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A Triple-Band EBG Integrated Antenna For Wearable Applications

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ABSTRACT: The Electromagnetic Band Gap (EBG) structure integrated with microstrip patch antenna is designed for various wearable applications. This antenna resonates at three bands 2.81GHz,7.72GHZ and 8.64GHz which supports the ISM band and for military applications. The EBG integrated antenna structure has the dimensions of 90 x 90mm which minimizes the size of the antenna. Specific Absorption Rate (SAR) value has also been determined to evaluate the absorption of radiation onto the human body which is a useful calculation for wearable applications.

KEYWORDS: Triple-band, Electromagnetic BandgapStructure (EBG), Miniature in size, Specific Absorption Rate (SAR), Wearable antenna,HFSS.

I. INTRODUCTION

An antenna is any structure or device used to collect or radiate electromagnetic waves. Wearableantenna is an emerging technology that finds application in many fields that include military, telemedicine, sports and tracking.The function of the antenna varies according to the substrate like jeans,cotton,polyester which has been used.

The characteristics of each substrate reacts differently with the human body since it is proximity to it. The waves generated by the human body which is a nature of it leads to a frequency detuning when a dielectric material is placed closed to it.

Many ways can be carried to reduce the detuning effect and improvise the antenna's performance. EBG structures or Artificial Magnetic Conductor(AMC) provides a very good performance on the reduction of those effects. The EBG structures are also successfully utilized in antenna arrays for reducing the mutual coupling between elements of the array.

To obtain an effective performance antenna for wearable applications, the size of the structure should be small enough. For an efficient antenna structure, the gain should be high.

Specific Absorption Rate (SAR) plays a vital role in antennas used for wearable applications. SAR is the amount of energy absorbed by the human body while a high dielectric elements is placed close to it. SAR value is limited to 1.6W/Kg according to the specified standard. Lesser the SAR value, better the performance of the system. In order to minimize the SAR value, the EBG layer is used in this proposed system.

II. RELATED WORKS

In literature , a fractal based EBG integrated antenna has been designed which operates at dual band of frequencies. It covers the GSM and ISM bands. The system has been integrated with EBG or AMC structures which eliminates the detuning effects.

The EBG array is packed with 3 x 3 which increases the size of the antenna element

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accordingly. Various substrates have been used for the dielectric material which produces in effect with the performance.

SAR analysis is also carried out in previous papers by comparing the values obtained while testing the element with an EBG layer and without an EBG layer. From the analysis , conclusion has been made that the SAR is limited while employing the EBG.

Scope of the Research

For military communication satellites, the International Telecommunications Union (ITU) has assigned the X band uplink frequency band (for sending modulated signals) as from 7.9 to 8.4 GHz. The ITU-assigned downlink frequency band (for receiving signals) is from 7.25 to 7.75 GHz.

This structure enables us to employ in such military applications which covers the X-band (7.72GHz). And it can also be employed in applications using the ISM band frequencies.

Proposed System

This proposed system antenna is simulated through the HFSS tool.The microstrip patch antenna is designed on substrate which is taken as jeans with a thickness of 1.6mm and with a dielectric constant = 1.7 and andtanδ = 0.085. The patch is assigned with a copper material and it is designed with the dimensions that are shown below:

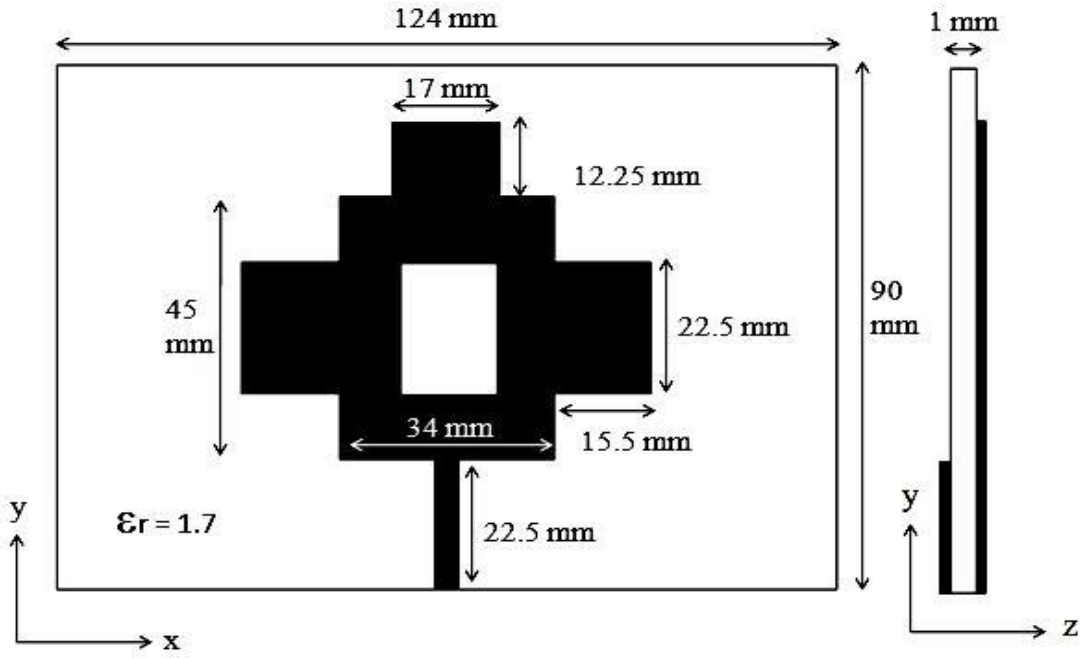

Fig. 1. Dimensions of microstrip patch antenna

The feed for the element is given in the x-z plane. For a microstrip patch antenna, the microstrip feed is given in the edge of the element.

The EBG array of 2x2 is designed on the jeans substrate (1). Above the EBG layer, another

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substrate (2) is employed to place the patch. In order to avoid the contact between two finte conductive material, the substrate (2) is designed.

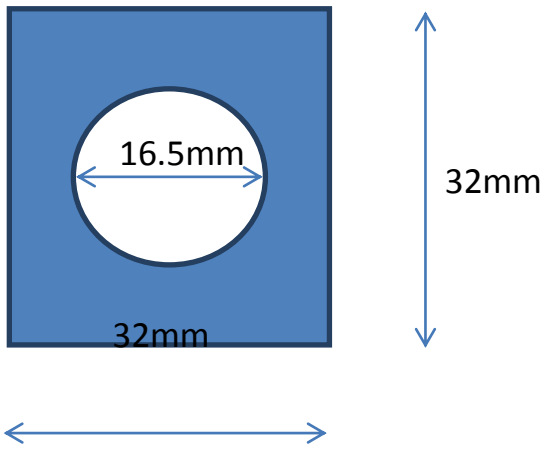
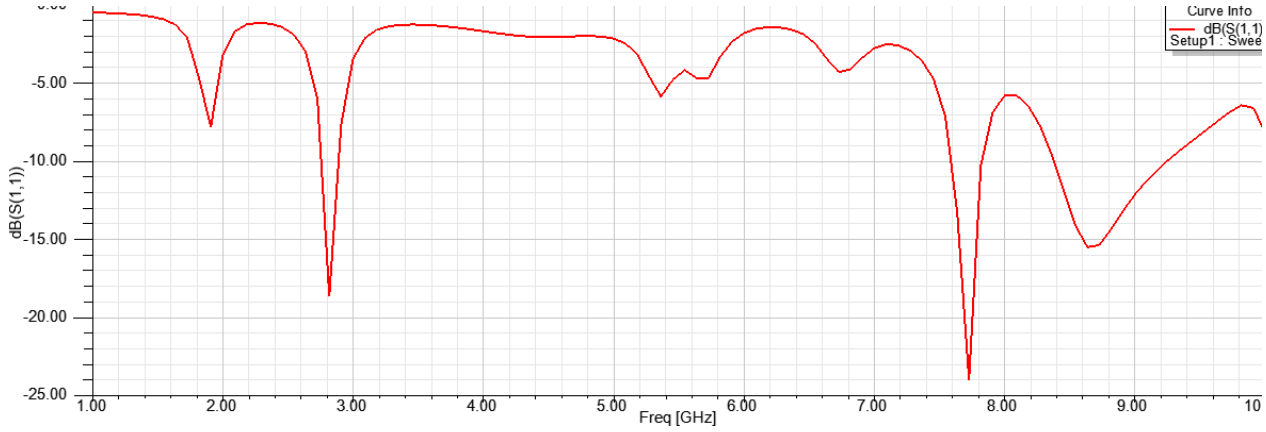


Fig.2.Dimension of a EBG unit cell

III. EXPERIMENTAL RESULTS

The entire structure along with the EBG resonates at triple bands. Various antenna parameters results for the designed antenna is depicted below.

1. Reflection Coefficient



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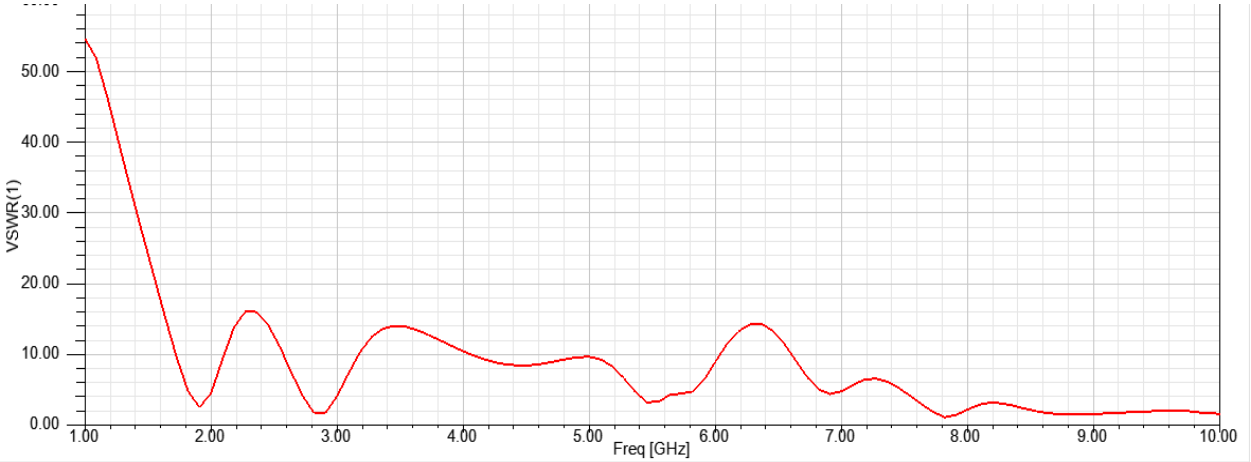
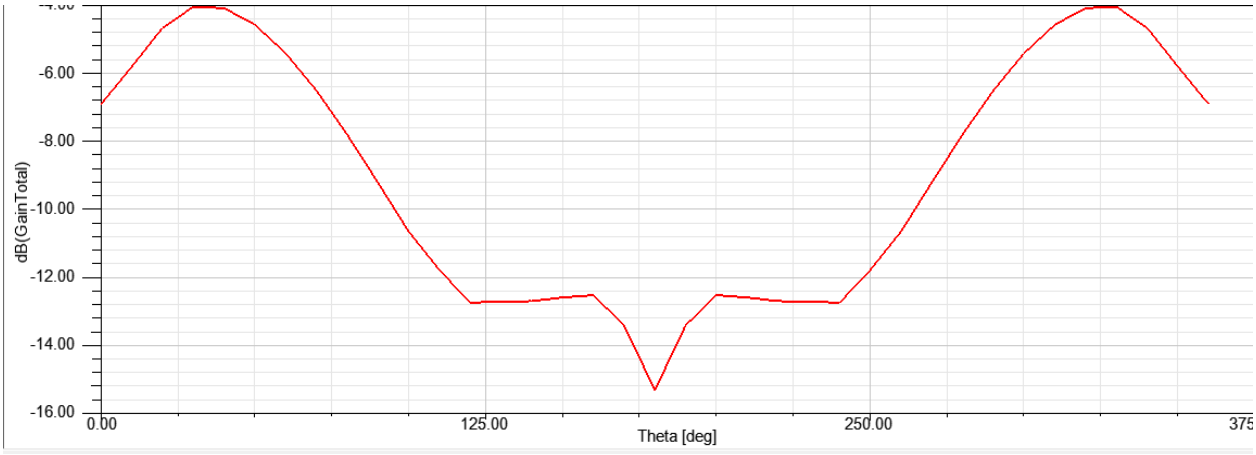
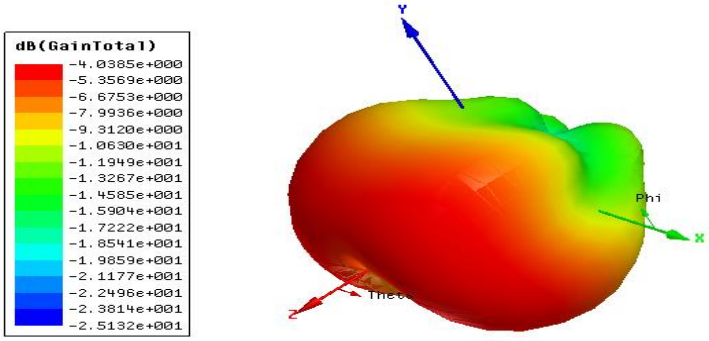
2.VSWR



3.Gain



4.Gain – 3D Plot



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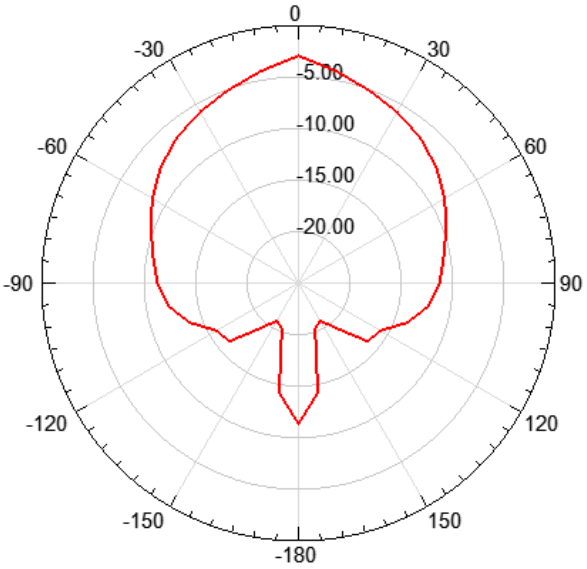
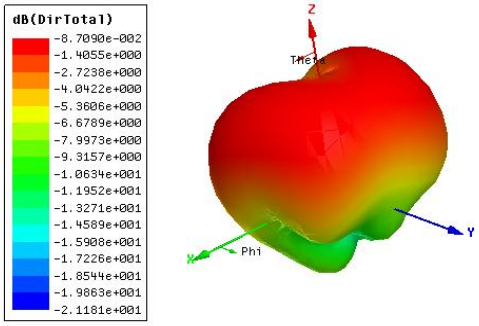
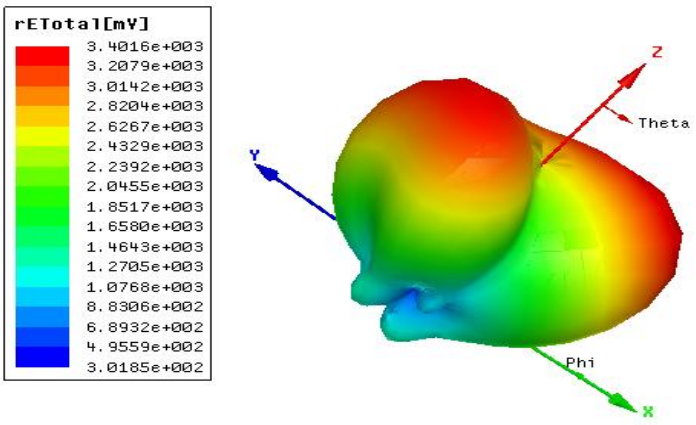
5.Directivity



6.Directivity – 3D Plot



7.Radiation Pattern



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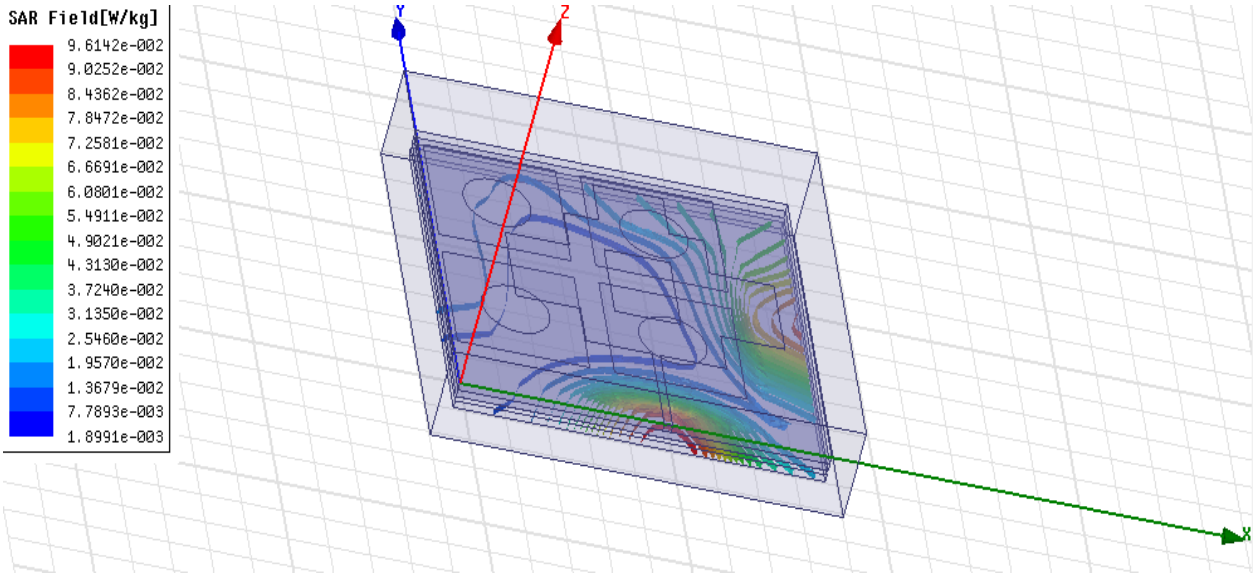
8.Specific Absorption Rate (SAR)



IV. CONCLUSIONS

From the simulated results of the designed EBG structured antenna, it has been observed that it resonates at triple band. The band reject characterization of an EBG layer corresponds to the reflection coefficient response. Though the size of the antenna is reduced, it attains high gain value. SAR analysis is also performed to validate the usefulness of the model for wearable applications. In this system, the SAR value has been reduced to 0.096W/Kg which comes under the standard limit.

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