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 Figure 1.

![Fig. 1: A Photo of the Antenna.](image-url)

2. Antenna Configuration

The antenna is fabricated on a felt substrate with dielectric constant (\(\varepsilon_r\))=2.4, loss tangent (\(\tan\theta\)) 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,

\[
W = \frac{c}{2f_0} \left[ \frac{\varepsilon_r + 1}{2} \right]^{-1/2}
\]

where;

\(f_0\) = operating frequency = 2.6 GHz

\(\varepsilon_r\) = dielectric constant = 2.4

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

Effective dielectric constant,

\[
\varepsilon_{eff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2} \left( \frac{1}{\sqrt{1+12\left(\frac{h}{W}\right)}} \right)
\]
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Effective Length,

\[ L_{eff} = \frac{c}{2 \pi f_0 \varepsilon_{eff}^{1/2}} \]  

(3)

Length Extension,

\[ \Delta L = 0.412h \frac{(\varepsilon_{eff} + 0.3)(W/h + 0.264)}{(\varepsilon_{eff} + 0.258)(W/h + 0.8)} \]  

(4)

where;

h=substrate thickness =3mm

Actual patch length,

\[ L = L_{eff} - 2\Delta L \]  

(5)

After Calculation, values of Patch Width(W), Effective dielectric constant (\( \varepsilon_{eff} \)), Length Extension(\( \Delta L \)), Effective Length(\( L_{eff} \)) and Patch Length(L) are as follows:

W=44 mm, \( \varepsilon_{eff} = 2.219 \), \( L_{eff} = 38.7 \) mm, \( \Delta L = 1.2135 \) and L=36 mm

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

Figure 2 presents the geometry and dimensions of the proposed dualband T-shaped microstrip patch 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 Figure 3, 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.
VOLTAGE STANDING WAVE RATIO (VSWR)
We can see from figure 4, VSWR is 1.1 at 2.46 GHz and 1.2 at 5.11 GHz.

IMPEDANCE
We can see from figure 5, Impedance is 50\(\Omega\) at 2.46 GHz and 55\(\Omega\) at 5.11 GHz.

DIRECTIVITY AND GAIN
We can see from figure 6, Directive Gain is 7.5\text{dbi} at 2.46 GHz and 6.8\text{dbi} at 5.11 GHz.
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