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Design of Compact UWB Printed Slot Antenna for GPS, GSM &Bluetooth Applications

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Abstract

The proposed design consists of an octagonal-shaped slot fed by a bevelled and square patch for covering UWB band (3.1–10.6 GHz)with extra the GPS (1.52-1.58GHz),GSM(1770–1840 MHz) & Bluetooth (2.3-2.48GHz) bands. Radiation patterns are stable and bidirectional with 6.5989 DB gain throughout the band. Radiation efficiency is 97.12%. Extensive simulation results using HFSS simulation software.

Keywords: Slot antenna, ultra wideband (UWB), Microstrip line feeding, HFSS Simulation software.

Introduction

The with the capability of transmitting ultra short 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.

Wireless devices and systems based on ultrawideband (UWB) radio technology, with the frequency allocation of 3.1–10.6 GHz, support low output power and high data rate(110–200 Mb/s) applications over short ranges (4–10 m). Also lower rate intelligent applications that provide accurate location tracking capabilities over increased link range, i.e., over30 m, are supported . The first successful UWB application is as a wireless universal serial bus (USB) enabler, where a PC or a laptop is wirelessly connected to a printer, hard drive, or other peripherals. UWB applications in mobile handsets are expected to follow.

The design of UWB antennas is one of the major factors
affecting the progress of UWB technology. As a result, UWB antenna design has been studied much in recent years [2]–[4].

UWB antennas must be electrically small and inexpensive without compromising on performance. Omni directional radiation pattern is desired in order to be well suited for ad hoc networks with arbitrary azimuthally orientations. Gain flatness and phase linearity, i.e., constant group delay, are also required for an UWB antenna in order to not distort the waveform of an ultra narrow on the order of nanoseconds electromagnetic energy pulse. In addition, the time-domain impulse response is another important criterion of UWB antenna performance. The antenna must transmit UWB signal with minimal dispersion effect. This effect typically manifests itself as a broadened received pulse, which may overlap with other multipath received signals, thereby making it difficult to distinguish individual multipath signals, a well-known advantage of UWB radio technology. In this paper, Design Printed slot antenna for GPS & Bluetooth application. The proposed printed slot antenna consists of an octagonal slot fed by a beveled and square patch that covers the GPS, Bluetooth bans & also cover part of GSM UWB bands. Details of designing the proposed printed slot 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 (f_0): The resonant frequency of the antenna must be selected appropriately. The UWB uses the frequency range of 3.1-10.6GHz Hence the antenna designed must be able to operate in this frequency range.

b)Dielectric constant of the substrate (ε_r): 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.

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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.

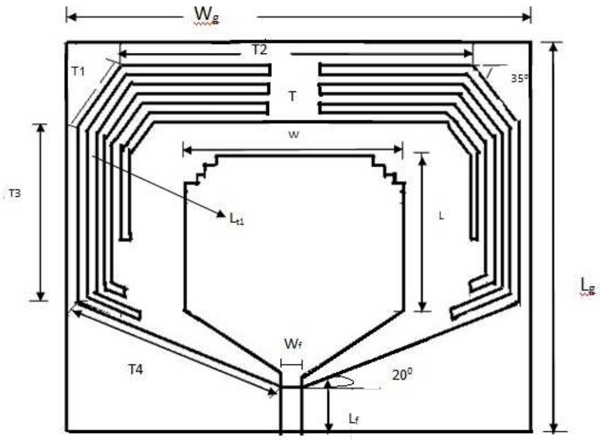

Fig 1.printed slot Antenna.

Table-I Design parameters of proposed printed slot antenna

Parameter	Description	Value
W_g	Width of ground	30mm
L_g	Length of ground	25.5mm
w	Some part patch width	7.46mm
L	Some part patch length	11.12
L_f	Feed length	4.1mm
W_f	Spacing of feed length	1.4mm
T	Specing between U-stripd	2mm
T1	Strip length	5mm
T2	Strip length	5mm
T3	Strip length	11.7mm

Antenna Configuration

The proposed antenna is shown in Figure 1. It consists of a octagonal-shaped slot fed by bevelled & square patch covering the GPS, Bluetooth and also covering part of GSM & UWB band. 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 L_f. The inset length y_0 is chosen such that impedance matching is achieved. Length L_f =4.1 mm and width W_f =1.4 mm. The overall initial dimensions of the octagonal shaped-slot patch are (Trial 1), the length *L* and width W of the patch are 11.21 mm and 15.04mm.

Simulated Results

a)simulated results for Base antenna

The software package An soft HFSS was used to modal the printed slot a. The proposed antenna consists of an octagonal-shaped slot fed by a bevelled square patch. This compact base structure can cover the UWB band. This structure is called as base antenna. The octagonal patch antenna was designed for operating frequency at frequency at 2.4GHz. 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 -18.8224db

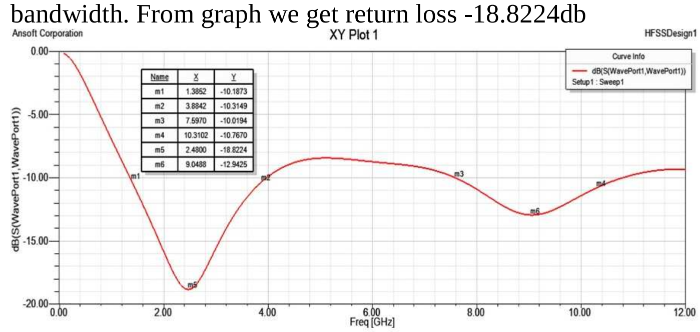

Fig. 2 S paramater

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=1.2604

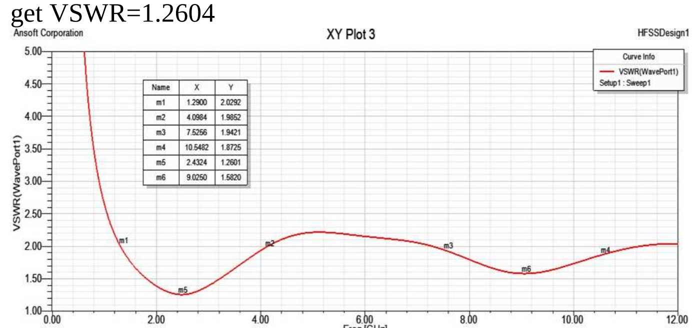

Fig. 3 VSWR

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 a stable bi-directional pattern and gain value is 6.5989db

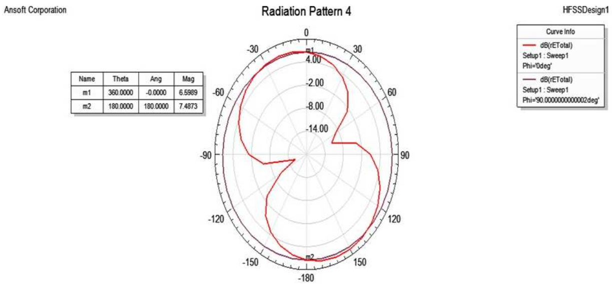

Fig. 4 Radiation Pattern

d)**Radiation efficiency**

The radiation efficiency for this antenna is illustrated in Figure & its value is 97.12%

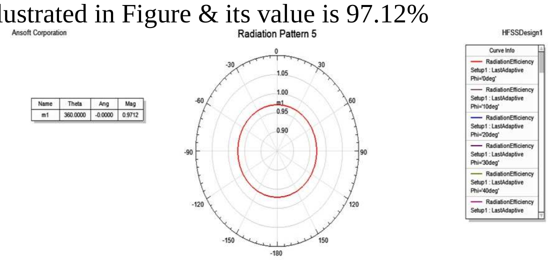

Fig. 5 Radiation efficiency

e) **Smith chart**

Name	Freq	Ang	Mag	RX
m1	10.0960	97.3665	0.2754	0.8060 + 0.4765i
m2	3.4558	2.6270	0.2415	1.6352 + 0.0384i

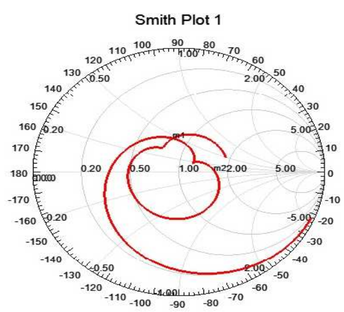

Fig. 6 Smith chart

Fig.6 Shows smith chart at frequency 2.4 GHZ gives perfect impedance matching &its value is 48.36 ohms.

f) **Current distribution of antennas**

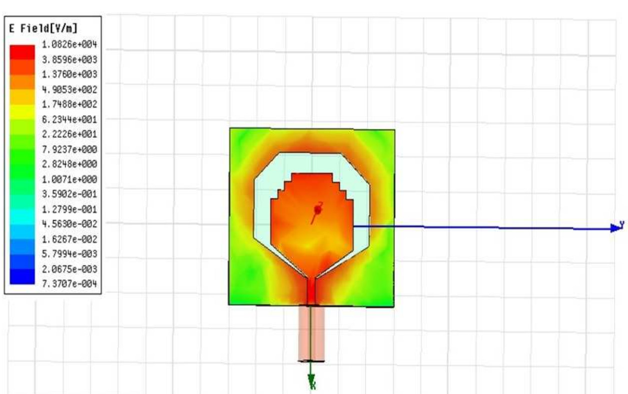

Fig. 7 Current distribution of antennas

current distribution on the final antenna design at f_0= 2.4 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

b)simulated results for Base antenna with three strips in one side

The proposed antenna consists of an octagonal-shaped slot fed by a bevelled square patch. Then inserted three strips in one side. 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 -17.1401db

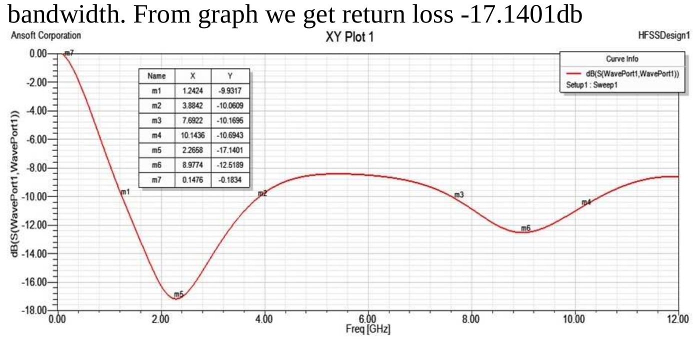

Fig. 2 S paramater

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=1.3238

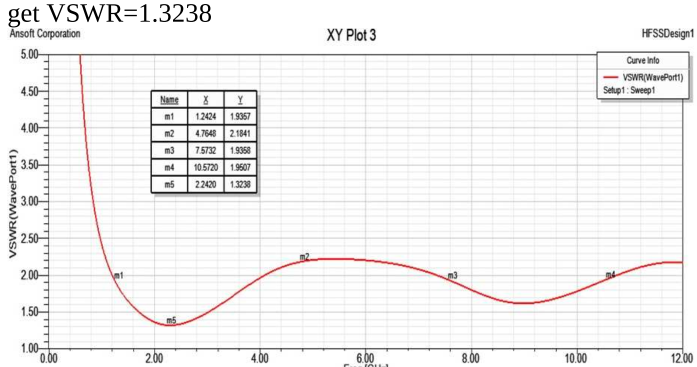

Fig. 3 VSWR

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 a stable bi-directional pattern and gain value is 5.6003db

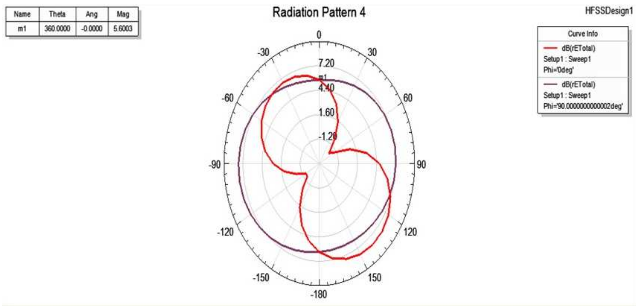

Fig. 4 Radiation Pattern

d)**Radiation efficiency**

The radiation efficiency for this antenna is illustrated in Figure & its value is 94.35%

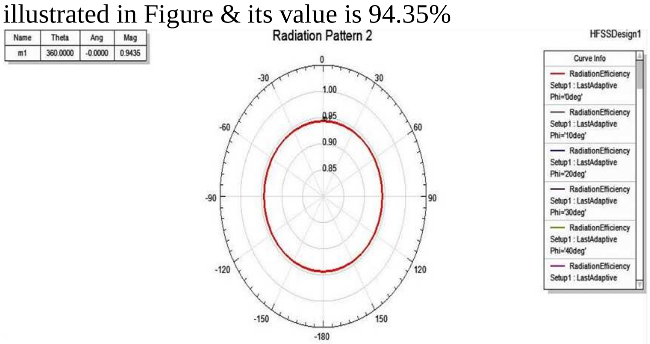

Fig. 5 Radiation efficiency

e) **Smith chart**

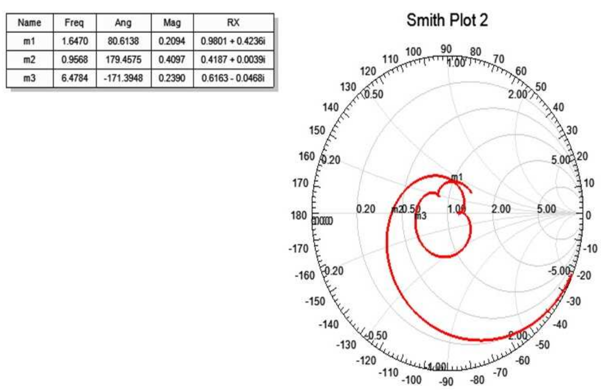

Fig. 6 Smith chart

Fig.6 Shows smith chart at frequency 2.4 GHZ gives perfect impedance matching &its value is 48.93 ohms.

f) Current distribution of antennas

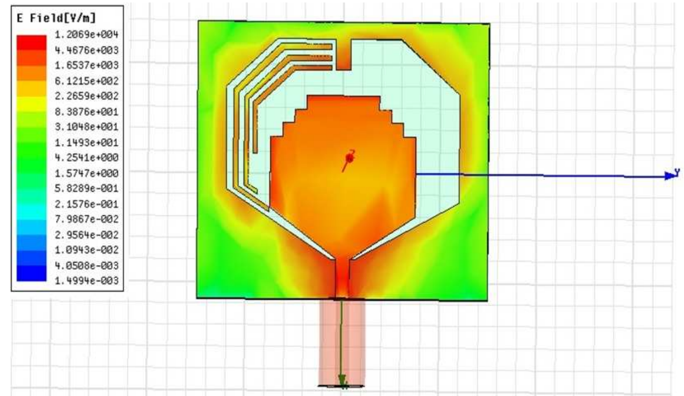

Fig. 7 Current distribution of antennas

current distribution on the final antenna design at f= 2.4 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

c) simulated results for UWB printed slot antenna with 3U-strips . UWB printed slot antenna with 3U-strips was simulated for operating frequency at frequency at 2.4GHz. 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 -22.2368db

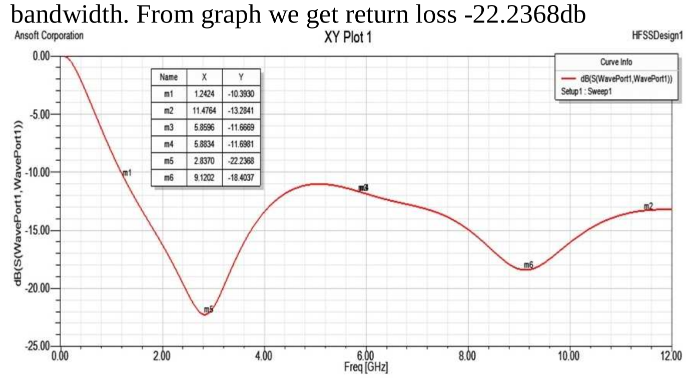

Fig. 2 S paramater

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=1.1685

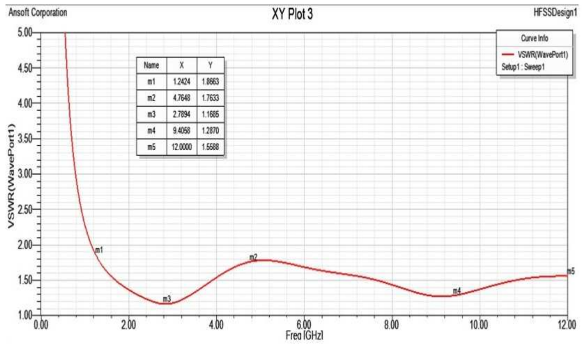

Fig. 3 VSWR

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 a stable bi-directional pattern and gain value is 4.5612db

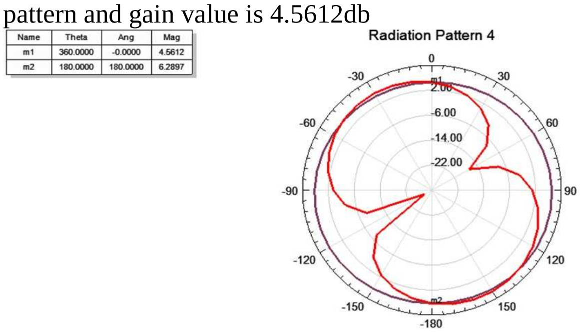

Fig. 4 Radiation Pattern

d)**Radiation efficiency**

The radiation efficiency for this antenna is illustrated in Figure & its value is 95.93%

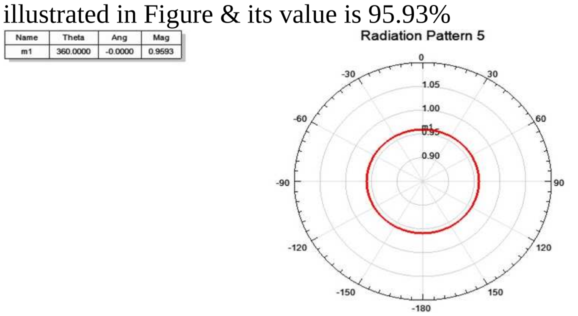

Fig. 5 Radiation efficiency

e) **Smith chart**

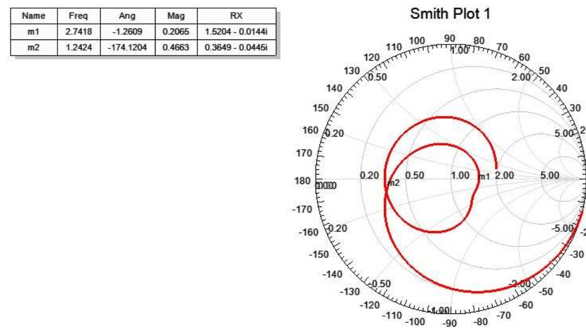

Fig. 6 Smith chart

Fig.6 Shows smith chart at frequency 2.4 GHZ gives perfect impedance matching &its value is 48.47ohms.

f) Current distribution of antennas

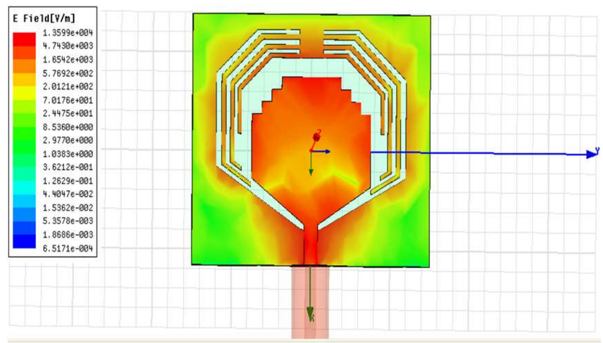

Fig. 7 Current distribution of antennas

current distribution on the final antenna design at f_0= 2.4 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

Table-II Comparision of simulated resluts

Antenna type	Return loss	VSWR	Gain	Radiation efficiency
Base antenna	-18.8224	1.2601	7.4873	97.12
Base antenna with 3 strips in one side	-17.1401	1.3238	5.6003	94.35
UWB printed slot antenna with 3 U- strips	-22.2368	1.1685	4.5612	95.93

Conclusion

The design of a UWB Printed slot antenna for GPS ,GSM & Bluetooth applications has been presented in this letter. Printed slot antenna has been proposed to radiate in the frequency range of 1.24GHz-12GHz. The return loss is –22.2368 dB and has a VSWR = 1.1685DB at frequency of 2.4GHz. The simulations results of the propose Printed slot antenna show radiation efficiency is 95.93, Gain4.5612DB,stable radiation pattern & better impedance matching over covering band of 1.24-12GHz.

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