Circular Polarized Textile antenna at 2.4 GHz

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Abstract - **In this paper a circular polarized textile antenna at 2.45GHz is designed and simulated. The antenna used the fleece material as the substrate with permittivity of 1.3 and loss tangent of 0.024 with a thickness of 1 mm. The circular polarized (CP) antenna is achieved by using an inverted z slot asymmetrical structure at the center of radiating element. When the z slot is incorporated onto the square patch, two orthogonal components of electric field are excited with a 90^0 time phase difference. The proposed antenna has a dimension of 70 x 70 x 1 mm^3. The simulated and measured results show that the antenna offers approximately 6.7% bandwidth (2.42GHz-2.59GHz) reflection coefficient, S_{11} is -32.16dB with impedance bandwidth of 167 MHz. The flexible antenna has axial ratio bandwidth of 80 MHz i.e 3.25% covering the frequency range of (2.42GHz - 2.5GHz). The wearable antenna is suitable for application of wearable electronics, wireless monitoring communication system and wireless local area network (WLAN).**

Index Terms — **circular polarization antenna, axial ratio, z slot, ISM band**

1. Introduction

Wearable antenna for body worn application is rapidly growing, which provide a tremendous range of application such as fire fighter, health care and body centric communication. Circular—polarized antennas could be matched in wide range of orientations because the radiated waves oscillate in a circle that is perpendicular to the direction of propagation [1-3]. Modern technology requires the antenna in more compact and also applicable for body worn application. Textile material forms interesting substrate because fabric antenna can be easily integrated into clothes with low profile and ease of fabrication. Therefore, by using fabric as the substrate and the limitation of the transmitter-to-receiver orientation can be effectively solved when antennas with circular polarization (CP) are utilized every person who is using wired technology device can easily move around while doing their job. The person can wear the wearable device onto their cloth. So, the problems of limited movements are solved [4-6]. The applications of wireless communication such as Global positioning systems (GPS), WLAN, satellite communication require more bandwidth due to integration of various services in single receiver [7].

Incorporating wearable devices is continously growing and attracting a lot of attention since the textile material allowed the user to not abandon the comfort zone. Wearable electronics provides robustness, flexibility, small size, confortable to wear and consume less amount of power [8-9]. In this paper, a technique to achieve circular polarization is presented for WLAN and wireless monitoring communication system. The fleece textile material is selected as the substrate because the antenna can be flexible, low cost, light weight and ease of fabrication. The textile antenna is designed using an inverted z slot at the center of the patch that gives the circular polarization. The proposed antenna can be placed on clothing and cover the 2.45GHz wireless band. The antenna is simulated using CST Microwave Studio. The simulated and measured results are in good agreement which validates the proposed antenna by using inverted z slot structure on flexible devices.

2. Antenna design and consideration

The geometry of the circular polarized textile antenna operating at 2.45GHz is shown in Figure 1. The flexible antenna is employed by the use of fleece fabric as a substrate which has a dielectric constant of 1.3, loss tangent of 0.024 and thickness of 1 mm. To enable circular polarization an inverted z slot asymmetrical structure is introduced at the center of radiating element. Once incorporated onto the square patch two orthogonal components of electric field are excited with a 90^0 time phase difference. Both the patch and the inverted z slot were adjusted such that the wearable antenna generates the circular polarized wave at the resonance frequency. The left hand circular polarization (LHCP) and right hand circular polarization (RHCP) orientation can be controlled by changing the position of the slot at the center of the patch.

Table 1: Optimized parameters of the flexible antenna.

Parameters	Dimension(mm)
Ws	70
Ls	70
Wp	50
Lp	50
Lslot	3
Wslot	10
L1	5
W1	1

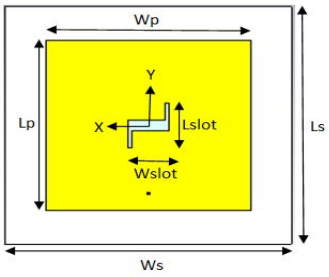

Figure 1: Geometry of the textile circular polarized Antenna.

3. Result and Discussion

Figure 2 shows the comparison between simulated and measured reflection coefficient (S_{11}) of the proposed antenna. At 2.45GHz, S_{11} is -32.16dB with impedance bandwidth of 167 MHz i.e. 6.7% covering the frequency range of (2.42GHz-2.59GHz). The measured reflection coefficient characteristic is in good agreement with the simulated reflection coefficient at the operating frequency..

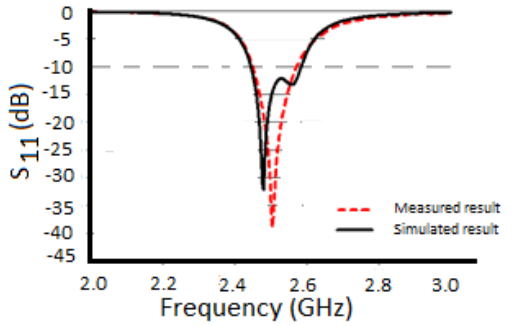

Figure 2. Simulated and measured reflection coefficient , S_{11} of the textile antenna

Figure 3 shows the comparison between simulated and measured axial ratio (AR) of the proposed antenna. The flexible antenna has axial ratio bandwidth of 80 MHz i.e 3.25% covering the frequency range of (2.42GHz - 2.5GHz). The antenna has a good performance in term of axial ratio.

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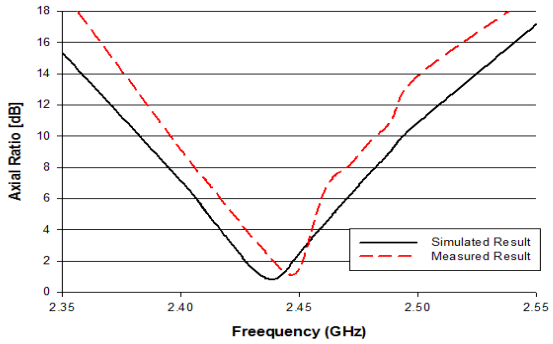

Figure 3. Simulated and measured axial ratio of the wearable antenna .

4. Conclusion

In this paper, a circular polarized textile antenna that operates at 2.45 GHz is presented. The flexible antenna which is made from a fabric material can be integrated into cloth and suitable for wearable application. Fleece fabric was used as the substrate and copper tape as the radiating element with fully ground plane. Two orthogonal modes are excited which gives circular polarization by optimizing the inverted z slot at the center of the radiating element. The proposed antenna gives a good operating frequency bandwidth of 6.7% (2.42GHz-2.59GHz) with axial ratio bandwidth of 3.25% (2.42GHz -2.50GHz). The proposed antenna shows that it is suitable for wireless local area network (WLAN) and wireless monitoring system.

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