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Design of UWB Printed slot Antenna for Bluetooth, GPS & GSM Applications with Defected Ground Structure

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Abstract

A novel printed UWB slot antenna is designed with UWB range with extra GPS band(1.52-1.59 GHz), part of GSM band (1.77-1.84 GHz) and Bluetooth band (2.385- 2.49 GHz). Simulated and measured results are presented and compared, which shows that the antenna has a stable radiation pattern both at the triple and the whole of the UWB bands. Due to its advantages such as low-cost, small size low weight and capability to integrate with Microwave integrated circuits, the micro strip patch 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, multiband, slot antenna, ultra wideband (UWB), HFSS Simulation software.

Introduction

In our modern world, where the technology is continuously changing, in the aircraft, spacecraft satellite a missile applications, where size, weight, cost, performance, ease of installation, and aerodynamic profiles are constraints, low profile antennas is required. Presently there are many other government and commercial applications, such as mobile radio and wireless communications that have similar specifications. To meet these requirements, microstrip antennas can be used. These antennas are small, low cost, low weight and conformable to planer and non planer surface. Due to this microstrip antennas are well suited for WLAN/Wi-MAX, GPS, GSM application systems. Microstrip antennas (MSA) have some disadvantages, like narrow bandwidth, low gain etc.

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, a UWB slot antenna with three extra linear polarized bands covering GPS, part of GSM and Bluetooth is explained. The base antenna consists of an octagonal slot fed by a bevelled and stepped rectangular patch that covers the UWB band (3.1–10.6 GHz). For generating the three additional bands, keeping the antenna compactness, three inverted U-shaped strips are used in the upper part of the octagonal slot antenna. 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

Sr. No.	Layer	Length (mm)	Width (mm)	Thickness(mm)
1	Ground Plane	25	28	.
2	Substrate	25	28	0.02
3	Patch	12.4	12.8	-

Proposed UWB printed slot Antenna Dimensions

TABLE I DIMENSIONS OF PATCH, SUBSTRATE AND GROUND

been selected since it reduces the dimensions of the antenna.

c) Height of dielectric substrate (h): For UWB printed slot antenna to be used in GPS, Bluetoth, GSM bands, it is essential that the antenna is not bulky. Hence, the height of the dielectric substrate is selected as 0.08 mm.

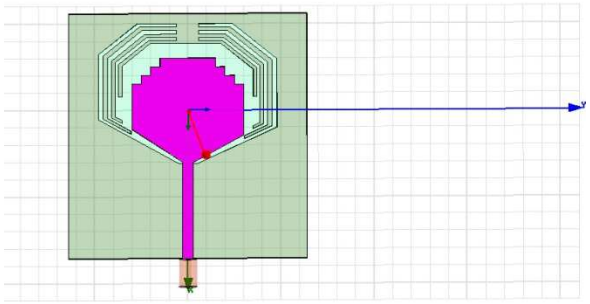

Fig 1. UWB printed slot Antenna.

Antenna Configuration

The proposed antenna is shown in Figure 1. It consists of a octagonal-shaped slot fed by beveled & stepped rectangular patch covering the UWB band(3.1-10.6 GHz).By attaching three inverted U-shaped strips at the upper part of the slot in the ground, additional triple linear polarized bands can be realized covering GPS(1520-1590 MHz),part of GSM(1770-1840 MHz) and Bluetooth (2385-2490MHz). 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 and position of the U-shaped slots .The dielectric material selected for the design is an FR4 with glass epoxy substrate of height h= 0.8 mm and ϵr= 4.4. A 50 Ω inset microstripline feed is attached to the proposed antenna and has a width *wt* and length *l*t. The inset length y0 is chosen such that impedance matching is achieved. Length *lf* =4.6 mm and width *wf* = 1.4 mm. The length of the inset feed is *y0* = 0.1 mm. The overall initial dimensions of the octagonal shaped-slot patch are (Trial 1),The length *L and width W of the patch are* 28 mm and 25mm.The length of each inverted U-shaped strips *Lt1=28.6 mm, Lt2=24.2 mm, Lt3=17.9 mm* and width Wt are 0.4 mm and also spacing between each strip is 0.4mm respectively.

Simulated Results

A. ***Simulated Results obtained for base Antenna:***

The software package An soft HFSS was used to modal the microstrip patch antenna. The base antenna, consists of an octagonal-shaped slot fed by a bevelled rectangular patch. This
compact base structure can cover the whole of the UWB band. The octagonal patch antenna was designed for UWB 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

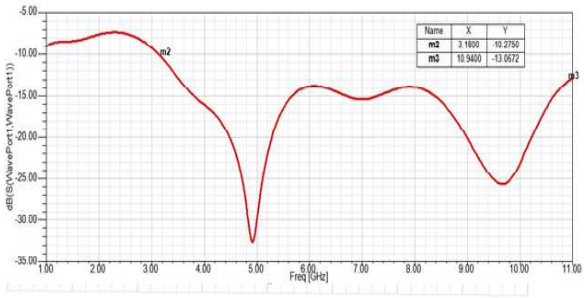

Fig.2 S paramater

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

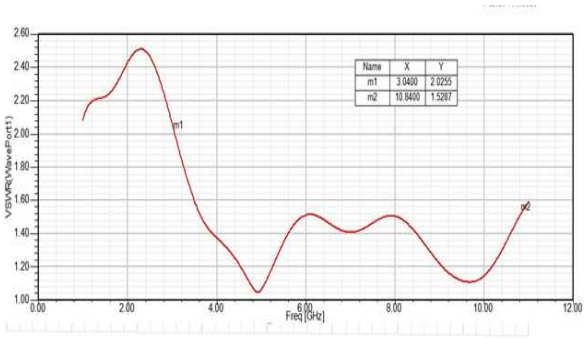

Fig.3 VSWR

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.

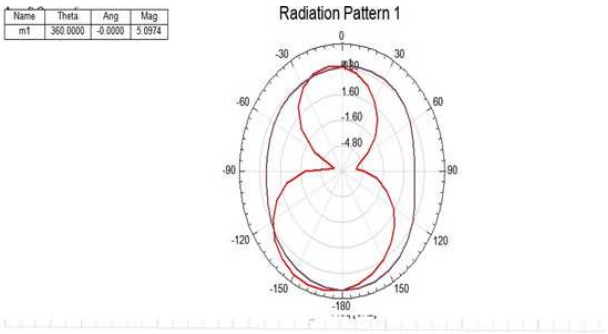

Fig.4 Radiation Pattern

B. ***Simulated Results for printed UWB slot Antenna.***

a) ***S parameters***

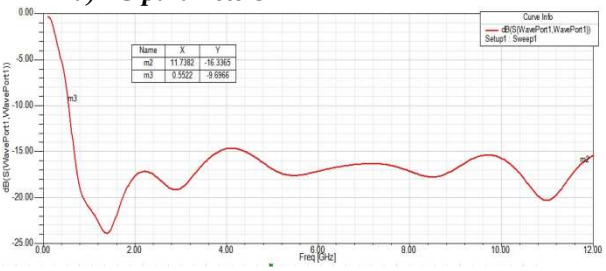

Fig.5 S parameters

b) ***VSWR***

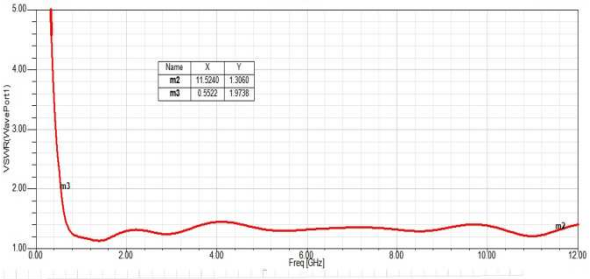

Fig.6 VSWR

c) ***Radiation Pattern***

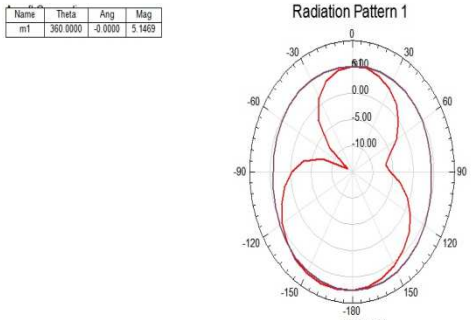

Fig.7 Radiation Pattern

d) ***Current distribution of antennas:***

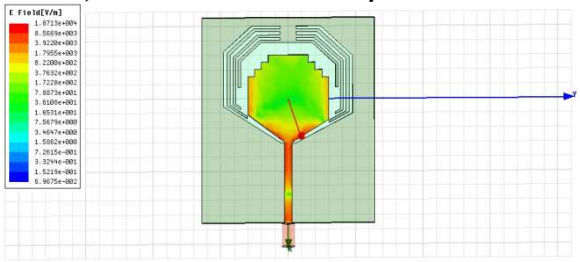

Fig.8 Current distribution of antennas

Conclusion

The design of a UWB slot antenna with three additional practical bands for the whole GPS and Bluetooth bands and GSM band has been presented in this letter. Antenna has an octagonal shape with compact structure. By attaching three strips of quarter-wavelength to the upper part of the slot ground, three extra bands are created. To have a better impedance matching over the added bands, these quarter-wavelength strips are also placed symmetrically on the other side of the fed patch that form inverted U-shaped strips. The simulations results of the antenna show stable radiation patterns over the whole of the UWB band as well as the extra bands.

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