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SRR Loaded CB-CPW Fed Antenna for Wearable WBAN and Interfacing Applications

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ABSTRACT

In this paper introduced the split ring resonator (SRR) loaded, conductor backed coplanar wave guide (CB-CPW) fed wearable antenna for glaucoma monitoring application and also used for interfacing with other wireless networks. The main drawbacks of existing antennas are the lower gain and poor radiation efficiency. This is SRR loaded antenna; hence, it had high gain, bandwidth and radiation characteristics. The designed SRR loaded technique exceptionally essential part for wearable transceiver module for healthcare monitoring. This antenna designed to fine-tune at resonating frequency 2.4GHz and 3.5GHz. The simulated results for the magnitude of reflection coefficient are -36dB at 2.46GHz, -14dB at 3.5GHz for non-SRR loaded structure,-36dB at 3.52GHz for SRR loaded with bio-tissue layered antenna, 35dB at 2.4GHz and 30dB at 3.56GHz for SRR loaded antenna without any bio-tissue layer respectively. The antenna required characteristic like such as far-field configuration, magnitude of reflection coefficient, VSWR and gain of the proposed antenna is presented.
Keywords: SRR, Bio-Compatible Substrate, CB-CPW, Specific Absorption Rate (SAR), Wireless Body Area Network (WBAN).

I. INTRODUCTION

The designed antenna consists of asymmetrical conductor backed coplanar waveguide (CPW) fed, two ground plane and central conductor are laid in same plane with different dimension. It is placed on the top of biocompatible substrate called Teflon. The split ring resonator loaded at bottom side of this substrate. The problem of existing antenna is lower gain, poor radiation characteristics and compatibility. However, this proposed SRR loaded antenna overcomes these problems. The main advantage of SRR loaded antenna had high gain and bandwidth, as compared to the conventional antenna. The designed SRR loaded antenna was negative permeability at the main resonance. The Teflon substrate material can solved by biocompatibility issue, since it used for glaucoma and other health care monitoring applications [11].The wearable device can easily interface with WI-FI Bluetooth, WIMAX, WLAN and other wireless communication technology as shown in Fig.1. The medical WBANs network communication are classified as on-body/wearable communication, implantable /in-body communications, and off-body/external communication respectively [1], [2].

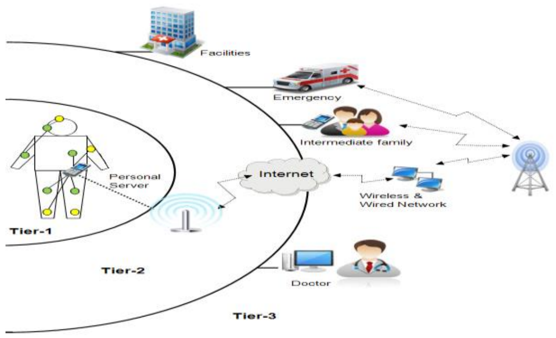

Figure 1: Interface in wearable WBAN & other wireless networks [1]

In this paper organized as Section II includes the explanation of the geometrical design of proposed antenna. The segment III indicated the geometrical revelation of proposed structure. The section IV of this paper point out on the simulation results and descriptions. Part V is the conclusion part of the paper.

II. MODELING AND DESCRIPTION

The conductor backed coplanar wave guide is the one of the quasi mode transmission line using in microwave printed circuits as well as in fabricated antennas, as signal carrying element. It consists of two identical ground plane and one middle metallic strip conductors are in the same plane. The effective dielectric constant and characteristic impedance of this line is given by [3].

$$\varepsilon_{reff,sub} = p(\varepsilon_r - 1) + 1 \tag{1}$$

$$z_o = \frac{30\pi y}{\sqrt{\varepsilon_{reff,sub}}} \tag{2}$$

The letter p is called the filling fraction, the expression for m depends on the shape of geometry and y is elliptical integrals [4],[5].

$$\varepsilon_{ref,sub} = \frac{\varepsilon_{r,sub}+1}{2} + \frac{\varepsilon_{r,sub}-1}{2}\left[1+12\frac{h}{w}\right] \tag{3}$$

The equation (3) indicates effective dielectric constant of substrate. This proposed antenna used a biocompatible substrate-Teflon with dielectric constant is 2.1 , thickness 1.6 mm, so as to resonate at 3.5GHz, then the width of single element of rectangular patch is given by[2],[6],[7].

$$W = \frac{c}{2f_{op}}\sqrt{\frac{2}{\varepsilon_{r,sub}+1}} \tag{4}$$

From equation (4) width of antenna 20mm obtained. Finally the effective length of a SRR loaded proposed antenna is calculated analytically [12].

$$L_{eff} = \frac{c}{2f_{op}\sqrt{\varepsilon_{r,sub}}} \tag{5}$$

From equation (5) the effective length of a SRR loaded proposed antenna is 20mm obtained. The relationship between permeability, permittivity and frequencies is given by equation (6) and (7).

$$\mu_b(\omega) = \mu_{ob}[1 - \frac{\omega_{pm,b}^2}{\omega_b\left(\omega_b - j\gamma_{m,b}\right)}] \tag{6}$$

$$\mu_b(\omega) = \mu_{ob}[1 - \frac{\omega_{pm,b}^2}{\omega_b\left(\omega_b - j\gamma_{m,b}\right)}] \tag{7}$$

III. LAYERED DESIGN

The electrical characteristic (effective dielectric constant) of the tissue is 53.65 at 2.4GHz, and conductivity is 0.91(s/m) at 2.4GHz [11]. The proposed antenna layered structure mention in Figure: 2, Figure: 3.The patch dimension is shown in Figure: 4, Figure: 5 and Table I respectively. The Comparison results of other wearable antennas as shown in Table II.

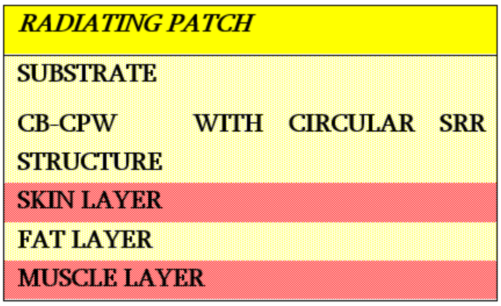

Figure 2. The Proposed Antenna Layers

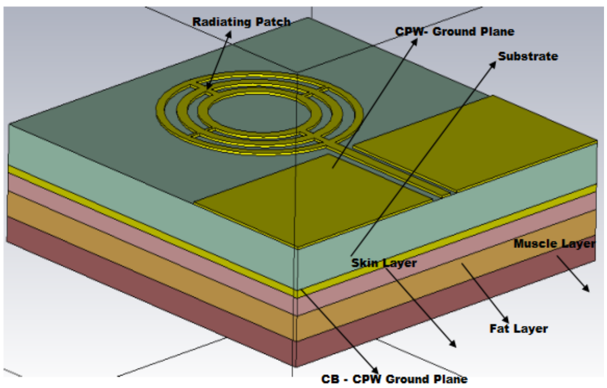

Figure 3: The Proposed Antenna Layered Structure

TABLE I: THE PROPOSED DIMENSION FOR GIVEN STRUCTURE

ANTENNA DIMENSION	VALUE(MM)
W	20
W_1	9.1
Q	6.7
R	5
E	8
D	1
N	10.7
L	20
L_1	6.4
N_1	3.6
H	0.8
H_1	1
M_1	6.5

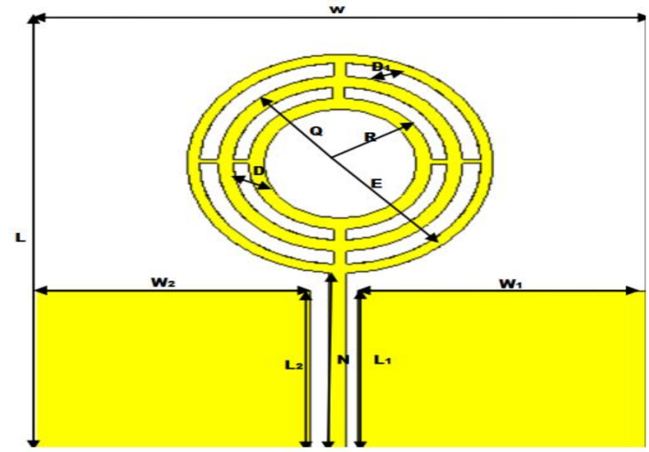

Figure 4. Geometrical Representation of SRR Loaded Proposed Antenna

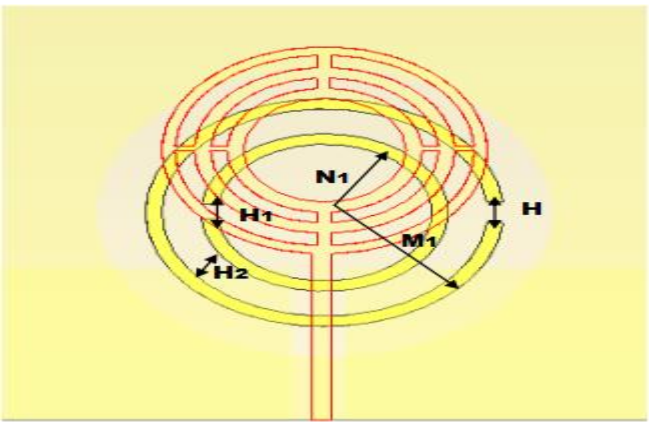

Figure 5. Geometrical Representation of SRR Structure for Proposed Antenna

IV. RESULTS AND DISCUSSIONS

The antenna is computer-generated while implement on body for wearable health monitoring or glaucoma inter ocular pressure (IOP) monitoring. The premeditated antenna is implementing on the skin, fat and muscle layer. Few antenna parametric results are discussed as give below.

A. Magnitude of Reflection Coefficient

The give designed antennas resonate at a resonating frequencies and it's corresponded magnitude of reflection coefficient are -36dB at 2.46GHz, -14dB at 3.5GHz for non-SRR loaded structure,-36dB at 3.52GHz for SRR loaded with bio-tissue layered antenna, 35dB at 2.4GHz and 30dB at 3.56GHz for SRR loaded antenna without any bio-tissue layered structure respectively. This magnitude of reflection coefficient parameter values are helped to interfacing between ISM band and other wireless network band. The magnitude of reflection coefficient for the proposed wearable antenna was shown in the Figure: 6, 7.

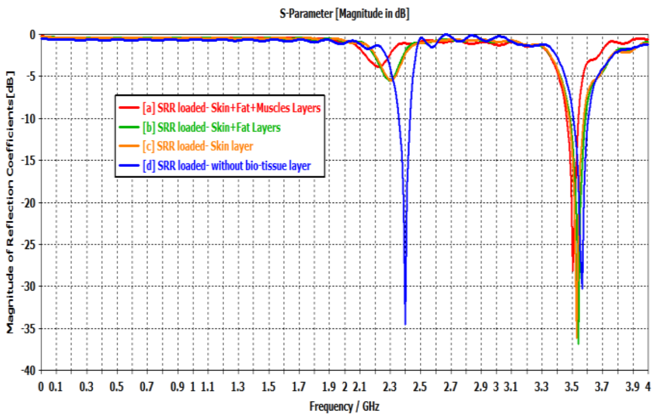

Figure 6. Magnitude of reflection coefficient versus frequency plot [a] Skin layer with SRR [b] Skin and fat layer, [c] Skin, fat and muscle layer, [d] SRR loaded antenna without any bio-tissue layers.

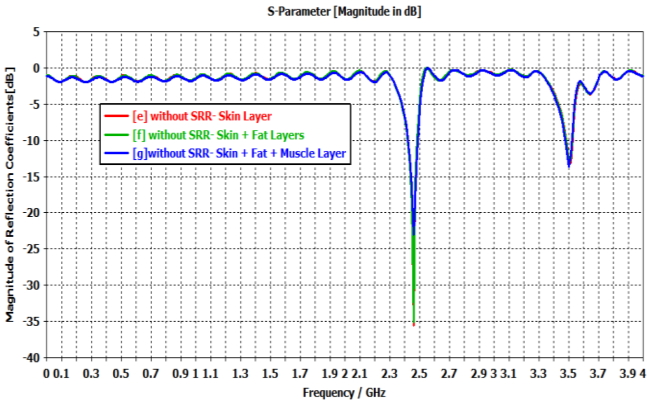

Figure 7. Magnitude of reflection coefficient versus frequency plot [e] Skin layer with SRR [f] Skin and fat [f] Skin, fat and muscle layer.

B. Voltage Standing Wave Ratio

The VSWR values are 1.05 at 2.46GHz, 1.55 at 3.5GHz for without SRR loaded antenna, 1.04 at 3.52GHz for SRR loaded, 1.03 at 2.4GHz and 1.1 at 3.56GHz for SRR loaded without any bio-tissue layered antenna was shown in the Figure: 8,9.

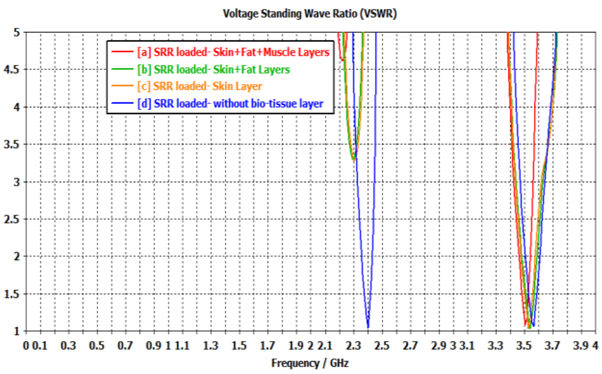

Figure 8. Voltage standing wave ratio - Frequency plot [a] Skin layer with SRR [b]skin and fat layer [c] Skin, fat and muscle layer[d] SRR loaded antenna without any bio-tissue layers.

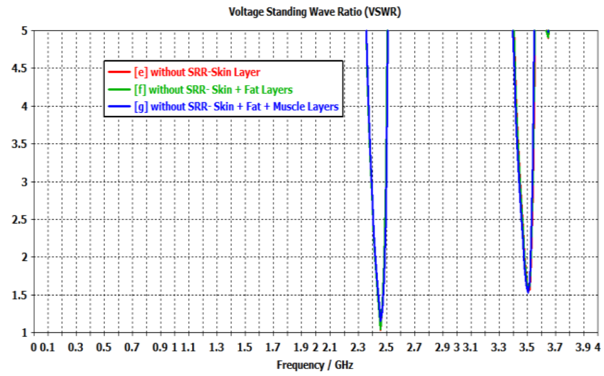

Figure 9. Voltage standing wave ratio - Frequency plot [a] Skin layer without SRR [b]skin and fat layer [c] Skin, fat and muscle layer.

C. Far Field Gain

The some amount of radiated power is absorbed by human tissue. This absorption rate is called SAR value, due to wearable antenna gain is reduced some amount [9].This absorption is related to the operating frequencies are shown in Figure: 10-12. The designed antenna directive gains are 2.3dBi at 2.46GHz, 4.2dBi at 3.5GHz for non-SRR loaded proposed structure, 5dBi at 3.52GHz for SRR loaded, 2.5dBi at 2.4GHz and 4.4dBi at 3.56GHz for SRR loaded without any bio-tissue layered proposed structure.

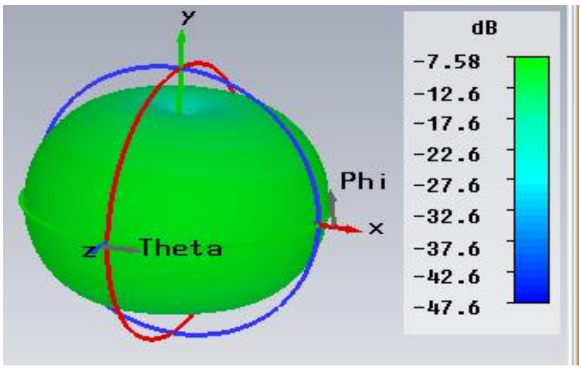

Figure 10. 3D- plot of gain at 2.46GHz

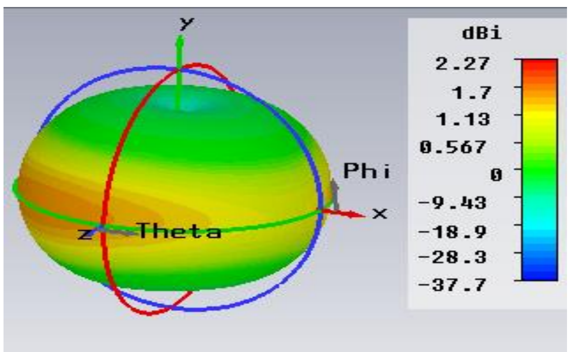

Figure 11. 3D-plot of directive gain at 2.46GHz

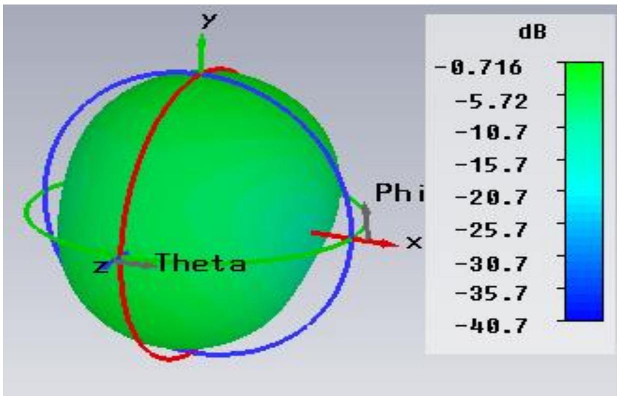

Figure 12. 3D- plot of gain at 3.5GHz

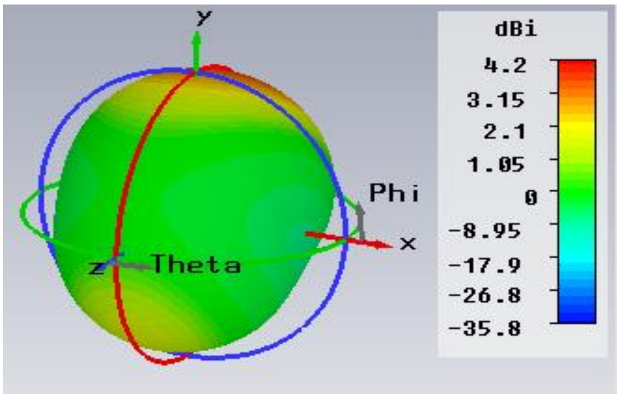

Figure 13. 3D-plot of directive gain at 3.5GHz

D. Radiation Pattern

It is a graphical representation or mathematical representation of radiation characteristic at far field as function of time as well as space [8], [10].the radiation pattern of proposed antenna are shown in Figure:14-16.

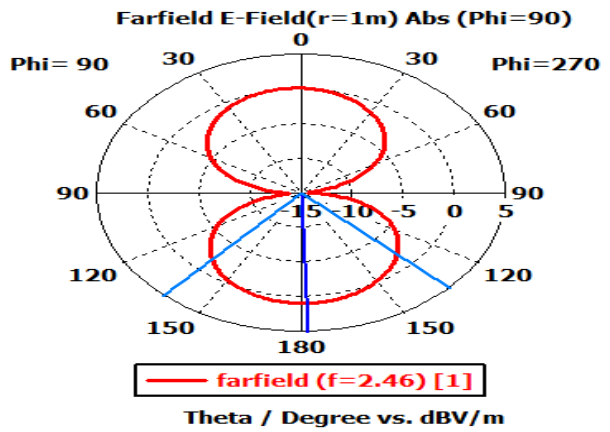

Figure 14. Shows polar plot of E-field at 2.43GHz

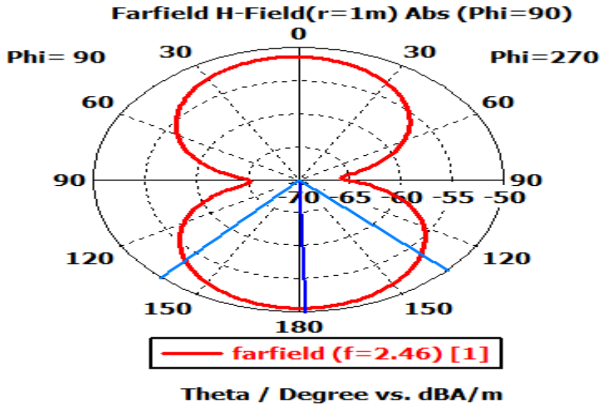

Figure 15. Shows Polar Plot of E-field at 2.43GHz

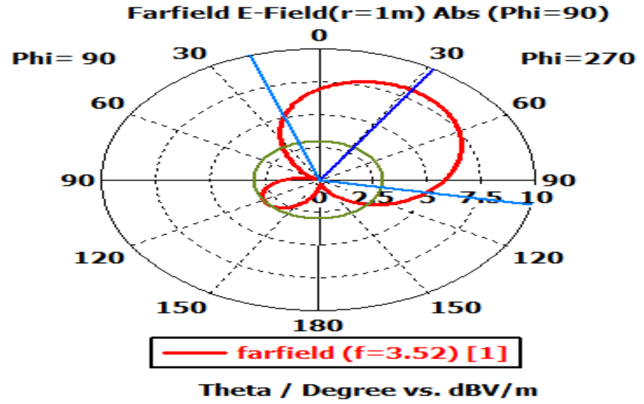

Figure 16. Shows Polar Plot of E-field at 3.5GHz

Reference	Dimension [mm³]	Gain [dB]	10dB-BW [MHz]	Dielectric Materials
[4]	15240	-16	12	ARLON1000
[5]	10240	-	20	Rogers3120
[6]	6480	-	20	RT/duroid6002
[11]	1265.6	-25	142	Rogers3120
Prop. Ant. with SRR-skin layer f=3.52GHz	640	-2	100	Teflon
Prop. Ant. without SRR- skin layer f=2.46GHz	640	-8	60	Teflon
Prop. Ant. without SRR- skin layer f=3.5GHz	640	-1	40	Teflon
Prop. Ant. without SRR without bio-tissue f=2.4GHz	640	-	80	Teflon
Prop. Ant. without SRR without bio-tissue f=3.56GHz	640	-	100	Teflon

V. CONCLUSION

The SRR asymmetrical CB-CPW fed multilayered dual band antenna is designed in this paper used for wearable WBAN applications. The designed antenna overall dimension is 20x20x1.6mm³, and simulated results for the magnitude of reflection coefficient are -36dB at 2.46GHz, -14dB at 3.5GHz for non-SRR loaded structure,-36dB at 3.52GHz for SRR loaded with bio-tissue layered antenna, 35dB at 2.4GHz and 30dB at 3.56GHz for SRR loaded antenna without any bio-tissue layer respectively. These are ISM band, WIMAX band and WLAN band, since these antennas are applicable for IOP monitoring through the various wireless networks. The proposed antenna simulation results and design methodology can believe for helpful to coming antenna researchers.

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