Dual Band Quasi-Rhomboid Antenna for Bio-medical Monitoring Applications

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Abstract

In this paper, we propose a dual band quasi rhomboid antenna for bio-medical monitoring applications. The proposed antenna consists of quasi rhomboid shaped element antenna on free space and human arm. This antenna is designed on copperplate and antenna analysis was conducted by using the CST program.

Keywords : Quasi rhomboid antenna, bio-medical

1. Introduction

In recent years, the increasing interest in antennas and propagations research for body communication systems [1]. IEEE 802.15 standardization group has been established to standardize applications intended for on-body, off-body or in-body communication. Body-centric communications takes its place firmly within the sphere of personal area networks (PANs) and body area networks (BANs). : link from an on-body device to external off-body system – off-body, links in an on-body network consisted of wearable devices – on-body, and links to medical implants and sensor network – in-body. The health care services are deployed the range of medical devices and systems being used on the human body is increasing rapidly are of special interest in new sensing and monitoring device for healthcare. Body communication is communications between wireless medical implants and on body node [2-3]. For example, important in Hospital health status of patients suffering from chronic diseases or heart disease to monitor real-time. The health parameters that may be transmitted wirelessly to remote stations (off body mode) in medical systems range from simple heart rate, pressure, temperature, glucose levels, Therefore, the antenna required small size, light weight, low manufacturing cost and easy method of fabrication. Antenna is proposed for the wearable or implanted antenna, monopole, microstrip, patch, cavity slot antenna, textile antenna. However, antennas have narrow bandwidth.

In this paper presents a dual band quasi rhomboid antenna for bio-medical monitoring applications. The proposed antenna consists of single element antenna on free space and on human arm. This antenna is designed on Copperplate and antenna analysis was conducted by using the CST Microwave Studio Suite. The proposed antenna is realized and experimentally examined, since it is small size, light weight, easy method fabrication and low manufacturing cost. In measurement, it is found that both antennas have bandwidth covered the frequency range of 2 – 2.8 GHz and 5.3-6.2 GHz, respectively. The resonant frequency is shift of 200 MHz compared to free space and human arm which covered wideband spectrum range with average gain of 3.5 and 3 dB at free space and on human arm for single element, respectively. This antenna has a return loss than -10 dB all over the operating frequency and Omni-directional patterns in azimuth plane. The proposed antennas are suitable for medical monitoring application.

2. On-body Antennas Concept

Antenna on the body required is Omni-directional patterns since the movement of the body looked different However, the human body are important parameters that effect the antenna is permittivity so we assume that the human arm model has homogeneous and muscle-equivalent tissue. The dielectric dispersion of the tissue was approximated by the single-pole Debye equation.

$$\varepsilon_r(\omega) = \varepsilon_\infty + \frac{\varepsilon_s + \varepsilon_\infty}{1 + j\omega\tau} + \frac{\sigma}{j\omega\varepsilon_0} \quad (1)$$

Where ε_0 is the free-space permittivity, ε_s is the static permittivity at zero frequency, ε_∞ is the optical permittivity at infinite frequency, τ is the relaxation time, and σ is the static conductivity. Since the Debye equation cannot fully approximate the actual value of muscle over the range, the parameters are individually defined on three ranges of 3-30 MHz, 30-300 MHz, and 300 MHz- 3 GHz, so as to be continuous at boundaries. Discrepancy between the literature [4] and approximated values is within ±10% over the whole frequency range.

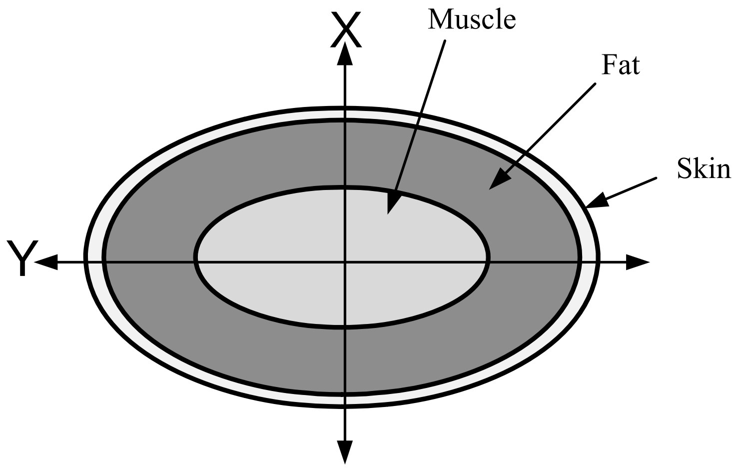


Figure 1: Human arm phantom model

3. Antenna Design

The main objective of this antenna designed is to provide dual bandwidth. The proposed antenna design was performed for copperplate. The analysis and design of antenna dimensions were optimized by using the CST Microwave Studio program The simulation result by using CST program, include impedance matching antenna length λ/4 (λ it mean wavelength in air.). The antenna dimensional parameters after adjustments are w1 = 37.41, w2 = 6.12, w3 = 4.27, l1 = 24.68, l2 = 5.75 unit in millimeter. This antenna consists of two identical printed patches, one on the top and one on the bottom the substrate material. The detailed geometry and parameters of the proposed antenna are illustrated in Fig.2.

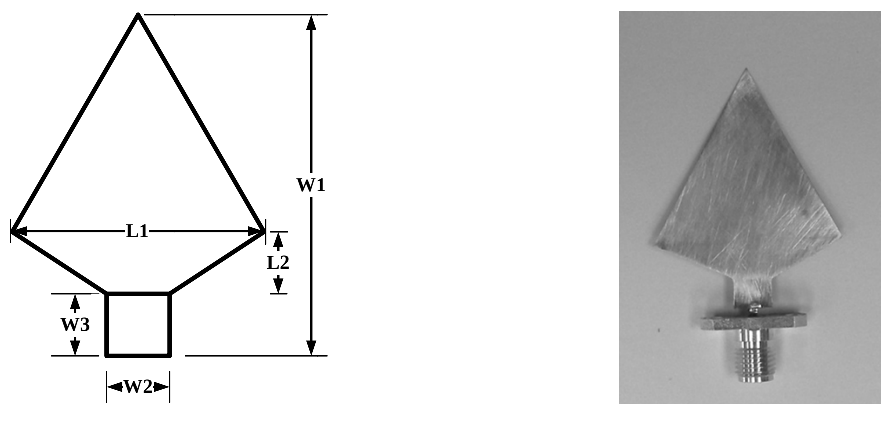
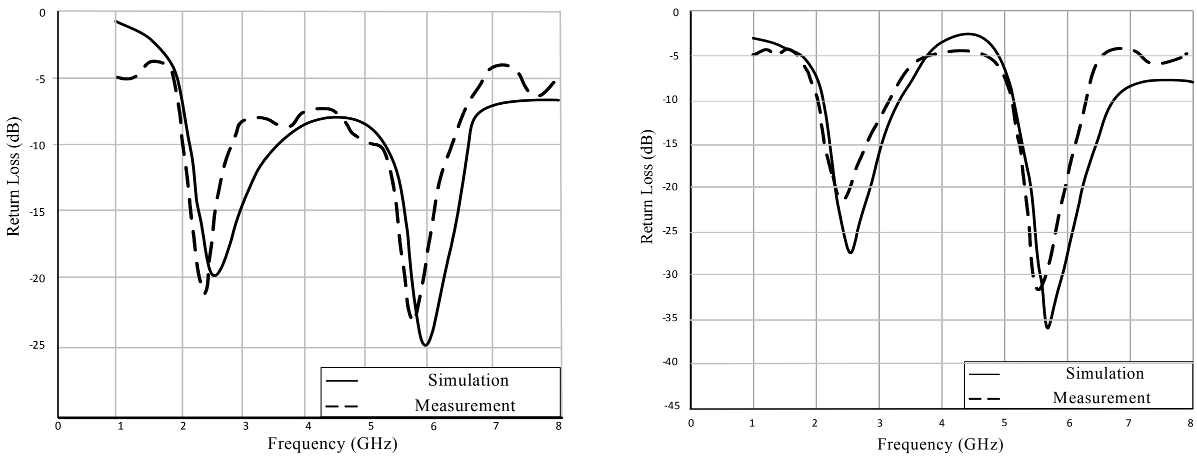


Figure 2: Structure and parameter of the proposed antenna.

4. Measurement and Result

4.1 Return loss

Fig.3 shows that the measured input return losses as a operation of frequency. The return loss of the proposed antenna is measured by using a HP 8772D vector network analyzer. The two resonances have been found that about 2.5 GHz and 5.8 GHz with the input return loss of more than -20 dB.

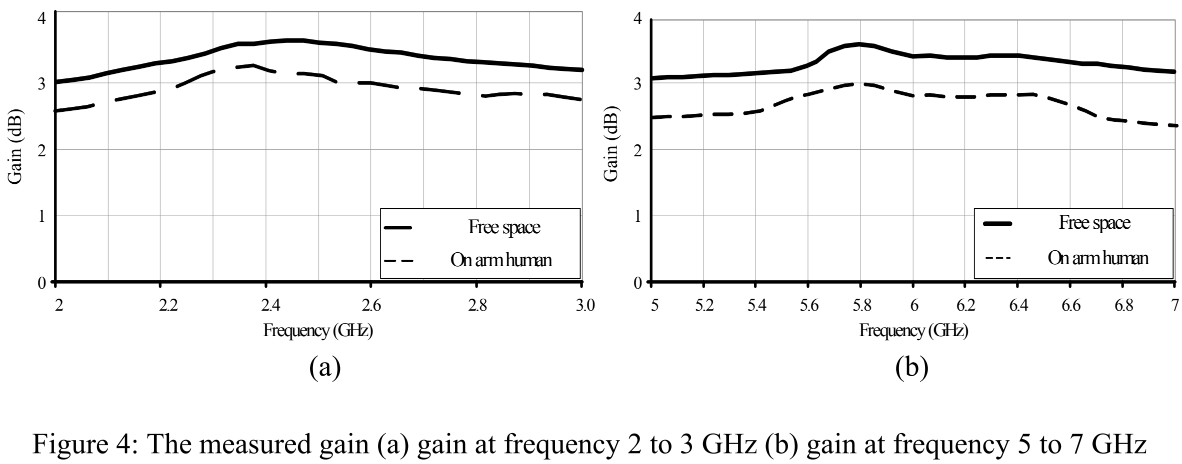


(a) (b)

Figure 3 : The simulation and measured return loss (a) The return loss for free space, (b) the return loss for human arm.

4.2 Gain

Fig.4 shows the gain of the proposed antenna is measured by using vector network analyzer. From this figure, average gain is about 3.5 dB and 3 db for antenna on free space and on human arm, respectively. The antenna gain in single element on free space is not same single element on human arm of antenna. In measurement, it found that an antenna on human arm has average gain less than antenna on free space about 0.5 dB.



(a) (b)

Figure 4: The measured gain (a) gain at frequency 2 to 3 GHz (b) gain at frequency 5 to 7 GHz

4.3 Radiation patterns

The far-field radiation patterns were measured in an anechoic chamber. The antenna patterns are measured at selective frequencies that cover the entire operating frequency, and the results are presented in Fig.5 for the E-plane and H-plane at frequency 2.45 GHz and 5.8 GHz respectively. When is received at 70 cm from the transmitting antenna for an antenna on free space and human arm structure, respectively. The proposed antenna is their stable radiation patterns. It can be seen that the antenna is satisfactorily in the considered frequency band. Referring to Fig.5 the measured E and H planes cross-polarization is not show because it is very low.

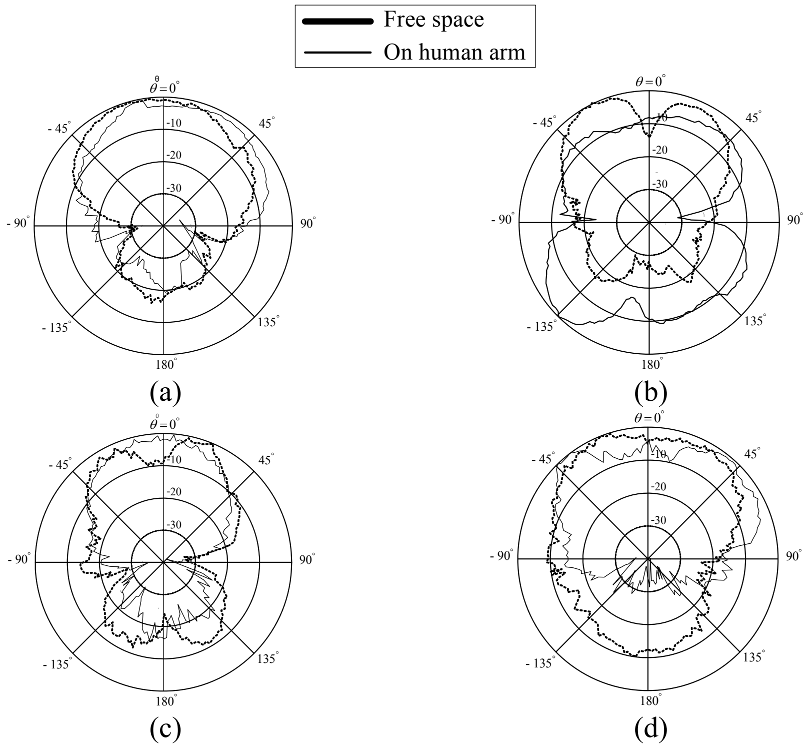


Figure 5: The measured E and H plane radiation patterns (a) E-plane at 2.45 GHz (b) H-plane at 2.45 GHz (c) E-plane at 5.8 GHz (d) H-plane at 5.8 GHz.

5. Conclusions

In this paper, a novel quasi rhomboid antenna is presented. The proposed antenna consists of single element on free space and single element on human arm. The proposed antenna provides covered frequency range 2-2.8 GHz and 5.3-6.2 GHz for a single element on free space and single element on human arm, respectively. The proposed antenna has a measured return loss less than -10 dB over the operating frequency for dual band bi0-medical Monitoring applications. This antenna pattern is satisfactorily Omni-directional in azimuth in the considered frequency band. The average gain for single element on free space is around 3.5 dB, while for single elements on human arm the average is around 3 dB. The proposed antenna is fabricated on copperplate, since it is small size, easy construction and very low cost. For lead to use benefit in designed impulse receive transmit system of dual-band technology.

References

[1] Kamarudin, M.R.: Nechayev, Y.I: Hall, P.S.; “Antennas for on-body communication systems” IEEE International Workshop on Antenna Technology: Small Antennas and Novel Metamaterials, 2005. IWAT 2005,7-9 March 2005, Page(s): 17 – 20.

[2] Hall, P S and Hao, Y., “Antennas and Propogation for Body Centric Wireless Communications”, European Conference on Antennas and Propagation (EuCAP), November 2006.

[3] A. Gareth, G. William “Antennas for Over-Body-Surface Communication at 2.45 GHz” IEEE Transactions on antennas and propag., vol. 57, No. 4, pp. 844-855 Apr. 2009.

[4] S. Gabriel et al., “The dielectric properties of biological tissues: II. Measurements in the frequency range 10 Hz to 20 GHz, Phys. Med. Biol. 41 pp.2251-2269, Apr. 1996.

Acknowledgments

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