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Research paper

Dual-band CB-CPW FED on-body antenna for wearable WBAN applications

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Abstract

In the article introduced the recent split ring resonator (SRR) loaded with bottom grounded coplanar waveguide fed patch element for wire-less body area network or healthcare monitoring applications. The main problems of existing antennas are the low gain and band widths. The metamaterials loaded antenna or split ring resonator loaded antenna had high directive gain and bandwidth. The premeditated patch an-tenna operated at resonated frequency 2.4GHz and 3.5GHz. The implemented outcomes for the magnitude of reflection coefficient are -20dB at 2.4GHz, -18dB at 3.4GHz for non-metamaterials loaded structure,-15dB at 2.3GHz and -22dB at 3.5GHz for metamaterials loaded antenna respectively. The patch requisite characteristic like far-field pattern, magnitude of scattering parameter and voltage standing wave ratio for the proposed antenna is presented.

Keywords: *Split Ring Resonator (SRR); Biocompatible Substrate; Conductor Backed Coplanar Waveguide (CBCPW); Wireless Body Area Network (WBAN).*

1. Introduction

The proposed antenna consists asymmetrical, bottom grounded coplanar waveguide fed patch element, with negative index material loaded at bottom sided patch. The problem of existing antenna is low gain and compatibility. But this proposed SRR loaded antenna overcomes these problems. The main advantage of SRR loaded antenna had high gain and band width, as compared to the conventional antenna. The permeability of SRR loaded antenna was negative at the resonance. The Teflon used as antenna fabrication material. It was a biocompatible material hence it can use for on-body monitor applications.

New advanced wireless and micro- sensor technology are enabled cost effective communication. The cost effective communication required cost effective design and manufacturing technique. The Teflon was largely available in market as well as low cost of material. The proposed antenna embedded in the modern healthcare device.

The on-body contrivance can without difficulty interface with WI-FI WIMAX, WLAN and other wireless communication technology [1] as shown in Fig.1.The medical WBANs network communication are three stages , first stage was implantable stage- the equipment communicating inside the device, second stage called as on-body communication stage-the equipment communicated between on the surface of body. Third stage known body external communication- equipment communicated between on-body and external device called body-external communication [2].

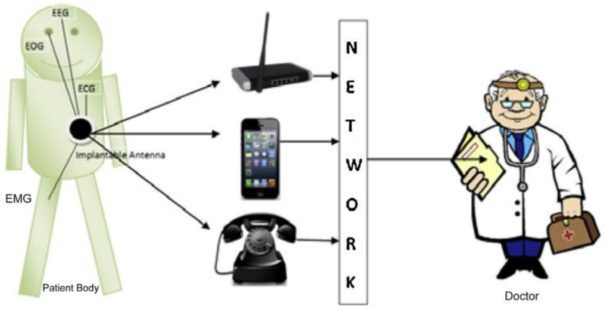

Fig. 1: Interface in Patient Body & other Communication Network [9].

In this paper ordered as part, [2] included explanation for geometrical design of proposed antenna and also indicated the geometrical demonstration of proposed structure. The third part of this paper discussed on the simulation results and implementation. The division 4 is the wrapping up part of the article- talk about future scope of on-body EM radiator for the field ISM, WiMAX band communication.

2. Dimension and layered structure

The common path of reducing the size of the wearable patch was-used as biocompatible substrate material and SRR loaded technique. The proposed antenna designed by biocompatible Teflon substrate. It enhances the directive gain of given antenna. The electrical characteristic (effective dielectric constant) for bio-layer was 53.65 at 2.4GHz, and sigma is 0.91(s/m) at 2.4GHz [7, 8]. The proposed antenna layered structure mention in Fig.2, Fig.3.The SRR loaded technique mentioned in Fig.4. The patch dimension is shown in Fig.5 and Fig.6, Table I respectively. The Comparison results of other bio-medical antennas are shown Table

II. The skin, fat and muscle layers are highly depended on resonant frequencies. That means it is influenced on the value of dielectric constant

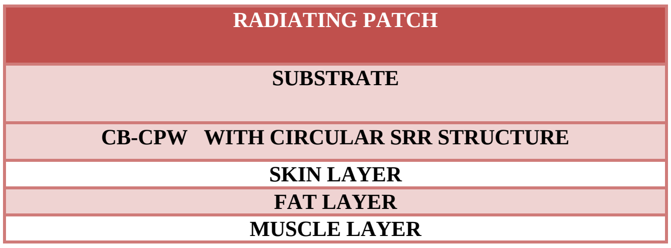

Fig. 2: The Projected Layered Model.

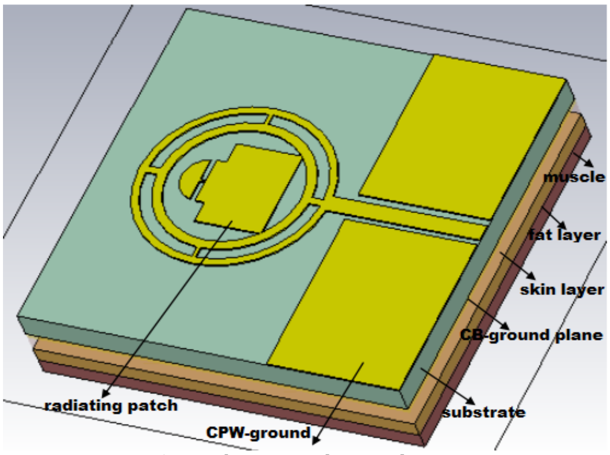

Fig. 3: The Projected Layered View.

Table 1: The Proposed Dimension for Given Structure.

Antenna Dimension	Value(Mm)
Q	20
W	13
E	7
R	13
T	10.7
Y	9.1
U	20
I	2.5
O	3.5
P	6
A	4
S	0.5
D	0.5
F	0.5
G	0.5
H	6.2
J	4.6

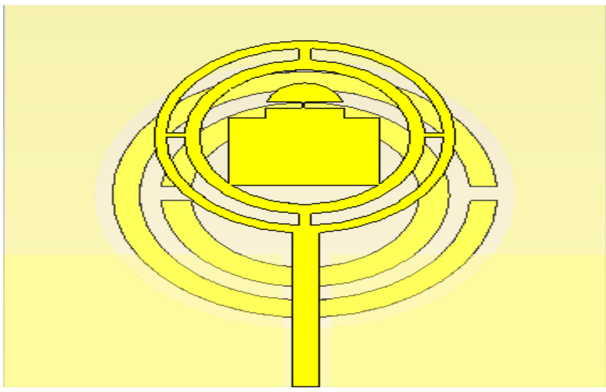
Fig. 4: SRR Loaded Technique for Projected Shape.

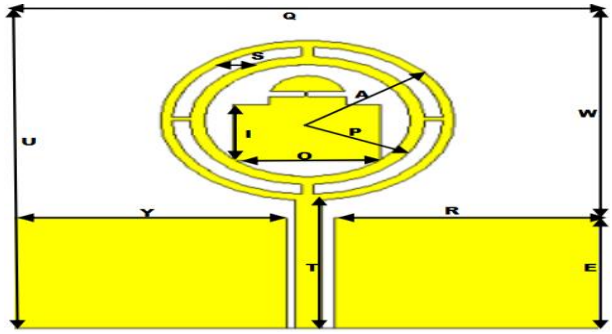

Fig. 5: Projected Model- [A] Front View.

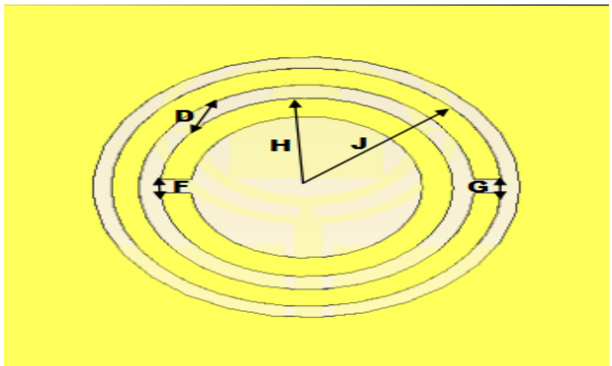

Fig. 6: [B] Backside View.

3. Results and discussion

The antenna is computer-generated while implement on body for wearable WBAN applications. The premeditated antenna is implementing on the skin, fat and muscle layers. Few antenna parametric results are discussed as given below.

3.1. Magnitude of reflection coefficient

The given designed antennas resonate at a resonating frequencies and it's corresponded magnitude of reflection coefficient are -20dB at 2.43GHz,-18dB at 3.37GHz for non-negative indexed loaded projected model,-30dB at 2.31GHz and -22dB at 3.54GHz, for negative indexed projected model, are shown in Fig.7,8.

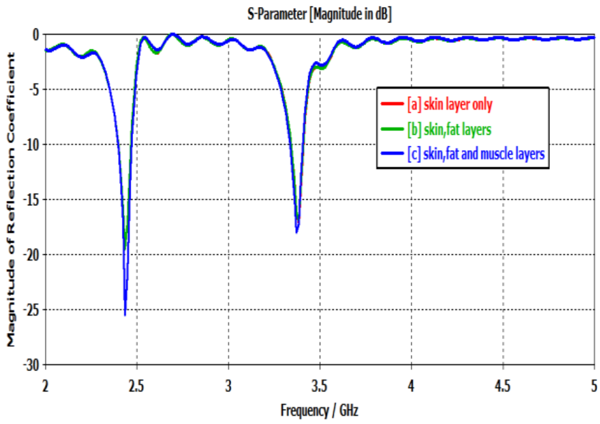

Fig. 7: The Graph Indicated Reflection Coefficient - [A] Skin Layer without SRR[B]Skin and Fat Layer, [C] Skin, Fat and Muscle Layer.

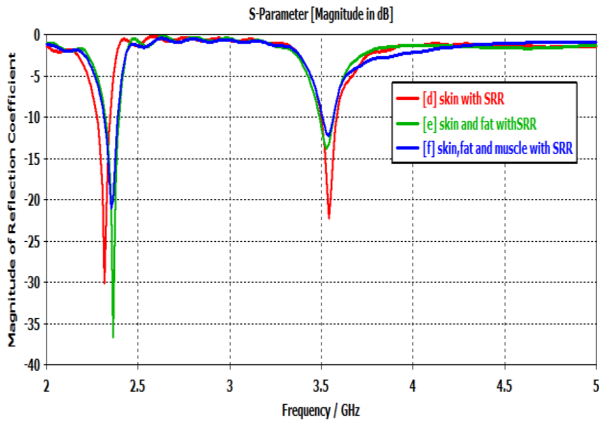

Fig. 8: The Graph Indicated Reflection Coefficient-[D] Skin Layer with SRR [E] Skin and Fat Layer, [F] Skin, Fat and Muscle Layer.

3.2. Voltage standing wave ratio

The VSWR values are 1.32 at 2.43GHz and 1.25 at 3.37GHz for non-SRR loaded proposed antenna, 1.06 at 2.31GHz and 1.16 at 3.54GHz for SRR structure are shown in Fig.9, 10.

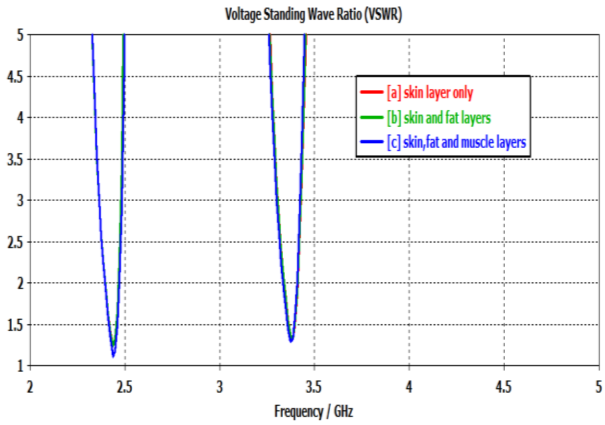

Fig. 9: The Graph Indicated VSWR- [A] Skin Layer without SRR [B]Skin and Fat Layer [C] Skin, Fat and Muscle Layer.

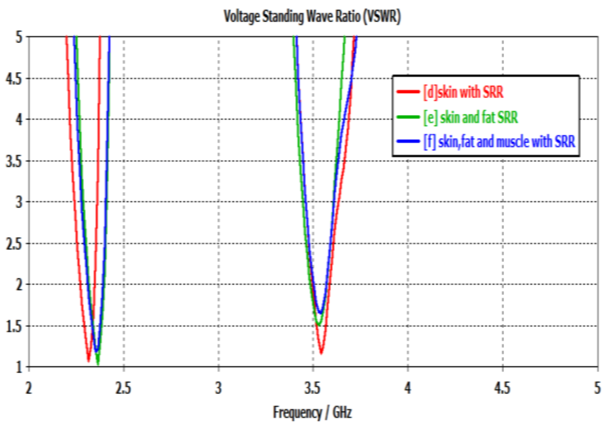

Fig. 10: The Graph Indicated VSWR- [A] Skin Layer with SRR [B] Skin and Fat Layer [C] Skin, Fat and Muscle Layer.

3.3. Far field gain

Electromagnetic signal are absorbed by human tissue. The rate at which the energy gain by tissue called specific absorption rate, due to this wearable antenna gain is reduced some amount [6]. This amalgamation is related to the working frequencies are shown in Fig.11, 12. The designed antenna directive gains are 1.5dBi at 2.43GHz, 5.2dBi at 3.54GHz for non-negative indexed material loaded projected model, 2.2dBi at 2.31GHz and 4dBi at 3.38GHz, for negative indexed loaded projected model.

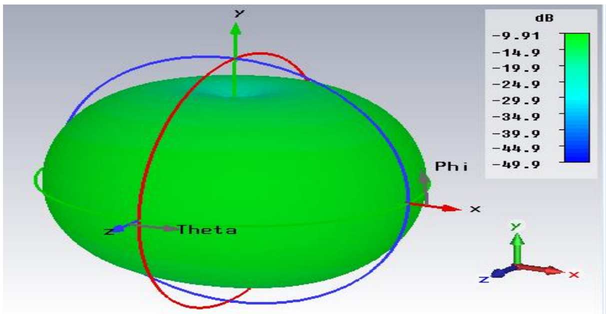

Fig. 11: Gain in ISM Band- 2.43 GHz.

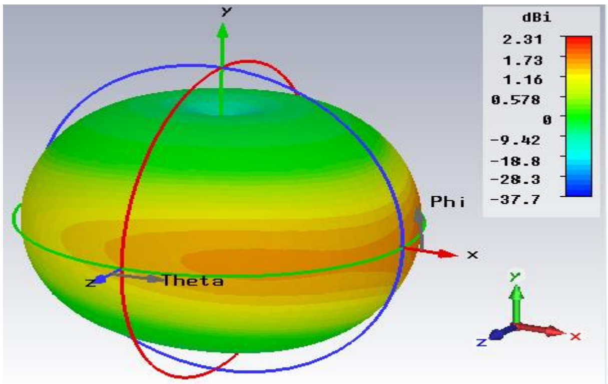

Fig. 12: Directive Gain in ISM Band - 2.43 GHz.

3.4. Angle of radiation plot

The angles of radiation plot are computational and graphical model of on-body antenna at long or near field distance. The angle of electric field, magnetic field plane pattern and other field pattern graph are publicized in Fig.13-16.

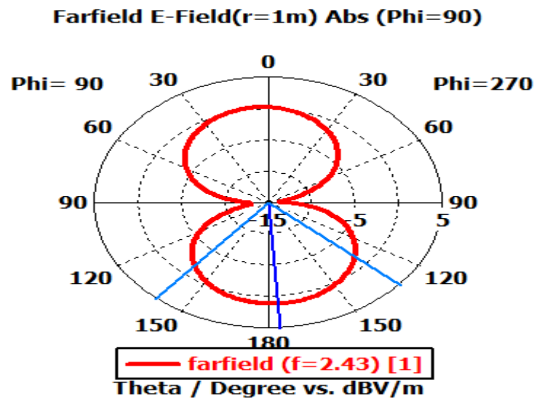

Fig. 13: Angular E-Field at 2.43 GHz.

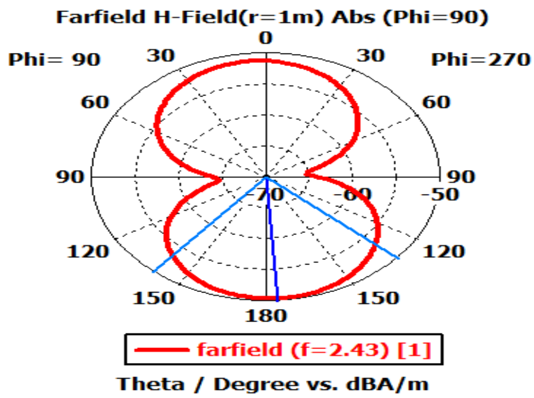

Fig. 14: Angular H-Field at 2.43 GHz.

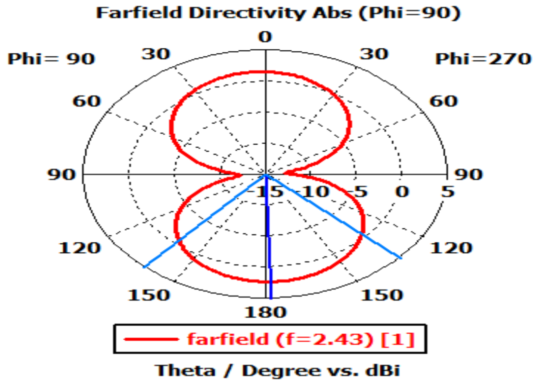

Fig. 15: Angular Plot for Directivity at 2.43 GHz.

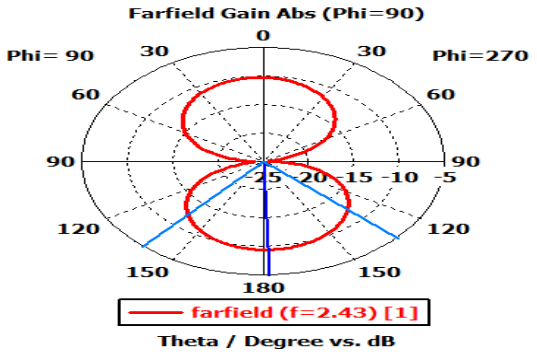

Fig. 16: Angular Plot for Gain at 2.43 GHz.

Table 2: Simulation Results of Different Bio-Medical Devices under Test

Ref.	Volume [mm^3]	Gain[dB]	bandwidth [MHz]	Dielectric Materials
[3]	15240	-16	12	ARLON1000
[4]	10240	-	20	Rogers3120
[5]	6480	-	20	RT/duroid6002
[7]	1265.6	-25	142	Rogers3120
Prop. Ant. without SRR loaded with skin layer f=2.43GHz	640	-10	70	Teflon
Prop. Ant. without SRR loaded with skin layer f=3.37GHz	640	-2	60	Teflon
Prop. Ant. with SRR loaded with skin layer f=2.31GHz	640	-14	80	Teflon
Prop. Ant. with SRR loaded with skin layer f=3.54GHz	640	-3	100	Teflon

4. Conclusion

The SRR asymmetrical CB-CPW fed multilayered dual band antenna is designed in this paper used for wearable WBAN applications. The premeditated antenna by and large volume is 20x20x1.6mm^3, and replicated results for the reflection coefficient are -20dB at 2.4GHz, -18dB at 3.4GHz for non negative index material loaded projected model,-15dB at 2.3GHz and -22dB at 3.5GHz for negative indexed loaded projected model respectively. These are ISM band, WIMAX band and WLAN band operated model used for medical communication and interfacing for other wireless networks.

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