Design Of Wearable High Gain Wide Band Antenna Using Semi Oval Geometrical Shape For Wireless Applications

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***Abstract*—In this paper, we introduce a semi-oval shape wideband, printed antenna, fed via the Co-Planar Waveguide (CPW) geometry. An increasing radiation pattern obtained using a reflector on the same level as the radiator and around it. The high impedance matching performance of the antenna was observed (at 3.9 GHz) throughout the whole wide spectrum of 3 GHz to 4 GHz. For Semi oval structure, the antenna was printed on the Rogers Ultralam 3850 substrate. With such characteristics, the antenna can be recognized in a number of wireless applications; such as WLAN, WI-Max and RFID, as well as, wearable applications.**

Keywords—high gain antenna; semi oval; wearable antenna; wideband antenna; wireless applications; wearable applications.

Introduction

In recent years, the field of wearable antenna attracted great interest in research. Wireless antennas offered different designs, among this, the foldable antenna fixed on a non-planner substrate [1]. The design of the antenna must consider the changes in the radiation pattern due to the flexible substrate. So, the flexible antenna needs continuous studies and analysis [1-3]. Although traditional microstrip antennas have many advantages; such as, uni-directional pattern field in addition to low complexity and low cost in fabrication, as a result of their substrate thickness and dielectric constant (relative permittivity), they produce very narrow bandwidth which is not preferred in wireless and wearable applications [4].

Low profile Co-Planar Waveguide (CPW) fed antennas offer a wide bandwidth which can be applied in different wireless and wearable applications [4]-[6]. So the need for flexible high gain antennas in wireless and wearable applications increases. High gain antennas can be achieved by several methods such as using, Artificial Magnetic Conductors (AMCs), meta-material or a horn reflector [4], [7]-[8].

In this paper, we assume a flexible, wideband antenna with high gain. A reflector attached to the ground and printed on the same side of the antenna, so high gain obtained. The obtained wide bandwidth designates this antenna to be used in wireless and wearable applications.

Antenna design and configuration

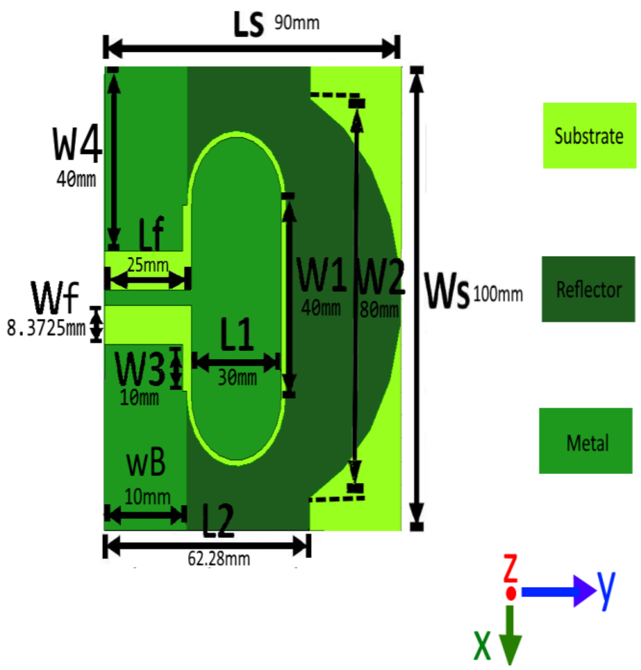


Figure (1): Antenna configuration and dimensions

Rogers Ultralam 3850, with a dielectric constant of 2.9, used to achieve the requirements. It consists of Liquid Crystalline Polymer (LCP) with a thickness of 100 µm and a loss tangent of 0.0025.

The proposed antenna 2D layout configuration, shown in Fig.1, where its dimensions are specified in Table I, was modeled and simulated by using the High-Frequency Structure Simulator Technology (HFSS) software.

The antenna consists of the radiating element, reflector, and the CPW feeder. CPW used to feed the antenna since it provides a single side fabrication. The radiating element proposed as a wide semi-oval, three rectangular patches used to form the semi-oval shape, which offers a wide bandwidth based on its operating frequency. The main element in the proposed antenna is the reflector which surrounds the radiating element to guarantee high gain achievement.

The CPW feed line's width and spacing, between the ground and feed-line, of (2.4) mm were used to achieve the 50Ω excitation for the proposed antenna.

The antenna bent as a semi-oval shape to suit the wearable applications as shown in Fig. 2. It was divided into three parts. The first part is straight with dimensions (30mm), while the other two parts are cylindrical with radius (4.77mm).

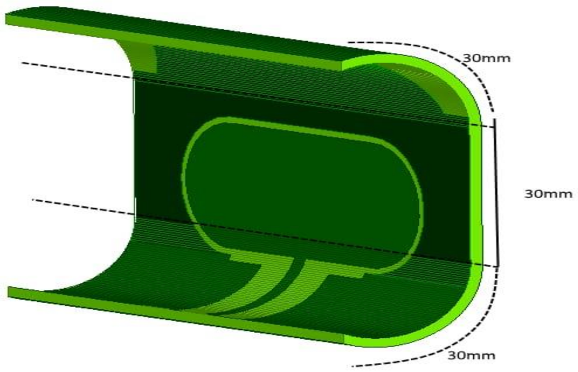


Figure 2: Antenna bent as semi oval shape

Table1. Antenna dimensions in mm

LS	L2	WS	WF	W4	WB	W3	LF	L1	W1	W2
90	62.28	100	8.3725	40	10	10	25	30	40	80

Simulation results and discussion

The performance of the antenna studied for a straight antenna with and without reflector and bent antenna with and without reflector as shown in Figure 3. In the first case, a straight antenna showed a -28dB reflection coefficient at frequency 3.28GHz and -16dB at 3.79GHz. These results decreased by adding the reflector to -23dB at 3.28GHz and -13 dB at 3.79GHz. The bent antenna without reflector showed -19dB at 3.29GHz and -35 dB at 3.81GHz, while bent antenna with reflector showed – 18dB at 3.8 GHz. Good impedance matching observed in the case of straight without reflector, bandwidth from 3GHz to 3.9GHz, while in the case with a reflector the bandwidth was from 3GHz to 3.8GHz. Bending the antenna along the X and Y axes did not affect its matching performance.

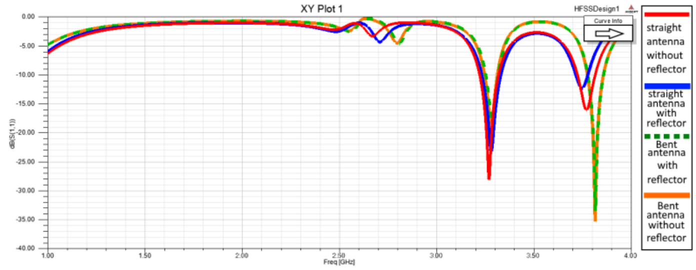


Figure 3: Comparison between the simulated reflection coefficient of the structures, including the straight structure with and without reflector and the semi oval structure with and without it, against frequency.

It is well known that the radiation pattern of the antenna gives an exact idea about the gain of the antenna system. The radiation pattern of the proposed antenna was plotted in polar form, as shown in Fig. 4. The radiation gain was conducted at 2.45 GHz, for the straight antenna without reflector was 1dB, increased after adding the reflector to 15dB. In the case of the semi-oval bent antenna the radiation gain was 10 dB with and without reflector, i.e. bending the antenna did not affect the radiation pattern.

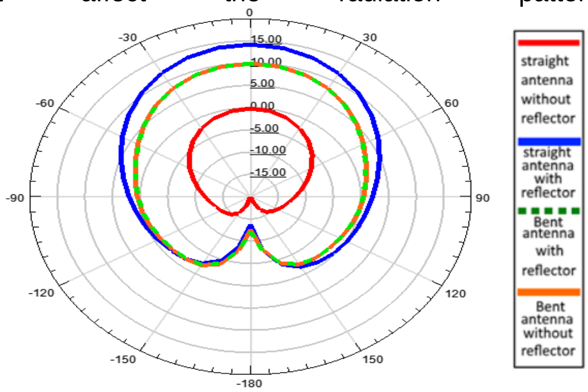
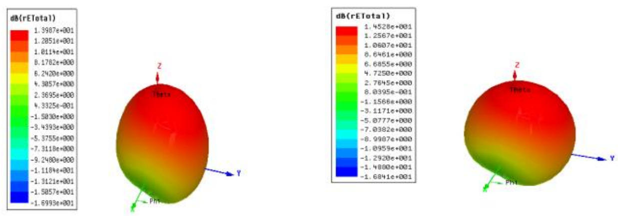
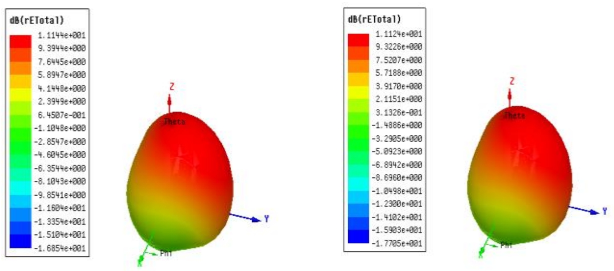


Figure 4. Comparison between the radiation patterns at 2.45 GHz in polar plot demonstration of the structures including the reflector and when bent.



(a) **(b)**



(c) (d)

Figure 5. The radiation patterns, at 2.45 GHz, in 3-D plot of the structures

(a) Straight without reflector (b) Straight with reflector
(c) Bent without reflector (d) Bent with reflector

The 3D radiation pattern for all the cases illustrated in Figure 5, which shows the same results obtained.

Conclusion

An analysis of the performance of a flexible, wideband antenna with a high gain was presented. High gain and radiation efficiency of 5.63 dB and 0 dB; respectively, were achieved, by using the unique shape of reflector around the radiator, along with the wide bandwidth from 3 GHz to 4 GHz. Furthermore, the proposed antenna performed well, in terms of matching, as well as, preserved the omnidirectional radiation pattern, while bent, at 2.45 GHz. As a result of these properties, the antenna can be realized in wearable and wireless applications.

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