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A Dualband T-Shaped Microstrip Antenna for Wearable Application

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Abstract

In this paper, an T shaped dualband microstrip antenna fed by coaxial feed is presented for wearable applications in the ISM band (2.4-2.5GHz,5.7-5.8GHz).This antenna provides dual band performance. As for the wearable applications, we use a felt as the substrate to make sure the antenna can bend follow human body. The overall size of the proposed antenna is 44mm*36mm*3mm. Different parameters like Return loss, Voltage Standing Wave Ratio(VSWR), Impedance, Directivity and Gain are measured and discussed using Zealand IE3D simulation software.

Keywords: T-shaped, microstrip antenna, return loss, VSWR, Impedance, Directivity and Gain, wearable, Zealand IE3D Simulation Software.

1. Introduction

Recent years people pay more attention on Wireless Body area Network (WBAN), as the development of wireless communication [1]. Scientists are studying on its physical principle and considering about its rules. The public are very interested in the benefit brought by the WBAN. Wearable antenna is one of the keys to the WBAN. It has been used in many domains. In medicine, researchers use wearable antennas to detected breast cancer and to develop real-time medical diagnosis systems [2]. In the military field, some solo combat pack radar and solo communication system use wearable antenna technology [3]. And with the help of wearable antenna the Wireless Local Area Networks (WLAN) develops quickly [4]. Wearable antenna works near human body, so it must below profile to integrate into clothes easily. At the same time the antenna couldn't radiate much energy to human body.So the microstrip antenna may be a good type. Microstrip antenna is low profile, and the ground plane can shield human body from radiation. One of the difficulties of studying wearable antenna is the human body's effect. As the wearable antenna works near human body, the antenna must move and bend with body. Traditional antenna is hard and inflexible, and it will make users uncomfortable. So new materials must be found for the wearable antenna. Fortunately, many researchers have done much work about the materials [5]-[7]. As we make antennas of flexible material, the changing performance must be considered [8]-[10].In this paper, a dualband on-body-worn microstrip antenna with a flexible substrate which covers the 2.4 GHz and 5.8 GHz WLAN operations is proposed and shown in Figure1.

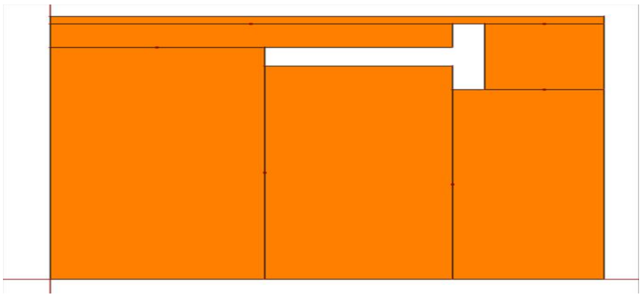

Fig. 1: A Photo of the Antnna.

2. Antenna Configuration

The antenna is fabricated on a felt substrate with dielectric constant (€r)=2.4, loss tangent (tanθ) is 0.048 and 3 mm thickness.

Length and Width of the T-shaped microstrip patch antenna can be calculated by using these equations:

Patch Width,

$$W = \frac{c}{2fo}\left[\frac{\varepsilon r+1}{2}\right]^{-1/2} \quad (1)$$

where;

fo = operating frequency = 2.6 GHz

ε r = dielectric constant = 2.4

c = speed of light = 3x10^8 m/s

Effective dielectric constant,

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

Effective Length,

$$L_{e_{ff}} = \frac{c}{2\,fo[\varepsilon reff\,]^{1/2}} \tag{3}$$

Length Extension,

$$\Delta L = 0.412h\frac{(\varepsilon reff\ +0.3)(W\ /\ h+0.264)}{(\varepsilon reff\ +0.258)(W\ /\ h+0.8)} \tag{4}$$

where;
h=substrate thickness =3mm
Actual patch length,

$$L= Leff - 2\Delta L \tag{5}$$

After Calculation, values of Patch Width(W),Effective dielectric constant (ε_{reff}), Length Extension(ΔL), Effective Length(Leff) and Patch Length(L) are as follows:

W=44 mm, ε reff =2.219,Leff=38.7 mm,ΔL=1.2135 and L=36 mm

There fore, Length and Width of the T-shaped microstrip patch antenna are 44mm and 36 mm.

Figure2.presents the geometry and dimensions of the proposed dualband T-shaped micostrip patch antenna

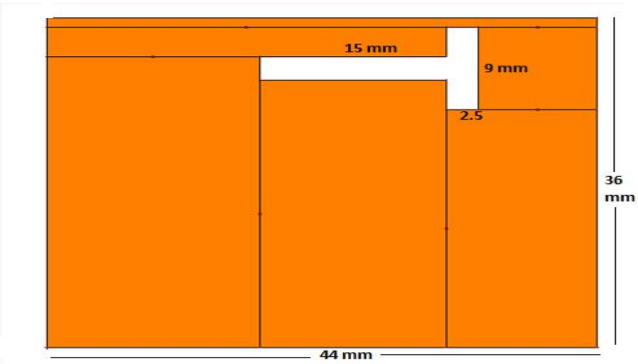

Fig. 2: Specific Dimensions of the Antenna.

3. Result and Analyses

The parameters such as Return loss, Voltage standing wave ratio (VSWR), Impedance, Directivity and Gain are simulated using IE3D simulation software and results are shown in this paper.

4. Return Loss

We can see from Figure3 ,the simulated return loss is less than -10db in the band 2.4-2.5 GHz and 5.1-5.8 GHz. The simulated return loss is -25.2db at 2.46GHz and -19.7db at 5.11GHz.

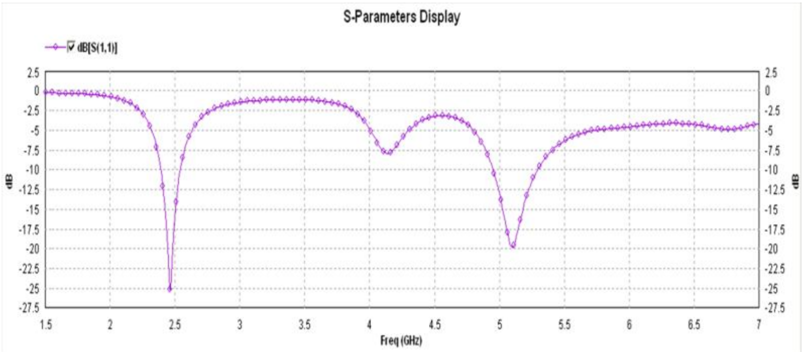

Fig. 1: Return loss (S11) Parameter Graph

VOLTAGE STANDING WAVE RATIO(VSWR)

We can see from figure4, VSWR is 1.1 at 2.46 GHz and 1.2 at 5.11 GHz.

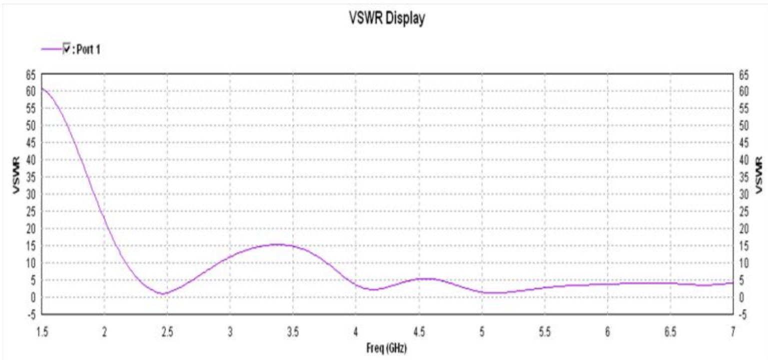

Fig. 2: Voltage Standing Wave Ratio(VSWR) Parameter Graph

IMPEDANCE

We can see from fig5, Impedance is 50Ω at 2.46 GHz and 55Ω at 5.11 GHz.

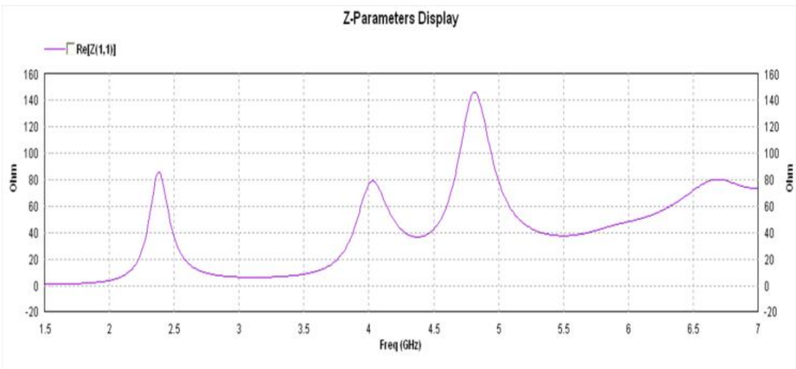

Fig. 3: 1Impedance Parameter Graph.

DIRECTIVITY AND GAIN

We can see from fig6, Directive Gain is 7.5dbi at 2.46 GHz and 6.8dbi at 5.11 GHz.

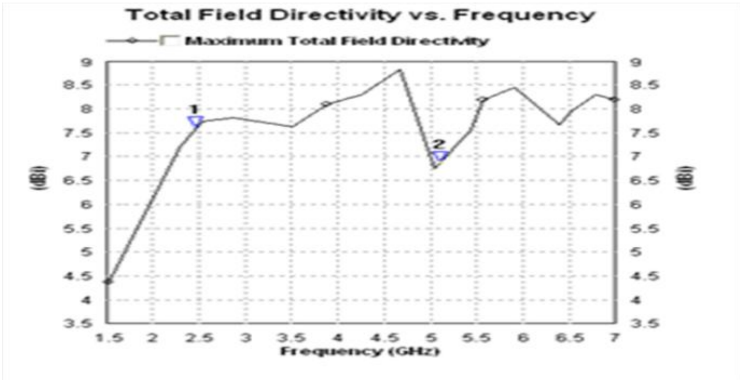

Fig. 6: Directivity vs Frequency Graph.

5. Conclusion

In this paper, a wearable dualband microstrip antenna for WLAN communication is presented. wearable antennas are required to be small size, light weight, but robust at the same time. With the help of the T type, the prototype of the antenna has achieved satisfactory dualband performance. For wireless body area networks to be applicable and accepted by the users and the consumer market, the radio system components, including the antenna, need to be comfortable and small in size and weight. So the selection of the substrate is also a good challenge to improve the wearable antenna. A piece of felt is used in this paper as the substrate, and this is a step forward for the wearable antenna study.

References

[1] Carla Oliveira, Micha□ Ma□kowiak, Luís M. Correia, "Challenges for Body Area Networks Concerning Radio Aspects," European Wireless,April 27-29, 2011 pp. 1-5.

[2] C. A. Winterhalter, et al., "Development of electronic textiles to support networks, communications, and medical applications in future 112 US Military protective clothing systems," Information Technology in Biomedicine, IEEE Transactions on, vol. 9, pp. 402-406, 2005.

[3] Koichi Ogawa, Tomoki Uwano, Masao Takahashi. "A shouldermounted planar antenna for mobile radio applications," Vehicular Technology, IEEE Transactions on, vol. 49, pp. 1041-1044, 2000.

[4] P. E. Massey. "GSM fabric antenna for mobile phones integrated within clothing," APS, 2001.IEEE Volume3,8-13July 2001 Page(s): 452-455 vol.3.

[5] I. Locher, et al., "Design and characterization of purely textile patch antennas," Advanced Packaging, IEEE Transactions on, vol. 29, pp. 777-788, 2006.

[6] C. Hertleer, et al., "A textile antenna based on high-performance fabrics," 2007, pp. 1-5.

[7] Y. Bayram, et al., "E-textile conductors and polymer composites for conformal lightweight antennas," Antennas and Propagation, IEEE Transactions on, vol. 58, pp. 2732-2736, 2010.

[8] Q. Bai and R. Langley, "Crumpling of PIFA textile antenna," Antennas and Propagation, IEEE Transactions on, pp. 1-1, 2012.

[9] Q. Bai and R. Langley, "Wearable EBG antenna bending and crumpling," 2009, pp. 201-204.

[10] Q. Bai and R. Langley, "Crumpled textile antennas," Electronics letters, vol. 45, pp. 436-438, 2009.