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A Novel Monopole Antenna enclosed with SRR and Triple stripped design for wearable devices

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Abstract:
A compact biomedical application-oriented antenna having complimentary split ring resonators at the flip side is presented in this letter. The frequency range 2.4 to 2.5 is mainly focused on the medical applications. The proposed antenna gives the best solution for the compact, low profile, robust for the medical bands. The proposed structure analyzed using ANSYS electronic desktop and results has been carried out by using the FR4 substrate. A normal rectangular patch antenna design has been taken with modified patch having three radiating strips connected to the feed line and the ground is modified with a complimentary split ring resonator and proposed antenna is used to work at the ISM band which is best suitable for medical application. It consists of almost 92% of efficiency towards radiation and a peak gain of 4dB with front to back ratio of 72%. In addition to that, an ideal radiation scenario is taken to perform time domain analysis to know the best possible way human body communication.

Keywords: ISM band, Defected Ground Structure, Complimentary Split Ring Resonator

Introduction:

The want for portability and correspondence is profoundly imbued in human instinct and in any remote correspondence framework the radio wire is a basic segment. A radio wire is utilized to either transmit or get electromagnetic waves. It fills in as a transducer for changing over guided waves into free-space waves in the transmitting mode or the other way around in the accepting mode[1-2]. All antenna work on a similar essential standard of electromagnetic hypothesis detailed by James Clerk Maxwell. With the appearance of the data period, various propelled correspondence innovations have emerged amid the previous two decades which have extraordinarily affected and profited each field of our general public. The expansion of an ever-increasing number of highlights in each new age correspondence framework requests widespread receiving wires reasonable for task in numerous groups. Notwithstanding multiband task, it is fundamental that the reception apparatus is little, light weight, low profile and can be effortlessly incorporated with other microwave parts. With a specific end goal to achieve this, the reception apparatus can be manufactured onto a printed circuit board (PCB) and inserted into the packaging of gadgets[3-5].

The electronic correspondence frameworks are unavoidable and indistinguishable piece of present-day correspondence devices. The IEEE characterizes the reception apparatus or flying as "a method for emanating or accepting radio waves". As a rule, a reception apparatus is a change gadget or a transducer, which change over guided wave into free space wave/photons

OR it is an impedance coordinating gadget which coordinates the impedance of a transmission line with that of free space OR it is a gadget which change over electrical current in a specific recurrence into electromagnetic wave in a similar recurrence and the other way around. The extensive variety of use of receiving wires is accessible in different areas of electromagnetic range. The sort and property of reception apparatus relies upon the recurrence locale at which it works. The electrical and mechanical qualities together with working expense and working condition will decide the outline model for a specific radio wire. Receiving wires are used for correspondence and broadcasting as well as for the interesting field of radio space science, biomedicine, resistance, radar, remote detecting, impact evasion, aviation authority, GPS, WLAN‟s and so forth. This extensive variety of utilization makes the field of receiving wire as a fascinating region of research[6-10].

Presently a days Wireless Telecommunication innovation has changed the lives when contrasted with the past. In the homes, workplaces and Educational organization the versatile compact gadgets give more opportunity to such an extent that the correspondence with each other whenever and in wherever is conceivable. Today there are numerous utilization of remote correspondence in nearly in each zone, for example, Personal Communications Services (PCS), Wireless Personal Area Networks (WPAN), Wireless Local Area Networks (WLAN) and numerous other Telecommunication frameworks, which gives dependable remote associations between PCs, compact gadgets and buyer hardware inside a short range. Correspondence framework having reception apparatuses which assumes significant part in remote correspondence, so these framework requests to plan the receiving wires with expanded usefulness, better execution, decreased size and low advancement cost. Omni-directional receiving wires enhance motions every which way for accepting and transmitting which makes them more powerless to get commotion and more inclined to create clamor for different gadgets[11-13]. By inserting different slots and stubs, were used to improve the isolation between the antenna elements[14]. Remote signs originating from different gadgets from different bearings will decrease the Signal to Noise Ratio (SNR) on a moronic Omni-directional receiving wire however not on a keen directional radio wire. It is conceivable to get change utilizing stupid directional reception apparatuses however that change is just gone for a solitary course[15-16]. Putting a mechanical turn gadget on a settled directional receiving wire can tackle the bearing issue however it's expensive and complex and has a moderate reaction time. The brilliant receiving wire utilizes a variety of reception apparatuses confronting an extensive variety of headings. The Digital Signal Processor (DSP) utilized as a part of keen receiving wire for all intents and purposes focuses the radio wire by just utilizing the bits of the reception apparatus that produce the most noteworthy SNR. Savvy Antennas are indispensable piece of frameworks because of high information throughput ability and low power necessities. As the developing interest for versatile interchanges is always expanding, the requirement for better scope, enhanced limit and higher transmission quality emerges. In this way, more proficient utilization of the radio range is required. Shrewd Antenna Systems (SAS) are able to do proficiently using the radio range and guarantee an effective answer for the 2 show remote framework issues while achieving dependable and powerful high-information rate transmission. In this article a compact antenna while works at the ISM band is simulated using HFSS software. Later the antenna is carried out with time domain analysis with two conditions face to face and side by side.

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Antenna Design:

A compact antenna which is enclosed with partial ground having substrate material as FR-4 epoxy which is having the dielectric constant of 4.4 and loss tangent of 0.002. The proposed antenna having Ls * Ws having substrate thickness of 1.6mm. The proposed antenna analyzed using commercially equipped tool ANSYS electronic desktop. Simultaneously time domain analysis in two cases (face to face side by side), has done by using CST Microwave Studio. The proposed antenna works at ISM band 2.45GHz which is most frequently used for biomedical applications. The antenna has been analyzed through iteration wise. The below table gives the information of the dimensions of the proposed antenna. Based on the normal microstrip line design the resonant frequency, length, width are calculated for this proposed model by using the below formulas

Design equations:

$$\text{Ereff} = \frac{Er+1}{2} + \frac{\text{Er}-1}{2}\left(1 + 12\frac{\text{h}}{\text{W}}\right)^{-1/2} \quad \text{-- (1)}$$

$$\Delta\text{L} = \frac{(\text{Ereff} + 0.3)(\frac{\text{W}}{\text{h}} + 0.264)}{(\text{Ereff} - 0.258)(\frac{\text{W}}{\text{h}} + 0.8)} \quad \text{--- (2)}$$

$$L = \frac{\text{c}}{2\text{Freq}\sqrt{\text{Eref}}} - 2\Delta\text{L} \quad \text{--- (3)}$$

$$\text{W} = \frac{\text{c}\sqrt{2}}{2\text{freq}\sqrt{\text{Er}+1}} \quad \text{--- (4)}$$

εr is the dielectric constant of material proposed antenna whereas, c is the speed of light in free space and h is the thickness of the material. L is the length of the antenna and W is width of the antenna. To reach the requirements of the biomedical applications the proposed antenna targeted to work in the ISM band region (2.45GHz). A compact size antenna has taken into consideration for the required frequency band. The layout of the proposed antenna has been seen below.

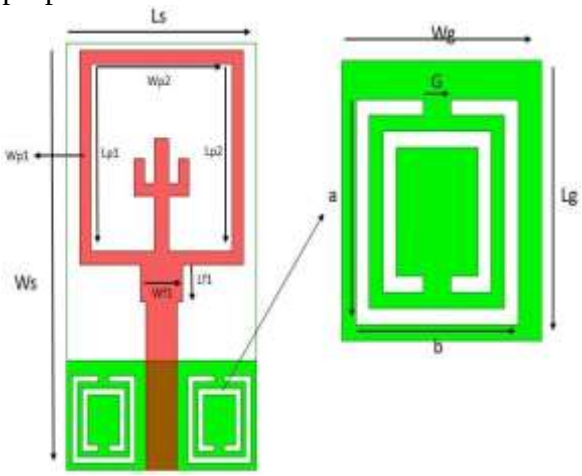

Fig 1: Layout of the designed antenna

Ls	34	Ws	18	H	1.6
Wf	3.5	Lf	13.4	L	3
W	4	Lp	17	Wp	15.5
Lp1	11	Wp1	13.5	L	9
A	3	B	1	C	5.2

Table 1: Antenna Dimensions

Results and Discussions:

Proposed antenna works at ISM band for biomedical application. The measured and simulated results coincide each other very well up to 7GHz, the proposed antenna works at three bands. The first band works from 2.4 to 2.75(ISM band). Second band works from 3.5 to 3.9(WiMax) and the third band from 6.6 to 6.75. We can also observe that a sharp rejection at the notch bands i.e., from 2.75 to 3.53(WLAN) and 3.8 to 6.6 is been observed. The gain vs. frequency plot clearly shows the deflections due to notch bands produced in the antenna.

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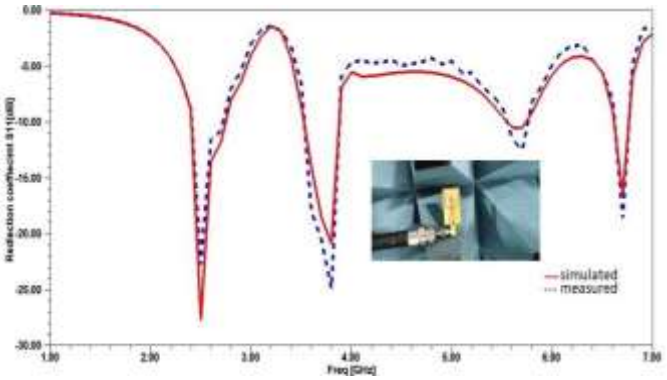

Fig1.1: Return loss of the prototype antenna

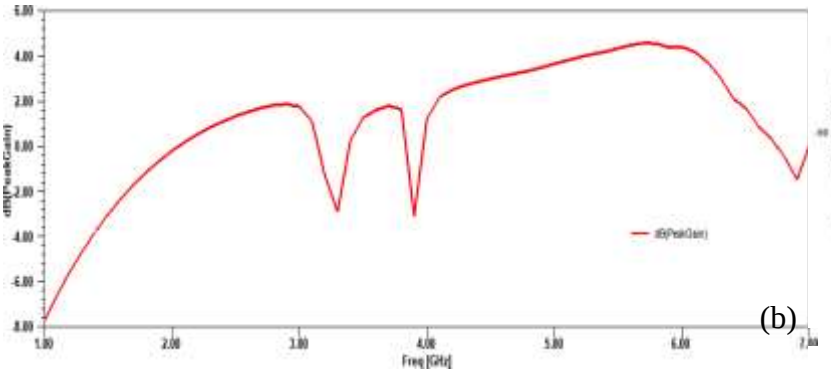

Fig1.2: Gain of the proposed antenna

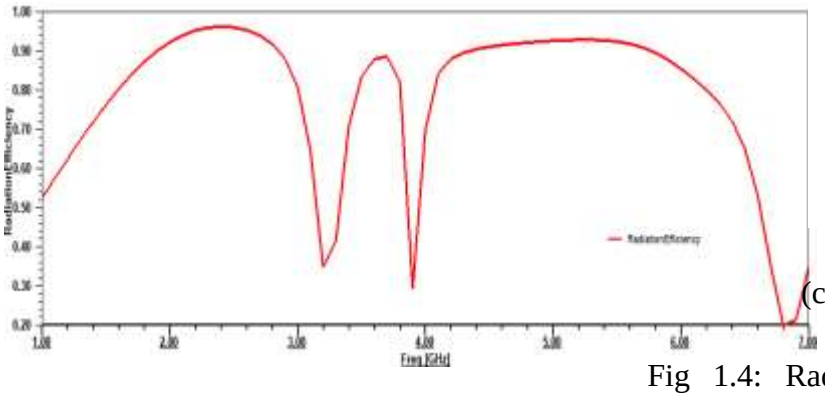

Fig1.3: Radiation efficiency of the proposed antenna

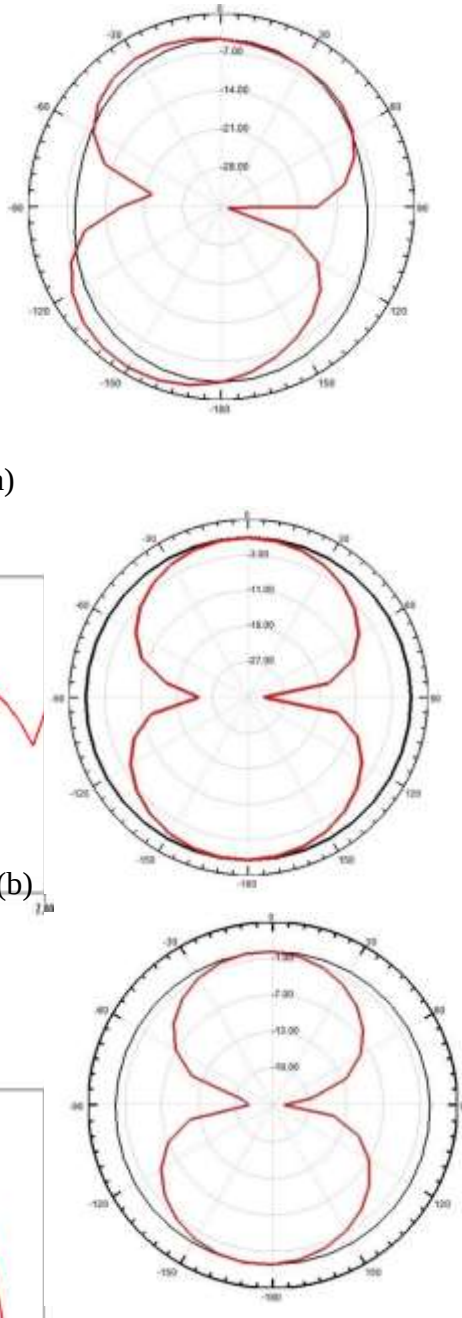

Fig 1.4: Radiation pattern at working bands and notch bands (a)2.5GHz (working band) (b) 3.8GHz (working band) (c) 3.2GHz (notch bands)

The radiation pattern of the proposed antenna is taken. It is observed that the E-plane of the antenna shows dipole type of patterns. The H-plane shows the Omni-directional type of pattern. The two working bands similar type of radiation patterns are observed at both notch bands. In fig1.5 current distributions have been noted at 2.5GHz (working band) and at 3.2GHz (notch band). At working band, the flow of current is denser than that of notch band.

Time Domain Analysis:

In modern communication system, correlations between the signals place a vital role. Especially, in antennas the transmitted strength should almost correlate with the receiving strength to get the proper communication in the channel. For this medical application-oriented antenna time domain analysis has been performed for two scenarios i.e., face to face, side by side for identical antenna by using CST software. Normally the input signal, transmitted signal and the received signal should not take much more than 2ns. Input signal of antenna at face to face condition is very much less than 1ns. Whereas the transmitted signal is extended up to 1.5ns. Received signal has distortion up to 2ns. This shows a strong correlation between the transmitted and received signal. The same behavior is also generated in side by side scenario, but a slit drop in the correlation between transmitted signal and received signal has been observed in the graph.

Face to Face:

The two identical antennas have been kept face to face with 0.5 mm. The pulse transmission signals have been noticed to analyze the performance of both antennas. The below figures show the input, transmitted and received signals in this scenario.

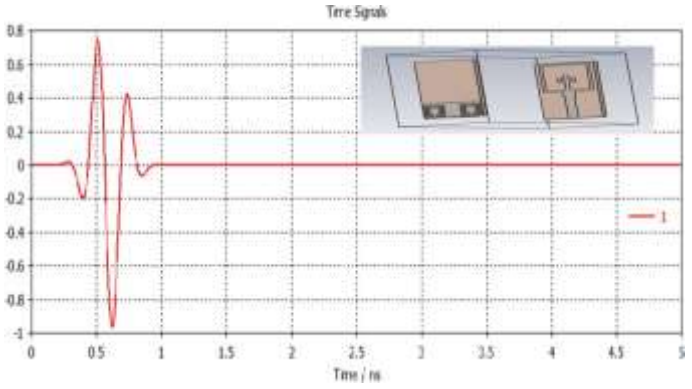

Fig2.1: Input signal

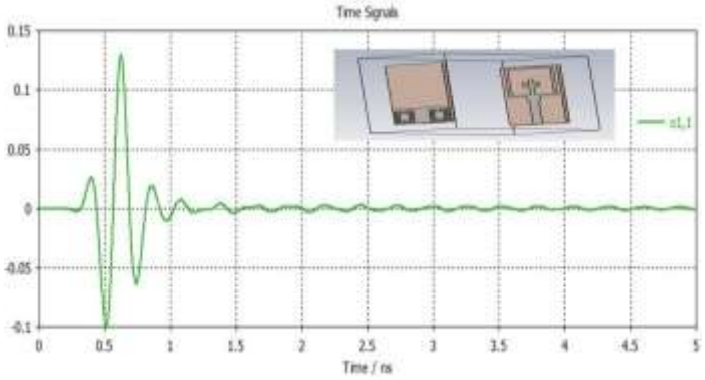

Fig2.2: Transmitted signal(antenna1)

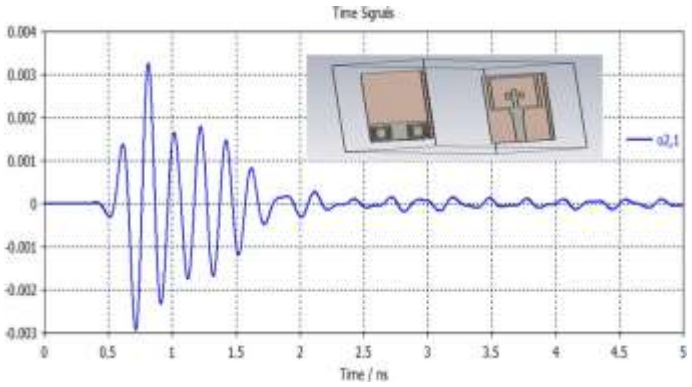

Fig2.3: Received signal(antenna2)

Side By Side:

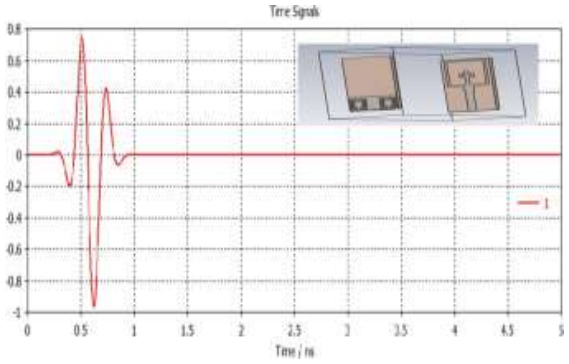

Fig3.1: Input signal

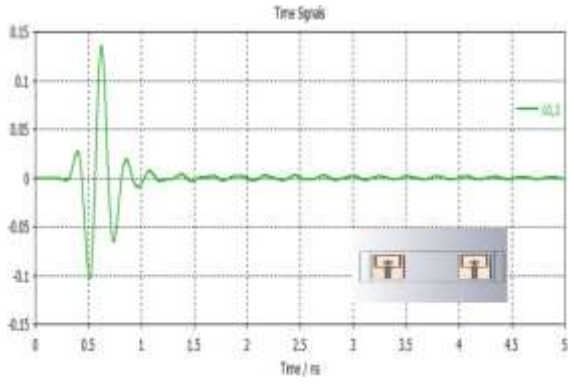

Fig3.2: Transmitted signal(antenna1)

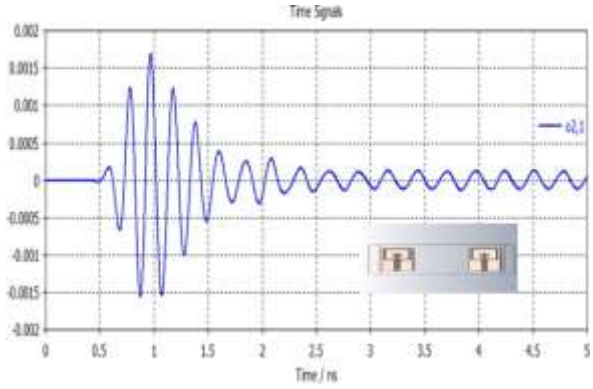

Fig3.3: Received signal(antenna2)

Conclusion: A dual band antenna having complimentary split ring resonant at the ground has been investigated in this article. The proposed antenna designed to exhibit to the ISM band and at the 3.8GHz (Ymax) frequency. Parallelly the time domain analysis has been carried out for the proposed antenna to check the correlation between them, when it is virtually placed on a human body. The front and back ratio which increases by 70% to obtain gain up to 4dB is also observed in this article. Thus, the proposed antenna consisting of CSRR in partial ground is a candour for the biomedical application.

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