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DESIGN OF U-SHAPE MICROSTRIP PATCH ANTENNA FOR BLUETOOTH APPLICATION AT 2.4GHz

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ABSTRACT: The Bluetooth technology becomes a rapidly growing area of research in the field of mobile charging, interference, recognition and profile. Bluetooth technology operates 2.400-2480MHz in unlicensed industrial scientific and medical (ISM) band and it cover short distances, typically up to 30 feet (10 meters). It can handle data and voice transmissions simultaneously. Bluetooth is designed to use very little power, low bandwidth wireless connections so simple to use in daily life. The objective of this paper to design of u-shape patch antenna for 2.4GHz and this is applicable (class2, range 10m) of Bluetooth technology. In this paper the design patch antenna using substrate material Rogers RT/duroid5880, its dielectric constant is 2.2 and dielectric loss tangent 0.0009.

KEYWORDS: HFSS13, U-shape microstrip antenna, Bluetooth.

1 INTRODUCTION

Microstrip patch antennas are widely used because of low profile, light weight. However, patch antennas have a main disadvantage- narrow bandwidth, and low gain. In microstrip patch increase the bandwidth [1][2],using air layer [3]. And also to increase the bandwidth and gain using u-shape microstrip patch antenna. The U-slot microstrip patch antenna was introduced in 1995 by Huynh and Lee [4]. The U-slot patch can significantly improve the bandwidth of microstrip antenna [5]. The U-slot patch antenna can be designed not only for wideband applications, but also for dual-band and, triple-band applications [6] with small and wide frequency ratio [7].

Bluetooth was invented in 1994 by L. M. Ericsson of Sweden. The standard is named after Harald Blaatand "Bluetooth". The Bluetooth Special Interest Group (SIG) was founded by Ericsson, IBM, Intel, Nokia and Toshiba in February 1998, introduced Bluetooth is a low-power, short-range, radio-based technology [8]. Bluetooth is a cable-replacement technology designed to wirelessly connect peripherals such as mice and mobile phones, desktop or laptop computer and to each other. Bluetooth devices operate at 2.4 GHz to 2.48GHz in the license-free, globally available ISM (Industrial, Scientific, and Medical) radio band [8]. The advantage of operating in this band is worldwide availability and compatibility. A potential disadvantage is that Bluetooth devices must share this band with many other radio frequency emitters. This range is far enough for comfortable wireless peripheral communication. It provides a high transmission rate and encrypts and authenticates for privacy.

1.1 VERSION

There are four versions (BT1.0, 1.1, 1.2, and 2.0) of Bluetooth given and its application - BT1.0/1.0B is the First Version of Bluetooth. BT1.1 it supports non-encrypted channels, can measured communicating signal strength, IEEE802.15.1—2002 standard created for 1.1. BT1.2 it provides higher practical speeds, better voice quality. BT2.0 including of enhanced data rate (3.0Mpbs), 100meter range even lower power usage ,better error handling, IEEE802.15.1—2005 standard created 2.0.

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Currently Bluetooth specification v2.1 is used and the maximum data rate is 3 Mbps, with typical performance in the range of 1 Mbps. Bluetooth (BT 3.0) is developing and will provide a data rate up to 480 Mbps and will use less power [9].

1.2 POWER

The equipments of transmission are qualified in 3 groups according to the level of power of emission, as we can see below [8].

Power class	Maximum power mw(dbm)	Range (meter)
Class1	100mw(20dbm)	~100m
Class2	2.5mw(4dbm)	~10m
Class3	1mw(1dbm)	~1m

2 ANTENNA STRUCTURE

The geometry of u-shape microstrip patch antenna is show in figure 1. The u-shape patch dimension are length (L) = 39.037mm, width (W) = 47.41 mm mm, and height (h) = 2.4mm. The u-shape patch antenna design using substrate material Rogger RT/duroid5800 and dielectric constant is$\varepsilon_r = 2.2$. The feed line also fabricated on RT/duroid5880 substrate material. The resonant frequency is 2.4GHz and simulated frequency 2.4 GHz which is applicable in Bluetooth application.

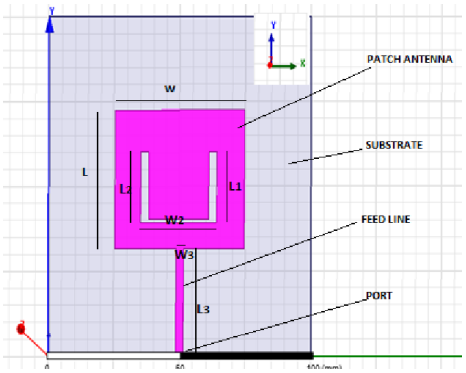

Fig. 1.geomatery of u-shape patch antenna.

Table 1: Specifications of the proposed u-shape microstrip patch antenna show in table.

Operating frequency	2.4GHz
Substrate	RT/duro5880
Dielectric constant of substrate	2.2
Hight of substrate	2.4 in mm
Patch width	47.41 mm
Patch length	39.037mm

2.1 MATHEMATICS CALCULATION

For design of microstrip patch antenna, the stander formula to calculate width and length of antenna at particular operating frequency as given bellow.

$$W = \frac{V_\circ}{2f_r}\sqrt{\frac{2}{\varepsilon_r + 1}} \quad (1)$$

$$\Delta L = h \times o.421\left[\frac{(\varepsilon_{ef} + 0.3)(\frac{W}{h} + 0.264)}{(\varepsilon_{ef} - 0.258)(\frac{W}{h} + 0.8)}\right] \quad (2)$$

$$L = \frac{V_\circ}{2f_r\sqrt{\varepsilon_{ef}}} - 2\Delta L \quad (3)$$

$$\varepsilon_{ef} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left[\frac{1}{\sqrt{1 + 12\frac{h}{W}}}\right] \quad (4)$$

V_O= speed of light

ε_{ef} = Effective dielectric constant

ε_r= Dielectric constant of substrate

f_r= fringing frequency

h = Height of dielectric substrate

W = Width of the patch

ΔL=extension of the length

3 SIMULATED RESULTS

The simulation results of u-shape Microstrip patch antenna are shown bellow.

3.1 RETURN LOSS

U-shape microstrip patch antenna resonating at 2.4GHz having a return loss of -29.5db and impedance bandwidth at -10 db is 180MHz, it shows in figure 2.

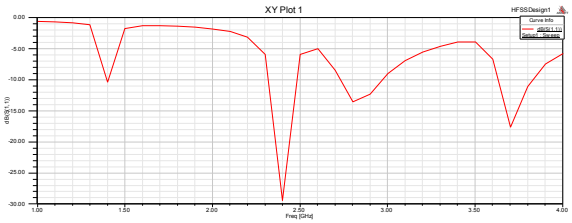

Fig. 2.Simulated return loss of antenna

3.2 GAIN

Figure 3 shows the simulated result of gain of the proposed antenna. The maximum achievable gain is 5.5dB.

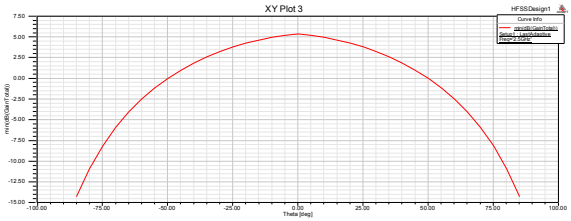

Fig. 3. simulated gain of antenna.

3.3 RADIATION PATTERN

The radiation pattern of the u-shape microstri patch antenna show in figure 4 and 5.

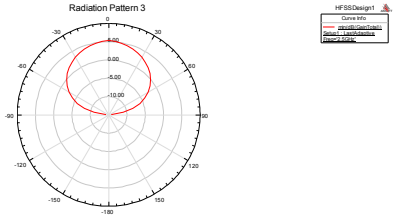

Fig. 4. Radiation pattern of antenna in theta.

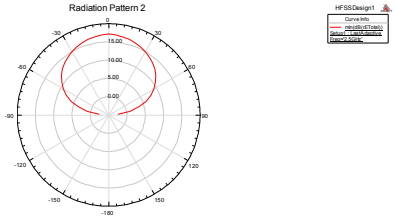

Fig. 5. Radiation pattern of patch antenna.

3.4 DIRECTIVITY

The directivity of the u-shape microstri patch antenna show in figure 6.

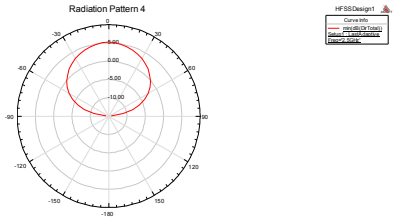

Fig. 6. directivity of patch antenna.

3.5 VSWR

The simulation result of Voltage Standing Wave Ratio, (VSWR) is shown in Fig.7, at operating frequency 2.4GHz, the VSWR value obtained is 0.8.

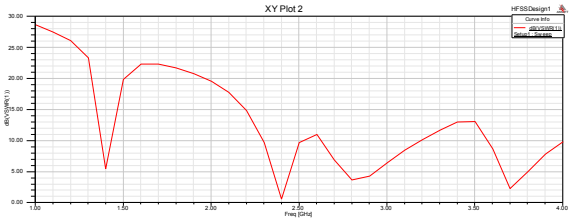

Fig. 7. VSWR of patch antenna.

4 CONCLUSION

In this paper, we design of u-shape microstrip patch antenna using high frequency structural simulator (HFSS) software. Because microstrip patch antenna is light weight, Small size, low cost, and it is easy to use in mobile, laptop, desktop and other device. The proposed antenna give a bandwidth is approximately 180MHz (7.5%) and gain 5.5dB .The VSWR is obtain equal 0.8 at operating frequency 2.4GHz.

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