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Design of Compact Printed slot Antenna for Ultra Wideband Applications

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Abstract

The design and performance of a printed slot antenna in the ultrawideband is presented in this article. The proposed design consists of an octagonal-shaped slot fed by a bevelled and square patch for covering the UWB band (3.1–10.6 GHz). The impedance bandwidth (VSWR < 2) of the antenna is from 3 to 11 GHz. Radiation patterns are stable and bidirectional with appreciable gain throughout the band. Performance of the antenna is also analyzed in the time domain, which reveals good pulse handling capabilities.. Due to its advantages such as low-cost, small size low weight and capability to integrate with Microwave integrated circuits, the slot antenna is a very good candidate for integrations in applications such as wireless communication systems, mobile phones and laptops. Due to development of communication engineering with integration technology demand size reduction of low frequency antennas as an important design perspective. Extensive simulation results using HFSS simulation software.

Keywords: Compact printed antenna, slot antenna, ultra wideband (UWB), HFSS Simulation software.

Introduction

The with the capability of transmitting ultrashort duration pulses in the ultrawideband (UWB) technology, UWB systems have received great attention for the short-range wireless communication. Based on the high data rate and low power consumption, one can anticipate that UWB systems will be soon used also in conjunction with the portable devices such as mobile handset . Design of a simple, compact, and multifunctional antenna is an important part in the integration of the UWB system with the portable devices since it can reduce the complexity of the receiver and transmitter section.

The widespread commercial deployment of ultrawideband (UWB)systems has sparked renewed interest in the subject of UWB antennas. An UWB system requires an antenna capable of receiving many frequencies at the same time with consistent performance across the entire band. It is also required to have a no dispersive transient characteristic. The design practice to realize ultra wide bandwidth is to generate multiple resonances and match them using appropriate techniques. In monopole radiators, step or exponential impedance inverters realized with ground and patch minimize the insidious reflections and radiate the guided signals. There are many approaches to design a slot antenna with ultra wide bandwidth. An exponential tapered slot antenna which is excited using a broad band microstrip-slot line transition to achieve ultra wide bandwidth. A coplanar waveguide is tapered to form a ring slot to accomplish ultrawide bandwidth. Other designs excite a wide circular, elliptical, or rectangular slot using a stub of similar shape.

Ultra-Wide Band (UWB) - is a communication method used in wireless networking to achieve high bandwidth connections with low power utilization. Originally designed for commercial radar systems has potential applications in personal area networks (PAN). UWB antenna is supposed to fulfil many requirements such as a small size, omnidirectional radiation patterns, constant group delay etc. With the capability of transmitting ultra short duration pulses in the ultra wideband (UWB) technology, UWB systems have received great attention for the short-range wireless communication. Based on the high data rate and low power consumption, one can anticipate that UWB systems will be soon used also in conjunction with the portable devices such as mobile handset. Design of a simple, compact, and multifunctional antenna is an important part in the integration of the UWB system with the portable devices since it can reduce the complexity of the receiver and transmitter section.

In this paper, Design Printed slot antenna for Ultra wide band application. The base antenna consists of an octagonal slot fed by a bevelled and square patch that covers the UWB band (3.1–10.6

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GHz). Details of designing the proposed antenna with simulations carried out through the software package HFSS

Design Specification

The three essential parameters for the design of UWB Printed Slot Antennas are:

a) Frequency of operation (*fo*): The resonant frequency of the antenna must be selected appropriately. The UWB uses the frequency range from 3.1-10.6 GHz. Hence the antenna designed must be able to operate in this frequency range.

b)Dielectric constant of the substrate (εr): The dielectric material selected for our design is FR4 with glass epoxy substrate which has a dielectric constant of 4.4. A substrate with a high dielectric constant has been selected since it reduces the dimensions of the antenna.

c) Height of dielectric substrate (h): For printed slot antenna to be used in Ultra wide band applications, it is essential that the antenna is not bulky. Hence, the height of the dielectric substrate is selected as 1.53 mm.

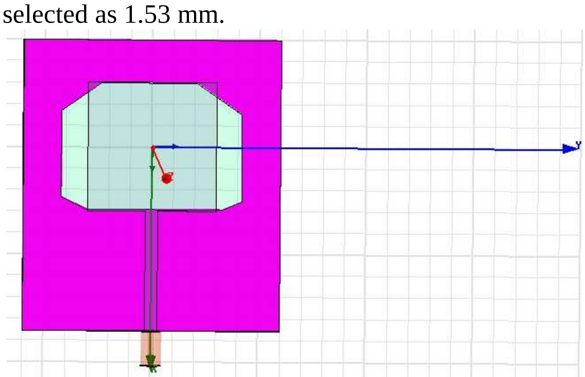

Fig 1.Printed slot Antenna.

Antenna Configuration

The proposed antenna is shown in Figure 1. It consists of a octagonal-shaped slot fed by bevelled & square patch covering the UWB band(3.1-10.6 GHz). In this paper several parameters have been investigated and a parametric study on the structure is made in order to obtain the best the possible compact size .The dielectric material selected for the design is an FR4 with glass epoxy substrate of height h= 1.53 mm and ϵr= 4.4. A 50 Ω inset microstripline feed is attached to the proposed antenna and has a width *wt* and length *lt*. The inset length y_0 is chosen such that impedance matching is achieved. Length L_f =28 mm and width W_f = 3 mm. The overall initial dimensions of the octagonal shaped-slot patch are (Trial 1), the length *L* and width W of the patch are 30 mm and 30mm.

Proposed UWB printed slot Antenna Dimensions

TABLE I

Sr. No.	Layer	Length (mm)	Width (mm)	Thickness(mm)
1	Groud Plane	60	67.8	.
2	Substrate	60	67.8	1.53
3	Patch	60	12.8	-

Simulated Results

A. **Simulated Results at gap between patch & substrate is 0.5mm**

The software package Ansoft HFSS was used to modal the printed slot a. The base antenna consists of an octagonal-shaped slot fed by a bevelled square patch. This compact base structure can cover the whole of the UWB band. The octagonal patch antenna was designed for Ultra wideband frequencies between 3.1GHz- 10.6GHz, with a resonating frequency at 6.85GHz. After simulation on HFSS we get following result.

a) S parameters

These are the scattering parameters. We get the return loss, resonant frequency, and return loss bandwidth. From graph we get return loss -13.06db

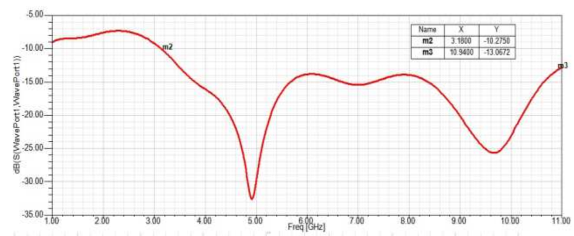

Fig. 2 S paramater

b) VSWR

This is the voltage standing wave ratio. Ideally it should be 1. VSWR bandwidth is taken at 2 i.e. the 11% reflected power or -10db return loss. From graph we get VSWR=1.5287

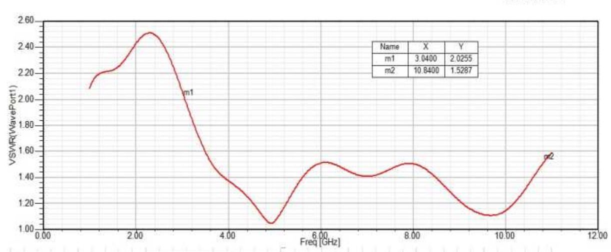

Fig. 3 VSWR

c) Radiation Pattern

Power flux density or gain is plotted on polar plot we get certain pattern of that property called radiation pattern. The radiation pattern for this antenna is illustrated in Figure showing an bi-directional pattern and gain value is 5.09db

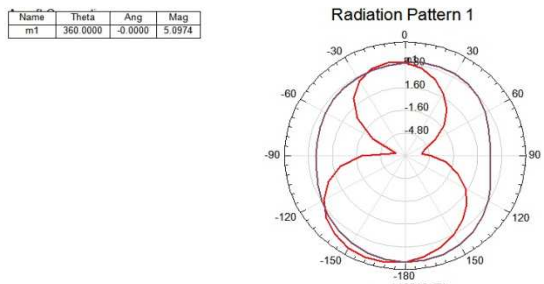

Fig. 4 Radiation Pattern

d) Current distribution of antennas

Current distribution on the final antenna design at f= 3.1 GHz. The current distribution on the patch antenna is quite dense and well spread. This implies good matching between the inset line and the patch.

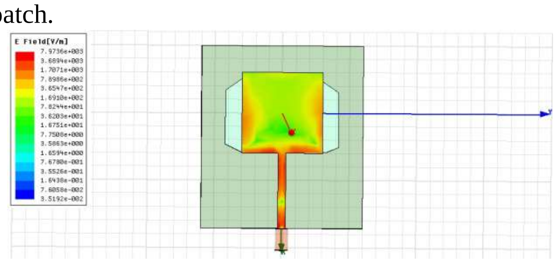

Fig. 5 Current distribution of antennas

B. **Simulated Results at gap between patch & substrate is 0.1mm**

a) **S parameters**

From graph we get two bands such as 3.66-7.26Ghz having return loss=-9.8771 & 8.32-10.42Ghz having return loss -11.6357db

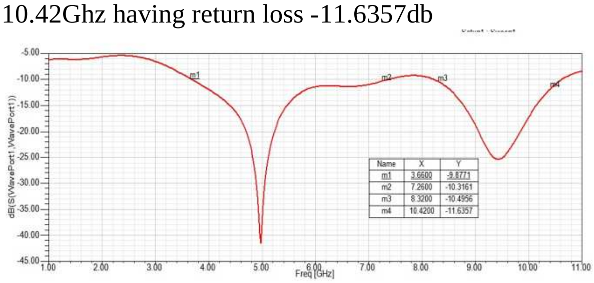

Fig .6 S parameters

b) **VSWR**

VSWR bandwidth is taken at 2 i.e. the 11% reflected power or -10db return loss. From graph we get VSWR=1.9579

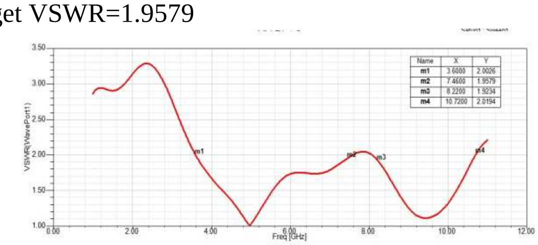

Fig. 7 VSWR

c) **Radiation Pattern**

The radiation pattern for this antenna is illustrated in Figure showing an bi-directional pattern and gain is 4.68db

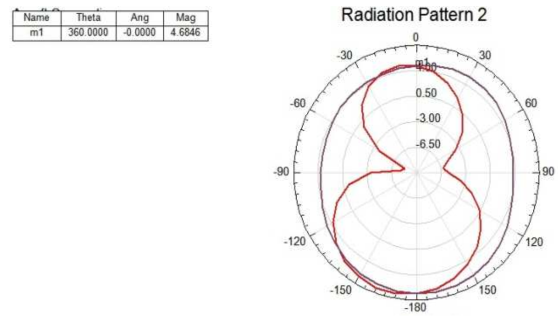

Fig.7 Radiation Pattern

d) **Current distribution of antennas:**

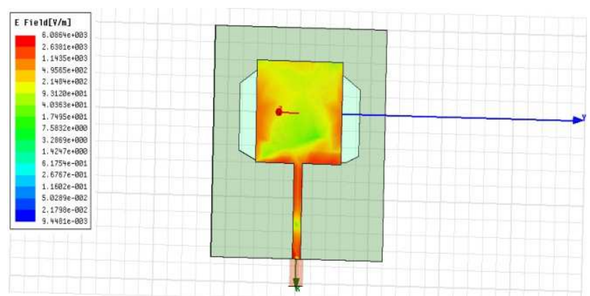

Fig .8 Current distribution of antennas

Conclusion

The design of a Printed slot antenna for Ultra wide band applications has been presented in this letter. Printed slot antenna has been proposed to radiate in the UWB frequency range of 3.1-10.6 GHz. The return loss is -13.067dB and has a VSWR = 1.5287 at at lower cut of frequency of 3.1GHz. The simulations results of the antenna show stable radiation patterns over the whole of the UWB band.

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