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UWB Rectangular Microstrip Patch Antenna for BAN Applications

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ABSTRACT

An Ultra-Wide Band (UWB) microstrip patch antenna for Body Area Network (BAN) applications is presented in this paper. This particular antenna design covers UWB i.e. 3.1GHz-10.6GHz. The substrate used is Rogers RT Duroid 5880 having a thickness of 1.577 mm. The rectangular body phantom of skin is considered for simulations. The return loss (S11) plot of antennas is presented along with the radiation pattern.
KEY WORDS: BAN antenna, Rectangular microstrip antenna, UWB antenna for BAN, Microstrip antenna for BAN

INTRODUCTION

BAN is that kind of network that works in the proximity of the human body either on the outside or inside. BAN is now gaining importance day by day in medical, consumer electronics and physical rehabilitation. Ultra wide band (UWB) is a very large band, consumes less power and it can be used in the wireless communication. The antennas are an important component of wireless system and can operate on different frequencies. There are several antenna types one of them is microstrip antenna, which provides less power and narrow bandwidth. These antennas are not wideband and there are no such specific formulas in the literature which can make them wideband. There are different techniques like meandering and slotting in the patch and ground plane are used to enhance the bandwidth.

In the literature different ultra wide band BAN antennas are present; some of them are discussed in this section. In [1-5] the whole range of UWB i.e. 3.1GHz to 10.6GHz for BAN applications was not covered. Some antennas covered the upper band of UWB while others covered the lower band. In [1] wearable finger antenna was presented which consist of helical and loop element, it is designed for BAN applications but not for UWB. In [2], the antenna consist of inverted monopole shaped antenna with double ring was presented and covers lower UWB (7.25-10.25 GHz). In [3], an UWB antenna for BAN applications was presented which covers the upper region of UWB (3.1-5.1 GHz).In [4-5]; the proposed antenna designs cover the lower band (7.25-10.25 GHz). In [6-12] the proposed antenna designs cover the whole range of UWB i.e. 3.1-10.6 GHz but they are not designed for the BAN applications.

This paper will present the design of the antenna that covers the whole range of UWB i.e. 3.1-10.6 GHz when the body phantom is attached. The antenna will no longer operate on the frequency range for which it was designed when the body phantom is attached so a comparison of results of UWB antenna and the results of the same antenna with body phantom is presented in the paper. The result of return loss (S11) is also presented in this paper along with the radiation pattern. This paper is divided further as, first it gives the introduction and literature review, then it provides information related to material and method , next it provides the simulated results of simple UWB antenna and UWB antenna with BAN, the parametric analysis and the Radiation Pattern are presented and then the paper is concluded.

MATERIAL AND METHOD

Microstrip patch antenna is used for BAN applications in this paper. Figure1 (a) and (b) shows the proposed microstrip UWB antenna's top and bottom view. The geometry of the proposed antenna consists of slots. The microstrip antenna has very narrow bandwidth; to make it wideband the slots are added in ground plane and patch. The proposed antenna is fabricated on a substrate Rogers RT Duroid 5880 with the relative dielectric constant ϵr of 2.2, the thickness is 1.577 mm and the dielectric loss tangent is 0.0009. The thickness of the copper is 0.0175 mm. This antenna was designed by the software HFSS (High Frequency Structural simulator).This software helps to analyze and study the characteristics of the antenna. The feeding method used in this antenna is microstrip line. The dimension of the rectangular patch is 30 mm x 15.4 mm and the dimension of ground plane is 35 mm x 16 mm.

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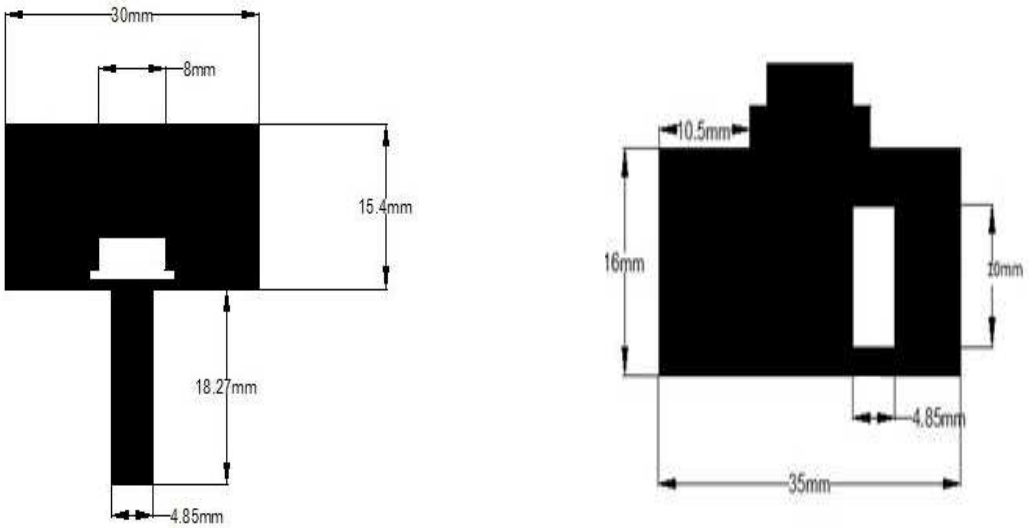
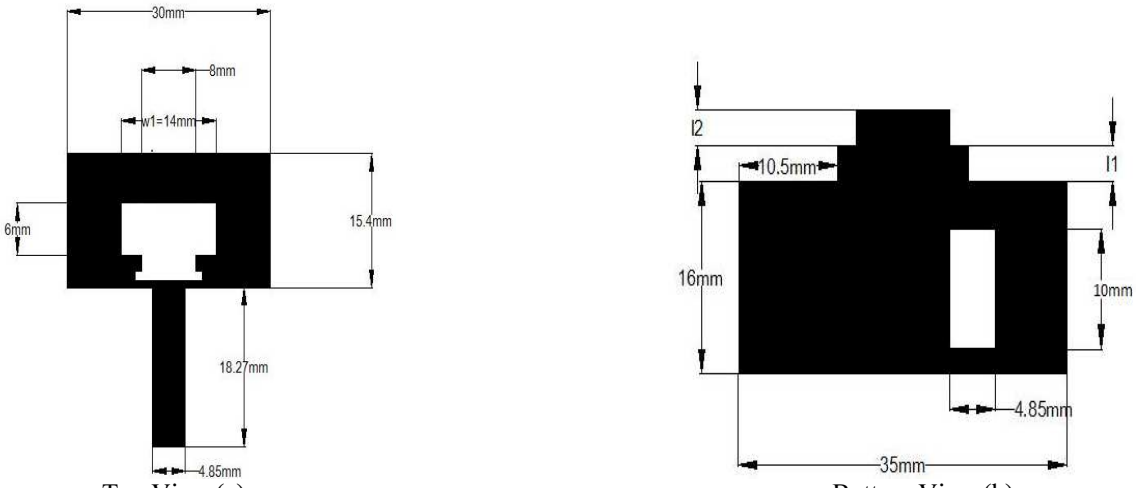


Top View (a) Bottom View (b)

Figure 1: UWB Antenna without body phantom

When the body phantom was attached with UWB antenna the response of the antenna changed, it was no longer operating in the UWB range. Some modifications are made in the antenna of Figure 1 so that it can operate on UWB after attaching the body phantom. Fig.2 shows the BAN antenna that is for UWB. The skin layer is used as phantom, the dielectric constant (∈r) of skin is 36.9, dielectric loss tangent is 0.29 and conductivity is 2.4 Siemens/m .The dimension of the skin material is 35 mm x 37 mm x 2 mm Figure 2 (a) shows the top view and Fig.2 (b) shows the bottom view of UWB BAN antenna.



Top View (a) Bottom View (b)

Figure 2: Modified UWB antenna with body phantom

Figure 3 shows the side view of model that was simulated in the software High Frequency Structural Simulator (HFSS). The thickness of the skin layer is 2 mm and it was attached directly with the antenna.

Figure 3: Side view of the model used for simulation in HFSS

RESULTS

This section will present the simulated results of the antennas in Figure 1 and Figure 2. It also shows the change in the results of UWB antenna when the layer of the skin is added along with antenna. Figure 4 shows the return loss plot of the UWB antenna of Figure 1 without body phantom and the results of Figure 1 antenna with body phantom. It can be clearly seen that when the phantom is attached with UWB antenna it will no longer operate on UWB. UWB antenna without body phantom covers the frequency range of 2.9-11.6 GHz and the same antenna with body phantom covers frequency range of 3.36-5.27GHz. Figure 5 is representing return loss plot of the antenna of Figure 2 that is designed for the BAN applications. This particular antenna covers whole range of UWB when the phantom is attached with it. The range of frequencies for which the antenna is operating is 3.03-13GHz.

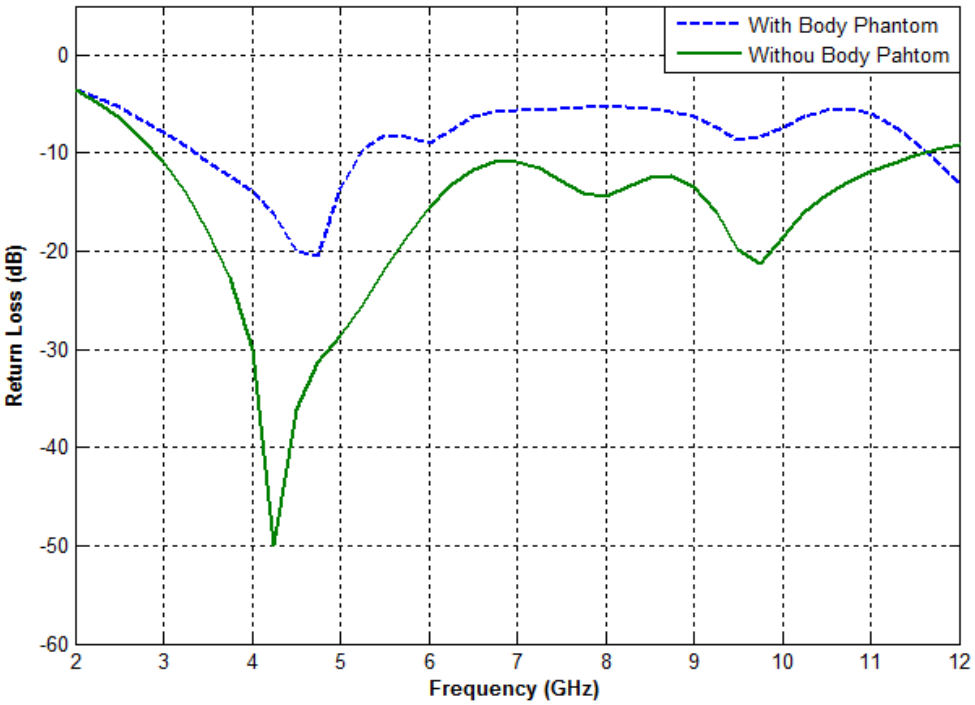


Figure 4: Return Loss

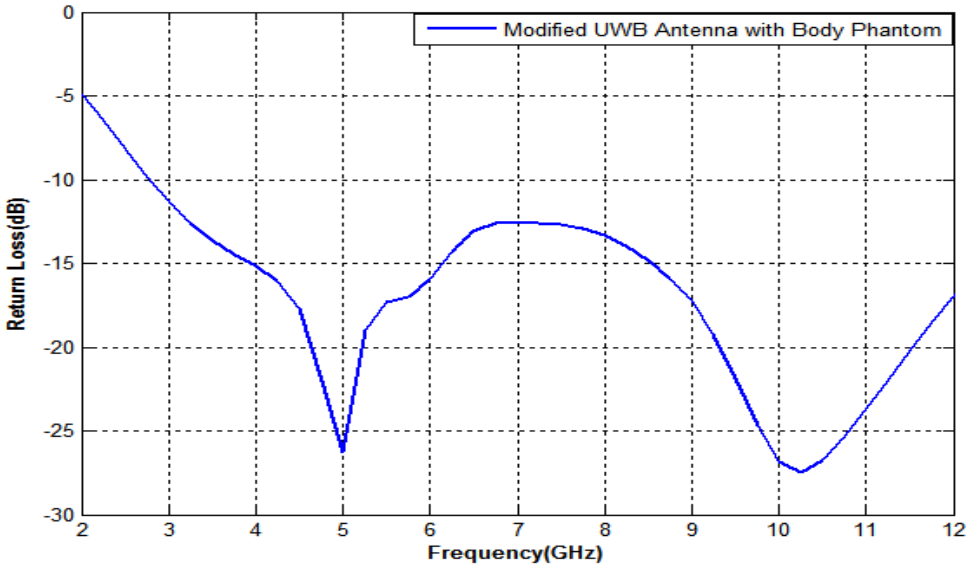


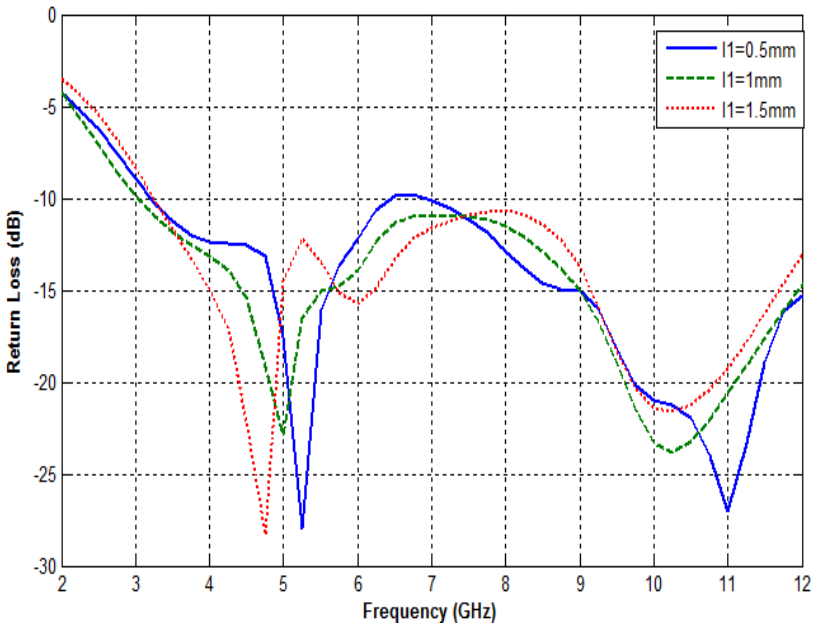
Figure 5: Return Loss

I. Parametric Analysis

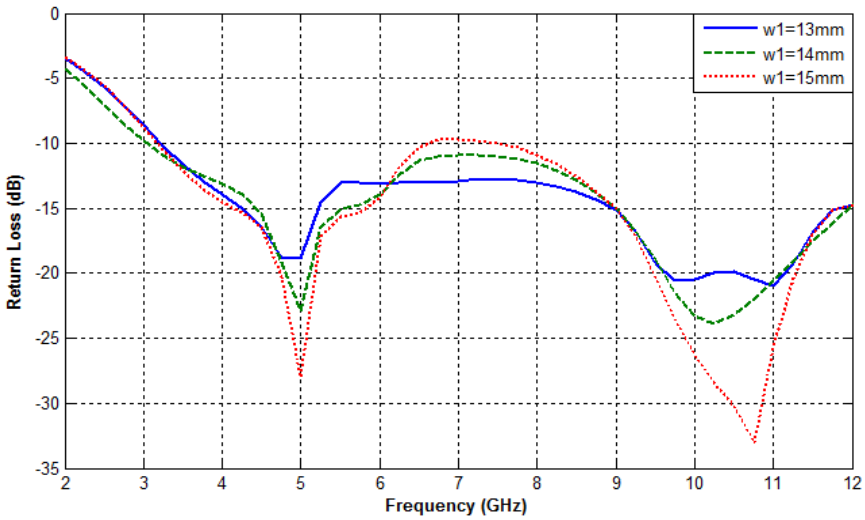
This section will present the results of parametric analysis of the BAN antenna in Figure2.The parameters that are varied are l1, l2 and w1, to see the response of the antenna in Figure 2.Figure 5, (a) shows the change in the behavior of the antenna when l1 is varied, (b) shows the results when the w1 go through variations and (c) shows the response of antenna when l2 is varied. The variation in the frequency response of the antenna due to each parameter is given in the Table I.

Table I: The variations of these parameters (l1, l2 and w1)

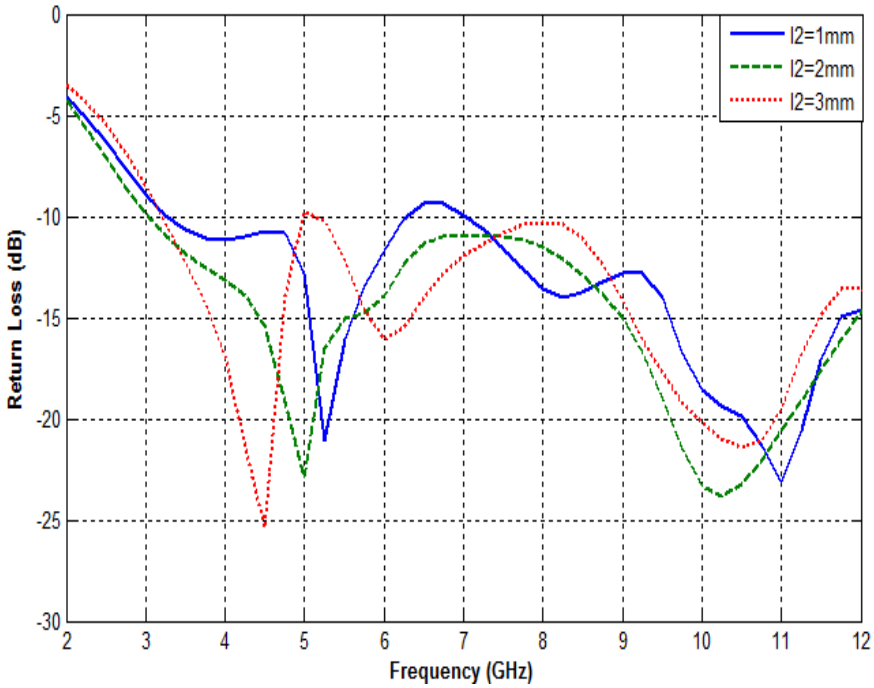
Parameters					
l1		l2		w1	
Values	**Frequency Range**	**Values**	**Frequency Range**	**Values**	**Frequency Range**
0.5 mm	3.2-6.44GHz and 6.9-13GHz	1 mm	3.26-6.29 GHz and 7.02-12.9GHz	13 mm	3.25-13 GHz
1 mm	3.03-13 GHz	2 mm	3.03-13GHz	14 mm	3.03-13 GHz
13 mm	3.25-13GHz	3 mm	3.2-4.95GHz and 5.12-13GHz	15 mm	3.17-6.62GHz and 7.45-13GHz



(a) Variation in parameter l1



(b) Variation in parameter w1

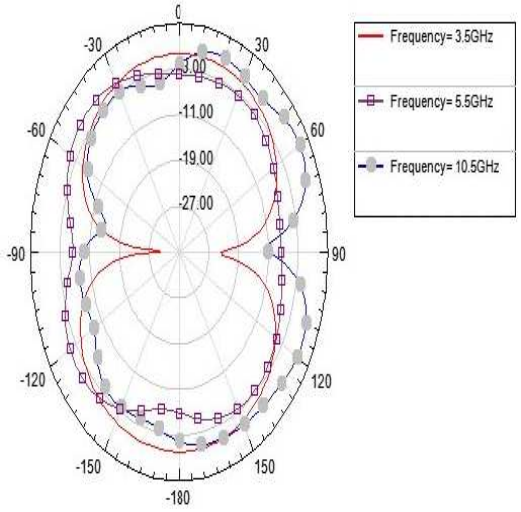


(c) Variation in parameter l2

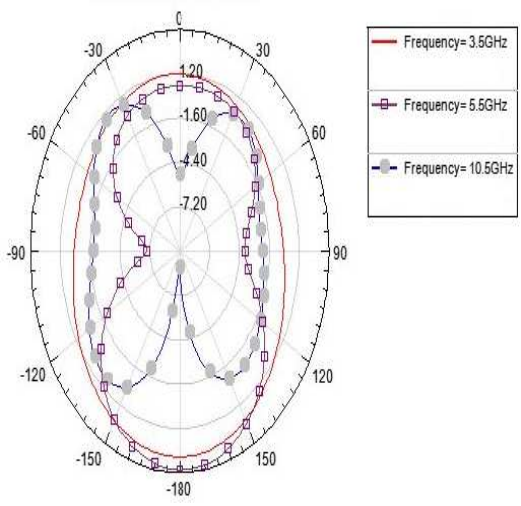
Figure 6: Parametric Analysis

II. Radiation pattern

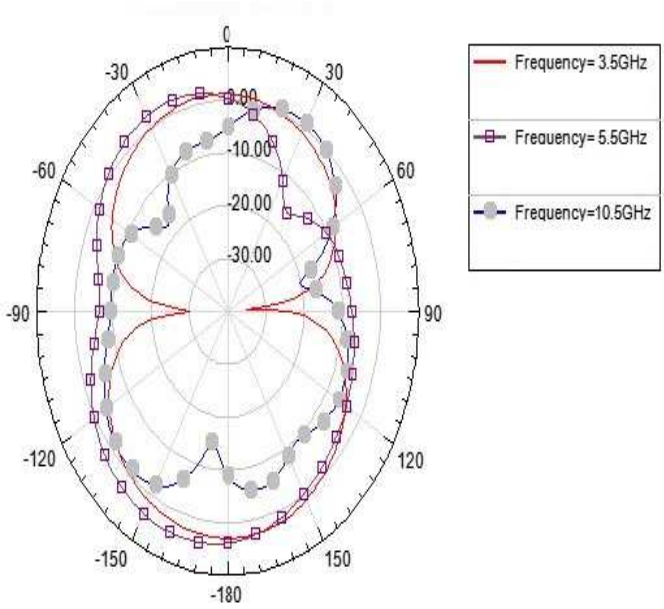
Radiation pattern shows the direction of power radiated by the antenna; Figure 7 shows the radiation pattern of the antenna in Figure2 and it is plotted on three frequencies 3.5GHz, 5.5GHz and 10.5GHz.The radiation pattern of the antenna in XY plane in all the frequencies is represented by (a), (b) shows the radiation pattern in XZ plane at all frequencies and the radiation pattern of all mentioned frequencies above in YZ plane is given in (c). In all the principle planes (XY, YZ and ZX) the distribution of radiated power is almost non-directional.



XY Plane (a)



XZ Plane (b)



YZ Plane(c)

Figure 7: Radiation pattern

Conclusion

In this paper a BAN antenna is presented which covers the whole range of Ultra wide band (UWB) i.e. 3.1GHz-10.6GHz. The antenna type used in this case is rectangular microstrip patch, the substrate used is Rogers RT Duroid-5880 and thickness of the substrate is 1.577 mm. The body phantom used is skin layer and it is rectangular in shape. The results of return loss (S11) show that the antenna is covering UWB when the body phantom is attached and the radiation pattern shows that antenna is almost omnidirectional.

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