Wearable Button Antenna For Dual Band Applications

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***Abstract*— A Wearable Button Antenna for dual band application is presented in this paper. The designed antenna is working in 7GHz (C band)and 9 GHz(X band) frequency bands. We design the frequency bands with micro strip feed. The antenna satisfies -16 DB at 7 GHz and -26 DB at 9 GHz. This antenna exhibits good VSWR, better impedance and satisfied gain. The design is simple, compact and can be used for wearable applications in both bands.**

***Keywords*—dual band , wearable ,micro strip, slot**

I. INTRODUCTION

Antennas are essential component of any communication systems. Wearable antennas have gained attractions in many of the fields in recent years. A wearable antenna is one that is designed to function when it is being worn. These antenna can serve as part of our clothes and used for many purposes. There are few challenges associated with this wearable antenna. It should not interrupt the movement of the wearer. Since human body is loss material for electromagnetic waves, it absorbs electromagnetic waves and converts the electric energy into heat energy. Therefore ,the efficiency of the antenna may get reduced. It is a micro strip feed antenna with circular patch and filleted edges on the substrate. The edge filleting of substrate helps to alter the sharpness and shape of the edge and provide smooth transitions between faces of the substrate. The design has circular radiating patch and resembles button shape. Since this design resonates in C band and X band, it can be used in many applications such as satellite communication, military defence tracking ,weather radar systems and wireless computer networks.

II. LITERATURE SURVEY

Antennas are the integral part of the wireless communication .Antennas have the capability to transmit and receive signals. With the advancements in technology ,Wearable antennas play a vital role in wide array of fields. These antennas have the capability to operate in more than bands.[1][2].The proximity to human body is the major challenge associated with this wearable antenna. [3]Wearable antenna should not interrupt the movement of the wearer .This antenna resembles a button shape due to its circular patch. Button antennas can also be integrated with clothes at several specific locations around the human body[4]. Button antennas [6]have several advantages compared to textile antennas. Textile antennas[5] are the special type of antennas that are partially or entirely made up of textile material. Button antennas are rigid in most of the circumstances. PTFE Taconic ceramic material [7] is used as the substrate in the design. The substrate is edge filleted to obtain a perfect shape. The slots in the circular patch helps the antenna to resonate in dual bands such as C Band and X Band[8].C Band frequency ranges from 4 -8 GHz. C Band has main application in satellite

communication[9].X Band frequency ranges from 8 -12 GHz. The applications of X Band [10]such as weather radar systems, military defence tracking etc.

III. ANTENNA DESIGN

The proposed antenna is designed in the form of radiating circular patch so that it gives the shape of a normal button. The

substrate used to design the wearable button antenna is the PTFE TACONIC substrate with a thickness of 3.18 mm and it has a

permittivity of 10. The Taconic substrate is an organic ceramic laminate. It is denoted as Taconic CER-10. The benefits of using

this substrate is it has exceptional inter-laminal bond, low moisture absorption, enhanced dimensional stability and circuit board miniaturization. The copper is used as a material for the radiating circular patch and the ground plane is also made of copper .The circular patch has a diameter of 20.24mm. The edge of the substrate is edge filleted in order to obtain the shape of a button. Here we are using copper because it is the efficient conductor of electrical energy. The feed used here is the micro strip feed. The proximity to the human body is reduced by designing the entire ground plane on the bottom patch.

Two slots with radius 1.8mm and 2mm are designed on the patch. The two slots are drawn into the circular patch to have dual band resonance and gain enhancement. The circular radiating copper patch and the feed has been united. These slots are used to resonate the antenna at two different bands that is the C band (7 GHz) and the X band (9 GHz).

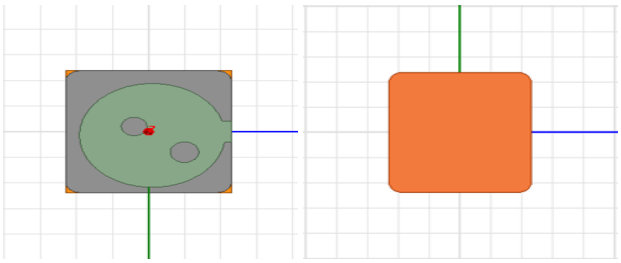

Fig 1: Antenna structure
(a)Top View
(b)Bottom View

IV.DESIGN EQUATIONS

The radius of the circular patch is obtained by the following equation:

$$a = \frac{F}{\sqrt{\left\{1+\frac{2h}{\pi\varepsilon_r}\left[ln\left(\frac{\pi F}{2h}\right)+1.7726\right]\right\}}}$$

$$F = \frac{8.791 \times 10^9}{f\sqrt{\varepsilon_r}}$$

Where h is the height of the Taconic substrate

f is the cut-off frequency

TABLE I

Dimensions of Antenna

Parameters	Dimensions (in mm)
Radius of patch	11.15
Length of substrate	23.73
Width of substrate	23.05
Height of substrate	3.18
Slot1	2
Slot2	1.8

IV.RESULTS

1) Return loss

It is the proportion of radio waves arriving at antenna input that are rejected as a ratio against that are accepted. It is also called reflection coefficient and S parameter

This design produces good return loss of -16 dB at C Band and -26dB.Fig.2 shows the reflection coefficient results of the designed antenna

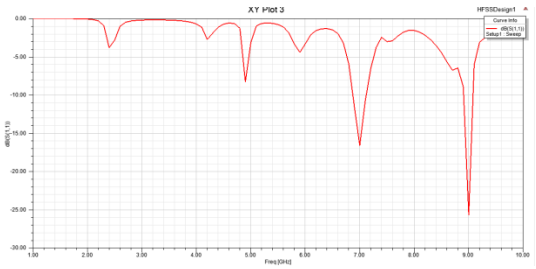

Fig. 2: Return Loss vs Frequency

2) VSWR

It is the Voltage Standing Wave Ratio. It is the function of the reflection coefficient .Smaller the VSWR, better the antenna is matched to the transmission line and more power is delivered to the antenna. This design produces 1.4 at C Band and 1.2 at X Band. Fig 2 shows the VSWR results of the designed antenna .

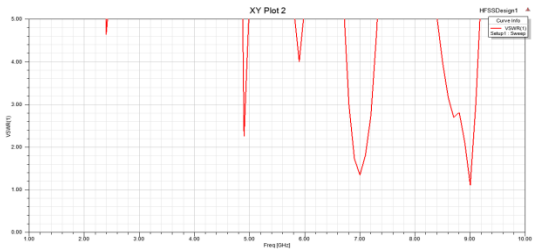

Fig 3: VSWR vs Frequency

3)Radiation pattern

This antenna produces unidirectional radiation pattern at C band and Omni directional radiation pattern at X Band. Fig 3.shows the radiation pattern at 7 GHz and Fig 4 shows the radiation pattern at 9 GHz

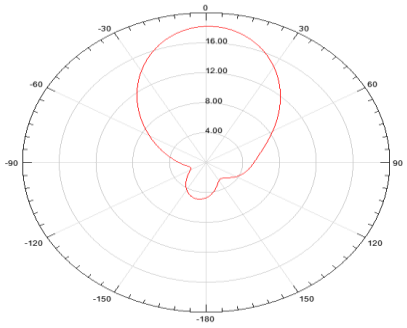

Fig. 3: Radiation Pattern at 7 GHz(C Band)

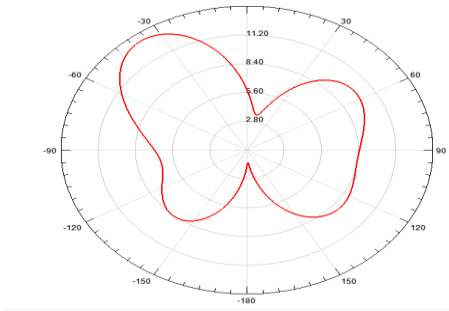

Fig. 4: Radiation Pattern at 9 GHz(X Band)

4) Bandwidth

It refers to the range of frequencies over which antenna can operate efficiently. This antenna produces good bandwidth of 250MHz at C Band and 170 MHz at X

Band. Fig 5 shows the Bandwidth results of the designed antenna.

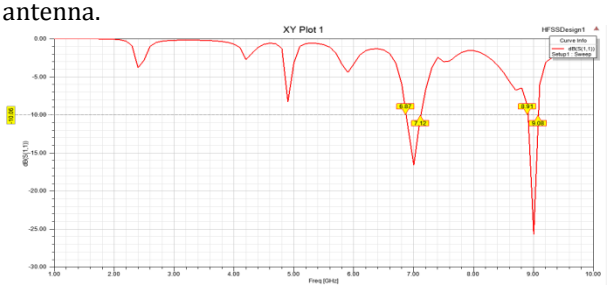

Fig. 5: Bandwidth vs frequency

V.SAR CALCULATION

SAR is the measure of allowable level of the electromagnetic waves to be produced by the antenna. The safety level of SAR is 1.6 W/Kg which is declared by FCC (Federal Communication Commission).This wearable dual band button antenna has a SAR value of 1.5 W/Kg. If the SAR value is more than the specified level then it may affect the human body. Fig 5.(a) shows the

Radiation distribution on human body.(b) shows the SAR results of the antenna.

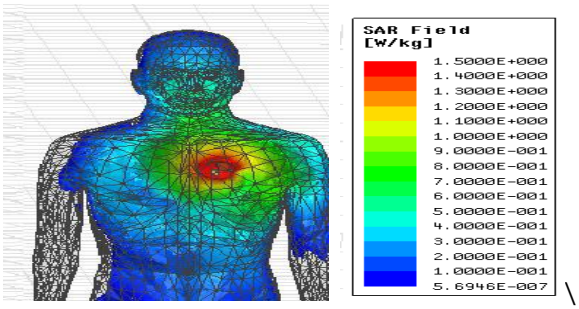

Fig 5.(a) (b)

IV.FABRICATED ANTENNA

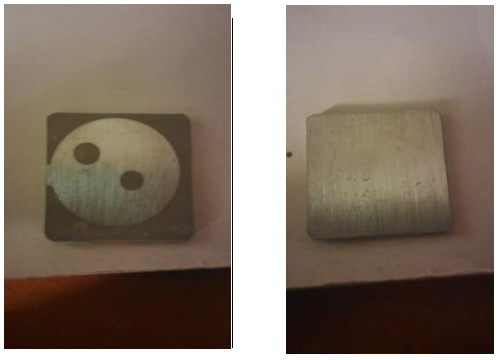

Fig 6.(a) (b)

Fig 6: Antenna structure

(a) Top View
(b)Bottom View

TABLE II
OBTAINED RESULTS

PARAMETERS	VALUE
GAIN	5.6dB
EFFICIENCY	84%
RETURN LOSS	-16 dB (C BAND) -26 dB (X BAND)
VSWR	1.4 (C BAND) 1.2(X BAND)
BANDWIDTH	250 MHz(C BAND) 170 MHz(X BAND)
SAR	1.5 W/Kg

VI.CONCLUSIONS

The Dual band button antenna is proposed for wearable applications. The antenna is made of copper ground and patch which makes it a good conductor of electricity. The prototype of this antenna has been fabricated. It has an increased efficiency and very good gain. The simulated results matched well with the fabricated results

VII.:REFERENCE

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