BANDWIDTH IMPROVED DESIGN OF SLOT ANTENNA

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The intent of this paper is to introduce a modified design of printed slot antenna used for ultra wide band (UWB) applications ranging for 9.1 to10.6 Ghz. Antenna element was feed by coplanar waveguide (CPW) for the suitable interfacing with monolithic microwave integrated circuits. Here it has been presented by simulation results that the antenna can cover wide bandwidth with suitable return loss.

Keywords: Ultra Wide Band, Coplanar Waveguide, Return Loss, Slot Antenna.

Introduction

The use of ultra wide band frequency range in the wireless communication had various applications [1]. Small size and lower configuration antenna system is demanded for such applications [2]. In advance, development of Micro strip antenna for WLAN application, WiMax application got popularity [1-6]. Wireless local area network (WLAN) operated on three frequency bands 2.4 GHz (2400-2484MHz), 5.2 GHz (5150-5350 MHz) and 5.8GHz (5725-5825MHz). WiMax (Worldwide Interoperability for Microwave access) has three allotted frequency bands. Lower band (2.5 - 2.69 GHz), Middle band (3.2 - 3.8GHz) and Upper band (5.2 - 5.8 GHZ) [2].

In addition of that X-band satellite communication UWB provides these all technologies [7]. Printed antenna becoming popular for its features like small size, low profile, light weight also wide bandwidth & reduced size is obtained by cutting slot at proper position on patch [1] [2]. To achieve wide band characteristic for slot antenna with coplanar waveguide (CPW) feed lines [1] [8-10] and CPW fed with triangular patch antennas [11] are studied. A suitable UWB antenna element should be able to yield an absolute bandwidth no less than 500 MHz and the designs shown in this paper are applicable for this.

Antenna Geometry

The reference design for the antenna has been taken from [1]. Then design of the antenna was get modified to achieve complete 100% of bandwidth for UWB application as shown in figure 1. The implemented CPW fed slot antenna discussed in this paper has single layer structure.

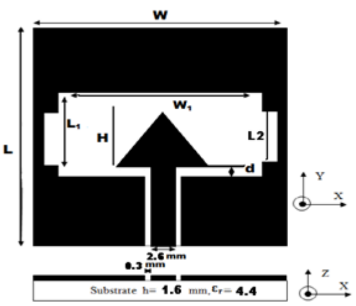

Fig.1. Geometry of Modified CPW-Fed Slot Antenna

The parameters ‘W1’ and ‘L1’ are the width and length of the rectangular slot respectively. ‘H’ is the Height of triangular tuning stub which is kept as [1] for upper resonance. The extra slot ‘L2’ is cut for the lower frequency at 3GHz with depth of 1.23mm. ‘d’ is the coupling distance between triangular patch and feed. ’W’ and ‘L’ are the width and length of antenna respectively. This design is carried out and simulated in IE3D with dielectric constant of 4.4 with thickness of 1.6mm. It helps for easy fabrication on Printed Circuit Board. The CPW feed is of 50 Ω with 2.66mm feed line width and 0.3mm gap [1]. By properly adjusting the dimension of slot and feeding structure we get improved bandwidth than reference antenna [1].The final optimizes parameters of modified antenna are shown in table 1.

Table 1. Optimized parameter of modified antenna

Parameter	Description	Value
L	Length of Antenna	26mm
W	Width of Antenna	20mm
L1	Length of Slot	12mm
W1	Width of Slot	15.30mm
L2	Length of second Slot	6mm
Depth	Depth of Second Slot	1.23mm
d	Feed Gap Distance	1.7mm
H	Height of Patch	7mm

Simulated Antenna Design

The modified antenna design and performance is carried out using simulation tool IE3D. The implemented design of printed slot antenna with triangular patch is shown in figure 2. To find out the wide band effect different antenna parameters are varied and the optimal values are fixed. First the simulation was performed on reference antenna then by adding identical slot L2 on both side modified design was simulated. Parameters are optimized using IE3d software with values given in table 1. Values of various parameters are kept similar to the reference design and a small modification results in the bandwidth improvement in the return loss curve which will be utilized for WiMax middle band application [2].

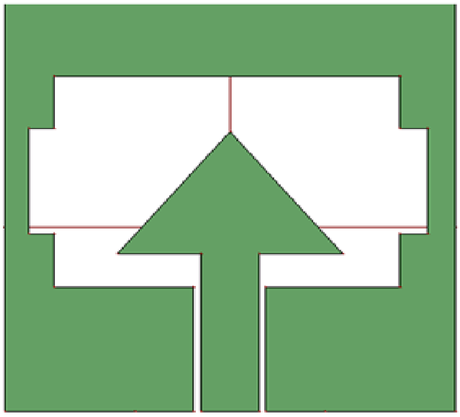

Fig. 2. CPW-Fed Slot Antenna

This wide band antenna is approximately same as that of the triangular patch antenna working for the UWB mentioned in [1]. The improvement can be easily achieved by matching the impedance of the feed line and antenna to the 50 Ω. Coplanar waveguide feed is used here with suitable calculations for improved matching of impedance. Also CPW feed and antenna both lies on same side of Printed Circuit Board allow simple fabrication [11].

Results

The simulated return loss is given in figure 3, it is clearly indicated that the reference antenna bandwidth is modified by slot L2. The design is successfully implemented and it gives -10dB return loss for the frequency range 3GHz-12GHZ which covers overall UWB range. The bandwidth of 9 GHz is obtained which is improved than 6 GHz as mentioned in [1]. It can be clearly observed at frequency of 7.75 GHz antenna has return loss of 32 dB and overall for the band of 3 GHz to more than 12 GHz it is below -10dB. The upper frequency resonance is due to the proper placement of triangular patch and the feed gap. At the lower frequency the sides are the resonating and the additional twin slot makes extra edge for the radiation causing the resonance near 3 GHz. Different positions for these twin slots are carried out and the simulation results were compared. Final values are selected when 100% bandwidth of UWB range is obtained with desired return loss.

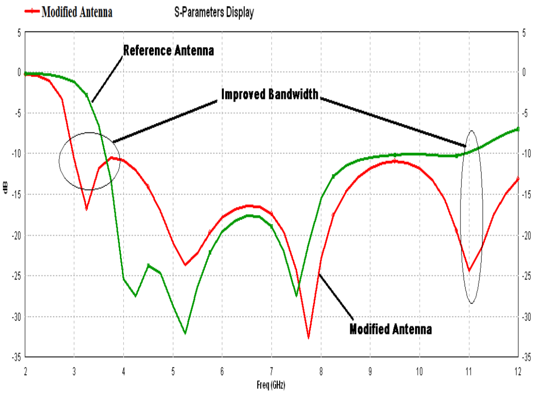

Fig. 3. Return loss

Radiation Pattern

The radiation patterns of the antennas were also obtained using IE3D. It is noticed that the printed slot antenna with CPW feeding has omnidirectional pattern in

H-plane and bidirectional pattern in E-Plane. The E-plane & H-Plane patterns are shown in figure 4, Patterns are observed at frequency 3.25 GHz, 5 GHz, 7.75 GHz as shown in Figure 4.

Proper geometrical selection of the antenna results variations in field distribution, which in turn affects the characteristics of the antenna. Equally distribution of radiation is simulated by the software. It is observed that the most important parameters controlling the resonant of antenna are:

W – Width of radiating element

L – Length of radiating element

W2 – width of inner slot

L2 - length of inner slot

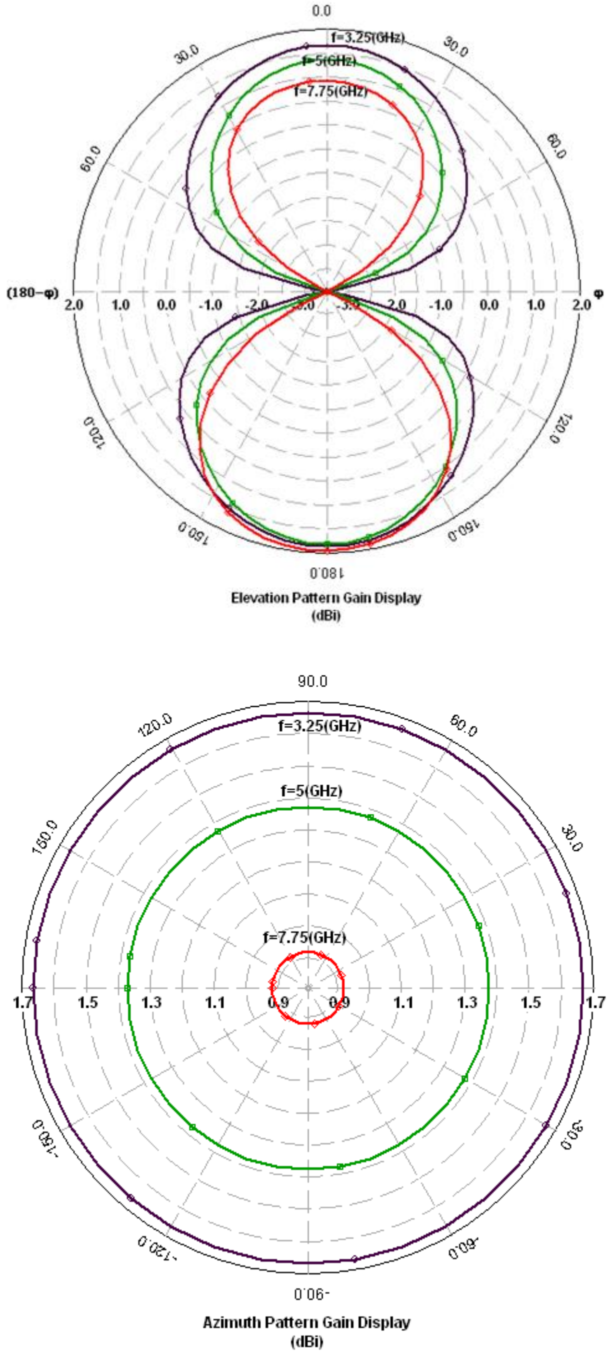

Fig. 4. E-Plane & H-Plane Radiation Pattern

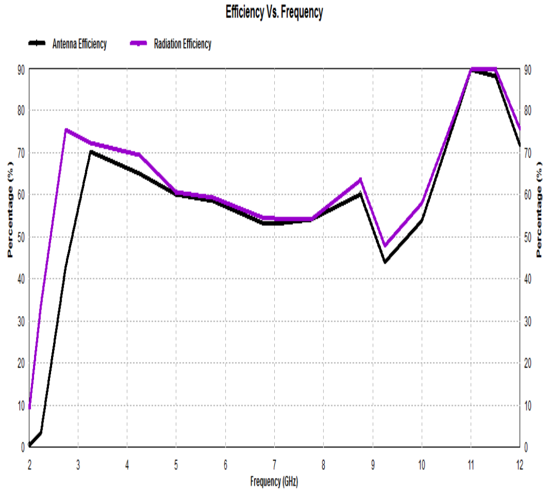

Fig. 5. Efficiency of Antenna

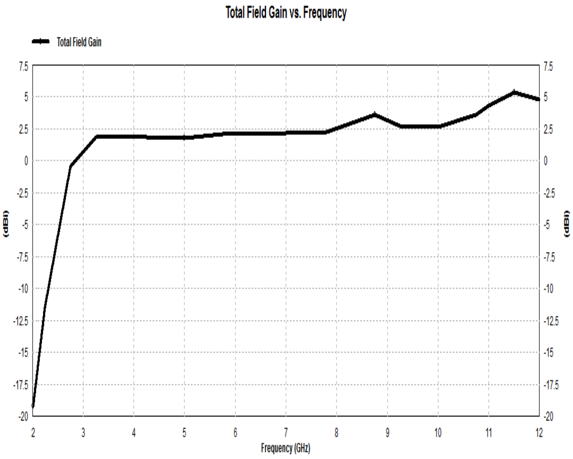

Fig. 6. Gain of Antenna

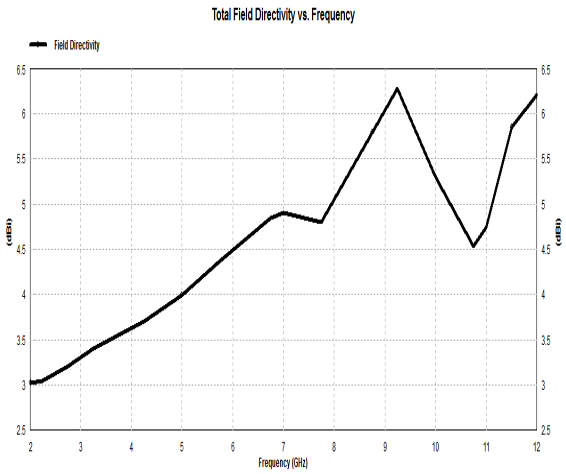

Fig. 7. Directivity of Antenna

In figure 5 maximum efficiency of antenna is displayed, it is clear that the antenna configuration has maximum efficiency thought the range of 3.1 GHz to 9.6 GHz. The field gain is positive and it is above the 25 dB as shown in figure 6. Maximum directivity is obtained at the frequency of 9 GHz shown in figure 7.

Conclusion

In this paper simple antenna structure is discussed & implemented using IE3D. Better impedance matching is obtained with the introduction of additional slot. The overall antenna dimensions are 26mm × 20mm × 1.6mm which promises the small size and low profile structure. It is observed that 100% of the UWB bandwidth is achieved ranging from 3GHz to 12GHz with -10dB return loss. An optimization for bandwidth is maintained in this work. Also for the WLAN application, WiMax applications and X-band satellite communication is observed. Hence this type of antenna can be used for UWB Application.

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