miniaturization of rectangular slot antennas for modern applications can be feasible by introduction of slits in both sides of the feed [9]. New techniques are still being discussed and experimented for miniaturization and bandwidth enhancement of slot antennas [7]-[13].

II. DESIGN PROCEDURE OF THE ANTENNA AND SIMULATION

The fundamental frequency for the design is considered to be 5.75 GHz. The rectangular slot antenna is designed on a substrate RT6010LM with its dielectric constant (ε_r) 10.2, length (L_{SUB}) 30 mm, width (W_{SUB}) 30 mm and thickness (h) 1.5 mm. The ground plane is assigned a finite conductivity of copper of 5.8×10^7 Siemens/m. The slot is created by making a rectangular cut in the ground plane. The length (L_{SLOT}) and width (W_{SLOT}) of the slot are 8.1 mm ($0.50\lambda_g$) and 1.5 mm ($0.09\lambda_g$) respectively where λ_g is the guided wavelength with a numeric value of 16.28 mm [2]. The length of the slot antenna is thus satisfying to be half of the guided wavelength. Microstrip line parameters can be determined from the relevant equations discussed earlier [3]. The width of the microstrip line (W_{STRIP}) for the design is calculated to be 1.5 mm. The antenna structure is shown in Fig. 1 and the simulated result is depicted in Fig. 2.

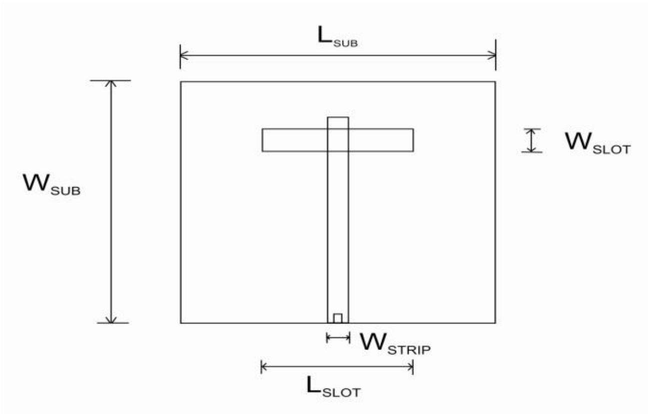

Fig. 1. Structure of a microstrip line fed rectangular slot antenna

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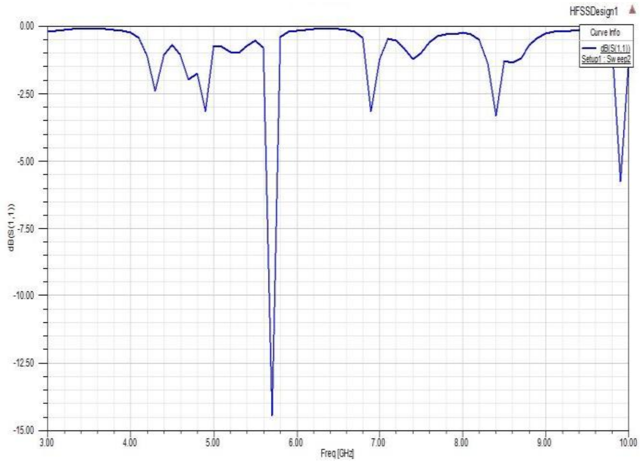

Fig. 2. S_{11} (dB) and frequency (GHz) plot at resonant frequency 5.7 GHz

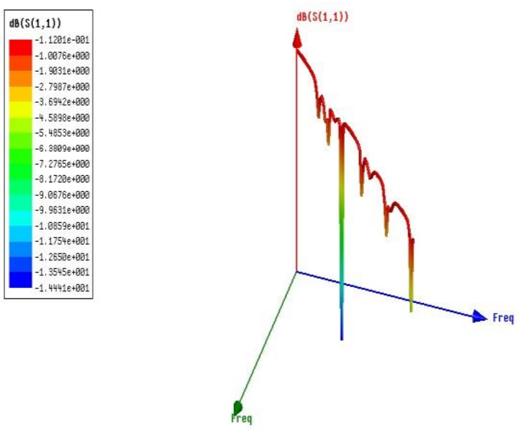

Fig. 3. 3D view of the S_{11} (dB) and frequency (GHz) for slot antenna

The simulation result shows the S_{11} (dB) plot with operating frequency (GHz).

From Fig. 2 it is observed very clearly that the design fundamental frequency (5.75 GHz) and the simulated resonant frequency (5.7 GHz) are very close to one another. The 3D view of the simulated result, depicted in Fig. 2, is shown in Fig. 3.

III. RESPONSE OF THE RECTANGULAR SLOT ANTENNA AFTER ADDING SLITS

The rectangular slot antenna designed previously is now modified and the corresponding response is studied. The slot antenna is now loaded with slits on both sides of the feed.

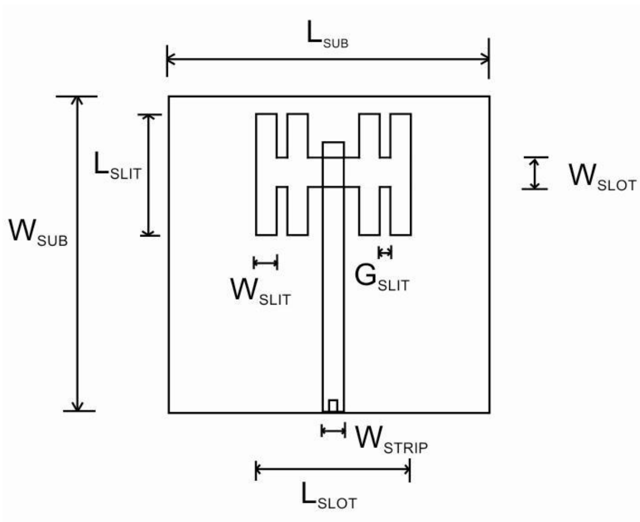

Fig. 5. Slot antenna structure with slit loading

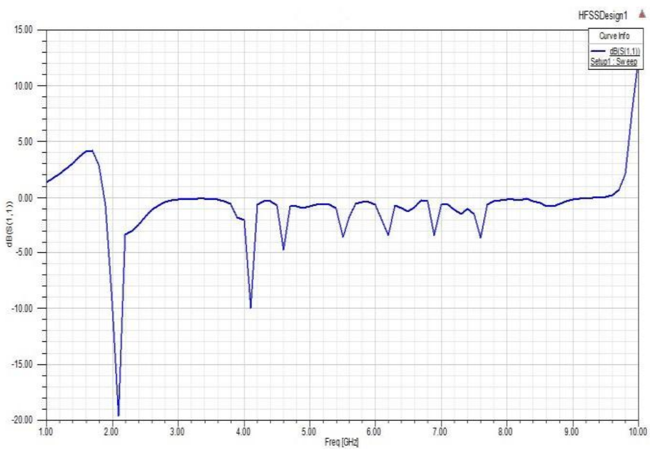

Fig. 6. S_{11} (dB) and frequency (GHz) plot of slot antenna with slit loading

Added slits have the tendency to introduce series inductive loading effect. The length (L_{SLIT}) and width (W_{SLIT}) of the slits are considered to be 10 mm and 1 mm respectively. The space between the individual slits (G_{SLIT}) is kept at 0.5 mm. The modified structure of the rectangular slot antenna is shown in Fig. 5. The simulation is executed and the simulated result is depicted in 2D and 3D view in Fig. 6 and Fig. 7 respectively.

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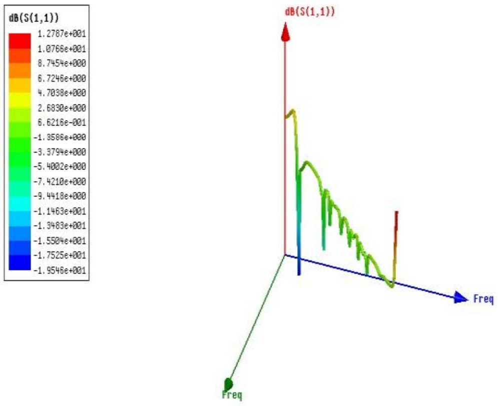

Fig. 7. 3D view of the S_{11} (dB) and frequency (GHz) for slot antenna with slit loading

The result is analyzed thoroughly and the consequences appearing are that the length and the resonant frequency of the modified slot radiator are reduced by 1.23% and 3.60% respectively.

IV. CONCLUSION

A rectangular slot antenna fed by microstrip line is proposed in this paper. A resonant frequency of 5.75 GHz is considered for designing and the simulated result reflects a perfect resonant frequency at 5.7 GHz. Thus the designed resonant frequency and the simulated resonant frequency are lying very close to one another. Further investigation is made by adding reactive elements along the radiating segment of the designed rectangular slot antenna. The length of the slot antenna reduces by 1.23% and the resonant frequency reduces by 3.60% due to addition of slits on both sides of the feed.

As the space allocation for designed antennas is very important factor, the size reduction techniques are necessary for development and further progress in the field of antennas. One technique is already explained in this paper. More slits can also be added to the slot antenna with proper dimensions to perform miniaturization. There exists no mismatch of impedance and cross polarization due to addition of series reactive elements in the slot antenna. Meandered line structures and interdigital capacitive terminations can also be introduced to a rectangular slot antenna for miniaturization.

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