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Microstrip Patch Antenna for Ban Applications

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Abstract : ***A microstrip patch antenna is designed for UWB (Ultra Wide Band) range i-e; 3.1GHz-10.6GHz. The antenna is particularly designed for BAN (Body are Network) applications. The substrate used is Rogers RT Duroid 5880 with thickness 1.577mm. Comparison between UWB antenna with and without body phantom is presented. It is shown that an UWB antenna can be modified and used for BAN. Radiation patterns and return loss plots are also shown.***

Key words: ***Microstrip antenna, Ultra wideband antenna, body area networks, UWB antenna for BAN, BAN antenna***

Introduction

A Body Area Network is formally defined by IEEE 802.15 as, "a communication standard optimized for low power devices and operation on, in or around the human body (but not limited to humans) to serve a variety of applications including medical, consumer electronics / personal entertainment and other" [1]. It finds various applications in medical field and is rapidly progressing due to increased demand. To support BAN, different antennas are being designed using different frequency ranges. UWB is widely used for BAN applications, therefore the proposed antenna is designed to cover entire UWB.

Microstrip patch antenna is being widely used these days. All the latest gadgets use this type of antenna for communication purposes. It is commonly used because it is cheap and consumes less power. The substrate used is Rogers RT Duroid 5880. The value of dielectric constant for the substrate is 2.2 and tangent loss is 0.0009. Thickness of substrate is 1.577mm.

During the literature survey, number of papers covered upper or lower bands of UWB range. In [2], the antenna was a wearable finger ring consisting of loop and helical elements and covered the MICS and ISM bands. In [3], an antenna which is T- shaped and is double fingered human ring covers the lower band of UWB range i-e. (7.25-10.25GHz). In [4], inverted hat shaped along with inverted U- shaped antenna were presented which again covered the lower band. In [5], an antenna covering the lower band of UWB consisting of inverted monopole shaped and double finger ring was proposed. In [6], an antenna was presented for UWB range which covered the upper band i-e. (3.1-5.1GHz). In [7],[8],[9],[10],[11] and [12] the proposed antennas are not designed for BAN applications however they cover the UWB.

This paper presents an antenna designed to cover entire UWB. A body phantom is then attached to the antenna and it is observed that antenna no longer operates in the UWB region. In order to make it to operate again in the UWB region different modifications are applied on antenna design. The modified antenna covers the whole UWB with body phantom. Its return loss and radiation pattern are presented.

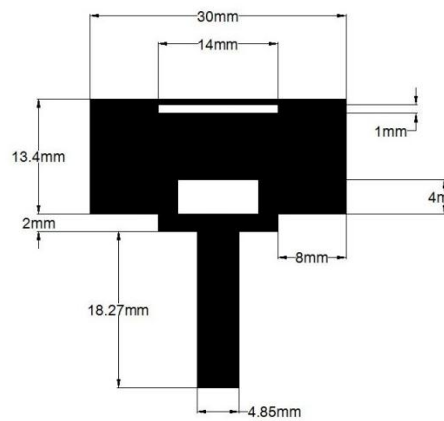
The paper is divided into following sections; section I presents introduction & literature review. Section II shows the proposed antenna geometry. In section III, the simulated results and parametric analysis are discussed. Radiation patterns are also shown in this section and in section IV, the paper is concluded.

Antenna Design

In this section, the design of the antenna is explained. The major objective to be achieved through this design was to cover complete UWB range i-e. (3.1-10.6GHz), when the body phantom is attached. Antenna is fabricated on a substrate having relative permittivity of 2.2 and tangent loss 0.0009. The thickness of substrate is 1.577mm and the copper cladding is 0.0175mm.

Figures 1 shows that antenna is operating in UWB without body phantom and fig. 2 represents the modified antenna which is covering complete UWB with body phantom. Figure 1 (a) and (b) are top and bottom view of UWB antenna without phantom. Figure 2 (a) and (b) show top and bottom view of antenna with phantom respectively. The software used for simulation is HFSS (High Frequency Structural Simulator).The dimensions of the patch are 30 x 15.4mm and the dimensions of ground plane are 35 x 16.5mm. Microstrip line is used as feeding method.

As shown in the fig. 1(a), the patch consists of two slots having dimensions 9.5 x 4 mm and 14 x 1mm respectively. These slots are introduced in order to make the antenna wideband. Two slits of 8 x 2 mm are present on both sides of patch. Partial ground plane technique is used. The ground plane has a slot pattern of varying dimensions. It is also shown in fig. 1 (b). The antenna covers the entire UWB range. The results will be discussed in detail in the next section.



Top view (a)

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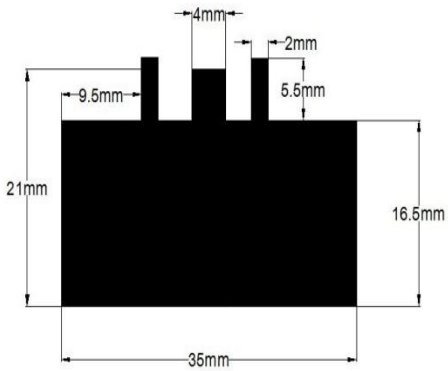
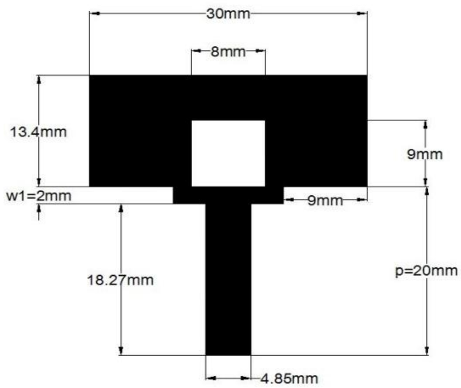
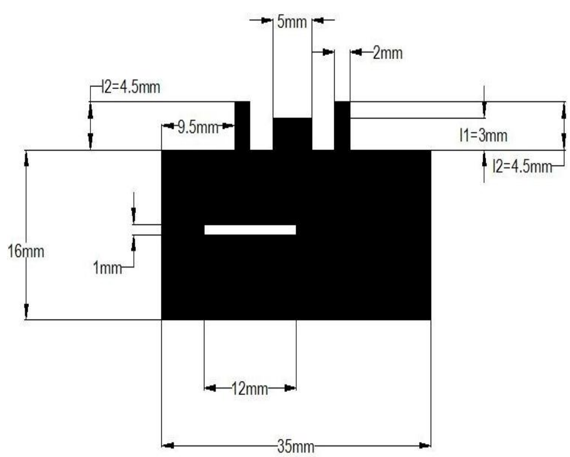


Bottom View (b)

Fig. 1 UWB Antenna without body phantom.



Top View (a)



Bottom View (b)

Fig. 2 Modified UWB Antenna with Body Phantom

Results

In this section, the results obtained by simulating the antennas presented in fig. 1 and 2 are shown. HFSS is used for the simulation. These results include return loss plots and radiation pattern of the proposed antenna.

Figure 3 shows the return loss plot when the skin layer is attached to the antenna. A comparison of the return loss of the antenna shown in fig.1 with and without body phantom is displayed in fig.3. It can be seen that the results are completely changed and the antenna no longer covers the UWB range. It is now a narrow band antenna. It is now operating from 3.2 to 3.8 GHz. This antenna design needs to be modified.

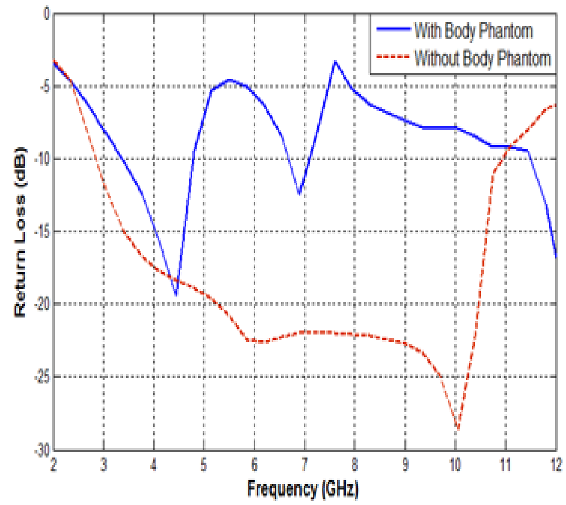


Fig. 3 Return Loss

Figure 4 shows the results of the modified antenna for BAN applications. In this plot, the antenna again covers the complete band with the addition of skin layer.

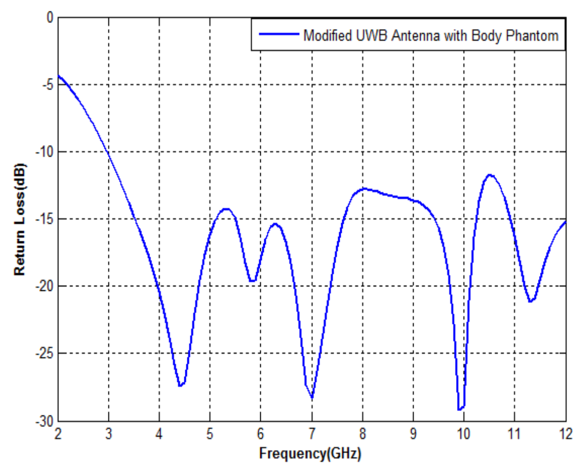
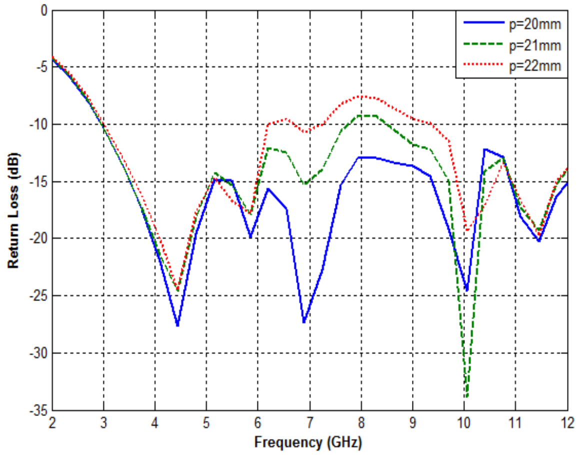


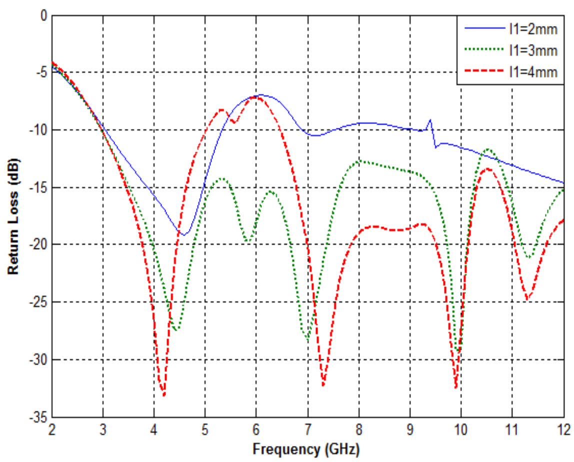
Fig. 4 Return Loss

Parametric Analysis

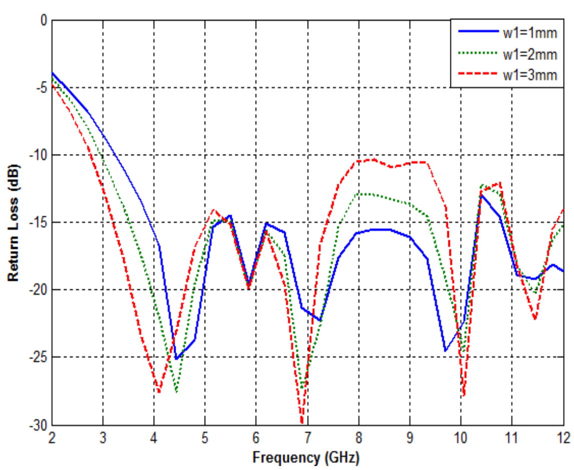
After obtaining the desired results, parametric analysis is performed. It basically presents the results by varying the dimensions and the positions of different slots on the patch and the ground plane. Figure 5 (a) shows the results when the position p of the slot on the patch is changed. When p is increased from 20mm to 22mm, then antenna does not operate in the region from 6.2 GHz to 9.5 GHz. In the similar fashion fig. 5 (b) displays the change in results when length l1 of the strip present in the middle of ground plane is changed. When it is decreased to 2mm then frequency band from 5.2 GHz to 9.2 GHz is not included in antenna's operating region. Similarly fig. 5 (c) presents the results when width w1 of the slits in the patch is changed. Fig. 5 (d) shows the results obtained by changing the length l2 of the strips in ground plane. On increasing this length the starting operating frequency moves to higher frequencies.



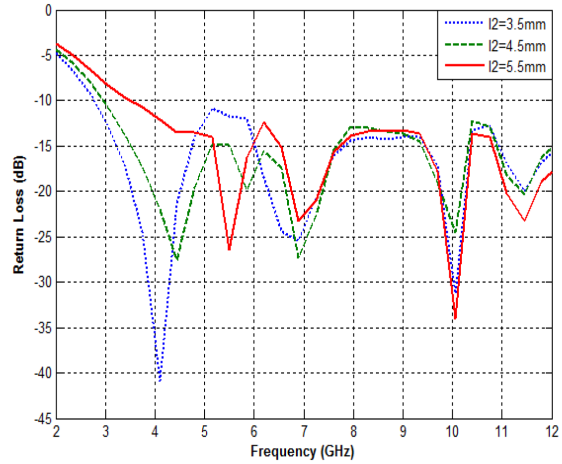
(a) Variation in parameter p



(b) Variation in parameter l1



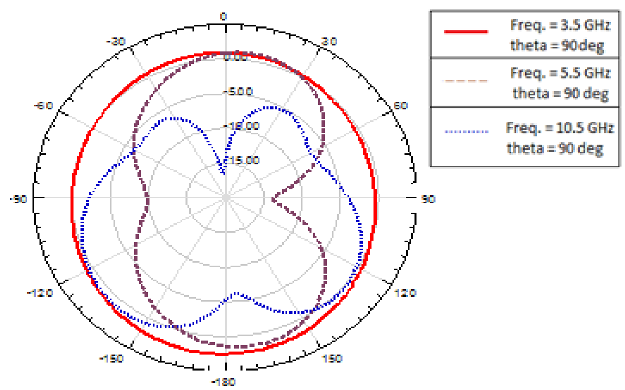
(c) Variation in parameter w1



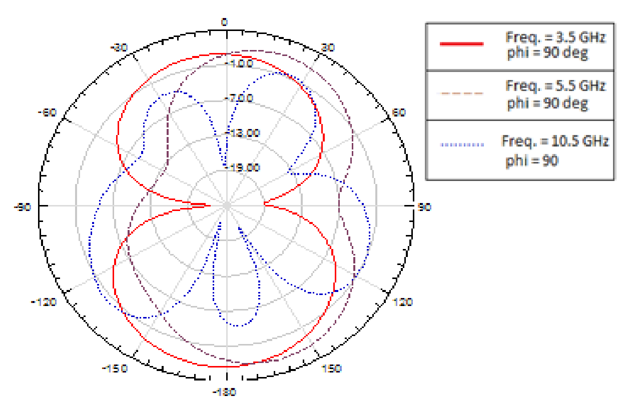
(d) Variation in parameter l2

Fig. 5 Parametric Analysis

In fig. 6 radiation patterns in XY, YZ and ZX axis are shown respectively. Figure (a) shows radiation pattern in XY plane, radiation pattern in YZ plane is presented in fig.(b) and fig. (c) displays the radiation pattern in ZX plane. These radiation pattern show that radiated power is not in a particular. It is non directional..



XY Plane (a)



YZ Plane (b)

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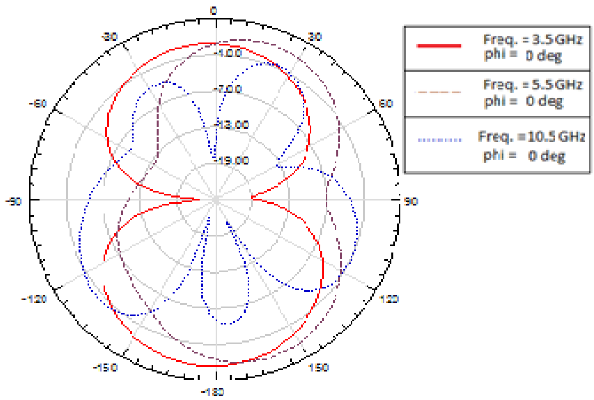

ZX Plane(c)

Fig. 6 Radiation pattern

Conclusion

A microstrip patch antenna for BAN applications is designed which covers the complete UWB range i-e. 3.1-10.6 GHz. Comparison between a simple UWB antenna and BAN antenna is also shown. All the related results are shown and discussed in this paper.

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