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Design & Analysis of Microstrip Antenna in Spiral Structure for Medical Application

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Abstract :- This work belongs to, spiral micro strip patch antenna using 2.4- 2.45 Ghz industrial scientific and medical frequency band **(ISM).** A spiral microstrip antenna having 29mm X 21mm X 1.63mm with single feed point, current distribution in spiral shape and using FR04 material with dielectric constant 4.4.

Key Words: **Compact Microsrtip antenna, Medical application, Spectrum band, Body tissue**

1. INTRODUCTION

Now a days, in telecommunication field, there is main application is 'Telemedicine or wireless medicine'. This technology provides medical information and service to remote area patient. In India there is most need of specialist doctors in rural area, because there is no good sufficient medical facility in rural area. And also there is no facility of proper road transport.

Some of the new technologies, in sensing, Medical imaging and wireless data communication are allowing telemedicine to provide healthcare at a distance place.

After Studying the previous work in this area we understand that there is two type of antennas which are used in medical applications. These are implantable antenna and antenna use as external device.

Implanted antenna which is use to provide the information from the body to external device and provide energy to cancer treatment. [7]

As per US federal communication commission we used MICS band which is between (402-405Mhz) and (2.4 -2.5 Ghz) ISM band which are used for Medical applications, Industrial applications and Scientific applications. [3]

2.4 Ghz band meant for ISM applications for unlicensed utilization of radio-LAN device. It has been also asked ETSI, (the agency in-charge of creating telecommunication standards in Europe) to formulated the standard and the measurement method approvals.[2]

For the patients' safety we emphasis on low power consumption; electrical and electromagnetic properties of the human tissue to transmit data with high performance, technical and medical design factors form biocompatibility.[6]

We studied many dipole antenna which have been proposed for medical implant communication applications, for patient monitoring system. Like slot dipole, loop antenna in which use magnetic field and less affected by the body tissue compared to dipole

At last we use light weight, small in size, less fabrication cost microstrip patch antenna.

2. ANTENNA DESIGN SPECIFICATION

In this paper, operating frequency 2.4 Ghz, which is used industrial and scientific operations and also this frequency band is used for cordless phone , blue tooth devices, near field communication device and wireless local area network device.

After a thorough study of the following parametric considerations; viz, the electrical length, dielectric constant, strip width, coaxial feeding position and with spiral structure patch design antenna. the antenna has been designed and measured using EM software like HFSS.
A spiral microstrip patch antenna with dimension of L x W mm^2 is proposed. This antenna is fabricated on FR04 substrate with 4.4 dielectric constant (ε_r) which is easily available in market. Dimension of patch antenna 30mm X 40mm X 1.63mm

RF spectrum allocation is harmonized on an international level through the Radio-communication sector within the International Telecommunication Union (ITU). It set guidelines for designed ISM bands according to ITU Radio Regulation in the affected area.

Table-1 *frequency allocation In ISM band and applications.*

Frequency range	Center frequency	Availability	Licensed users
902-928Mhz	915Mhz	Region 2 only (with some exceptions)	Fixed mobile expect aeronautical l mobile & radiolocation service in region 2 additional amateur service
2.4-2.5Ghz	2.45Ghz	World wide	Fixed mobile, radiolocation, Amateur & armature satellite service
5.725-5.875Ghz	5.8Ghz	World wide	Fixed mobile ,radiolocation, Amateur & armature satellite service
24-24.25 Ghz	24.125Ghz	World wide	Amateur & armature satellite Radiolocation & earth exploration satellite service
61-61.5Ghz	61.25 GHz	Subject local acceptance	Fixed inter-satellite mobile & radiolocation service

After referring previous papers about frequency range, their international rules and regulation and previous parametric study the following parameters have been selected

Table – 2 *Characteristics of the designed microstrip antenna*

Dielectric constant(ε_r)	Thickness(h)	Electrical length(L_e)	Length (L) (mm)	Width (W)	Operating frequency(f_r)
4.4	1.63 mm	27.63 mm	29 mm	23.5 mm	2.4Ghz

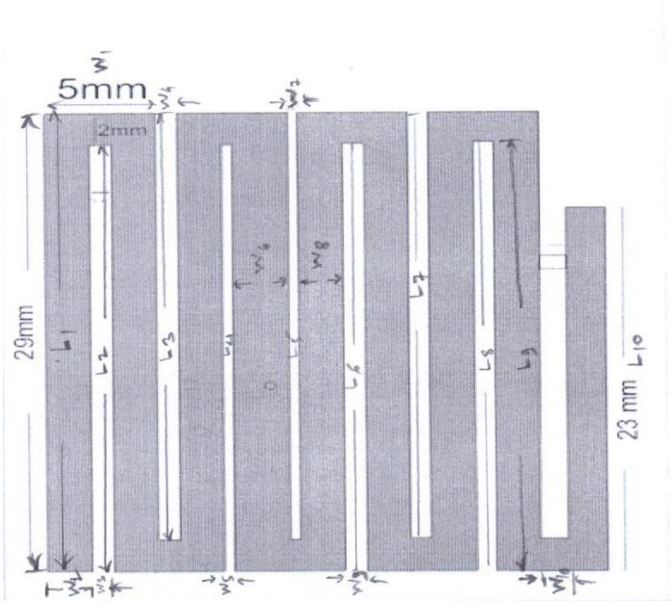

Figure 1 Proposed antenna with dimension

Length	Dimension(mm)	Width	Dimension(mm)
L1	29	W1	5
L2	27	W2	2
L3	27	W3	1
L4	27	W4	1
L5	27	W5	2
L6	27	W6	0.75
L7	27	W7	2.5
L8	27	W8	1.75
L9	27	W9	1
L10	23	W10	1.35

1.2 Result and discussion :-

Fig.1 shows the structure of antenna, which is designed for operating frequency 2.4 Ghz (which is in the ISM band) and same is simulated by the electromagnetic simulator High frequency structure simulators(HFSS) software

The antenna resonate at the frequency at 2.4 Ghz with in ISM band

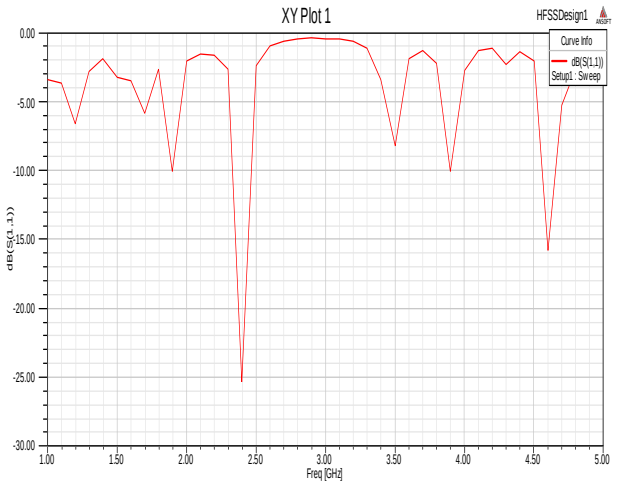

Fig- 2: *Simulated return loss at 2.4Ghz in air enviorment*

Figure 2 shows return loss of proposed antenna in air environment, which is approximately -25dB at operating frequency 2.4Ghz.

For medical applications we require a narrow bandwidth so microstrip patch antennas are preferable. Calculated bandwidth `is also so narrow, according to the simulation result it is 0.83% for the ISM Band which is sufficient to cover the desired frequency.

Due to the shape complexity of designed antenna, a small mismatch appears in the real part of the input impedance where it is 51.71Ω in the ISM band in the other hand the imaginary part in zero at 2.4Ghz frequency.

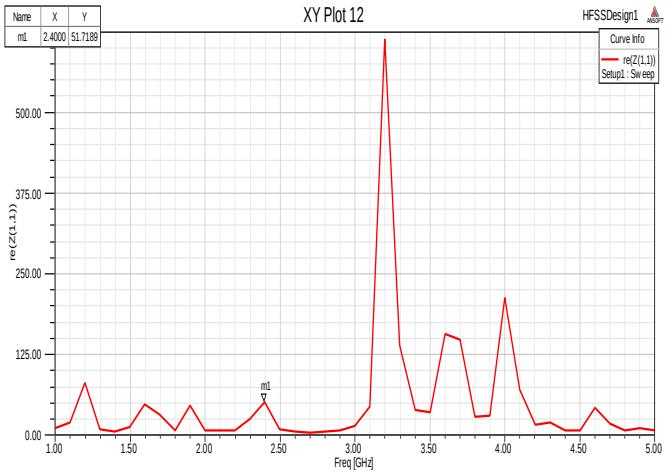

Fig- 3a: Input Real impendance at 2.4Ghz

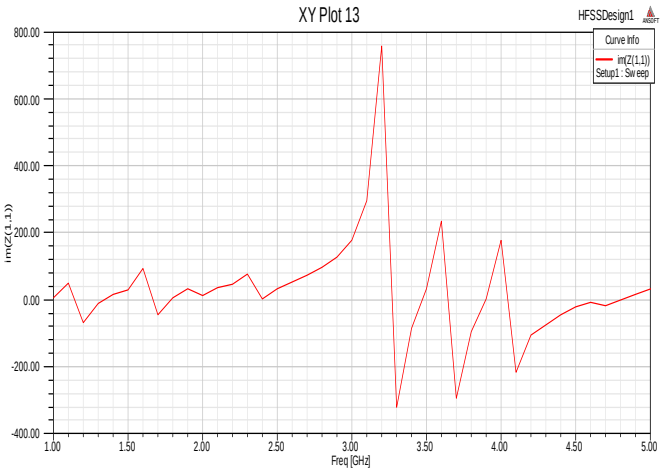

Fig- 3b: The imaginary impedance

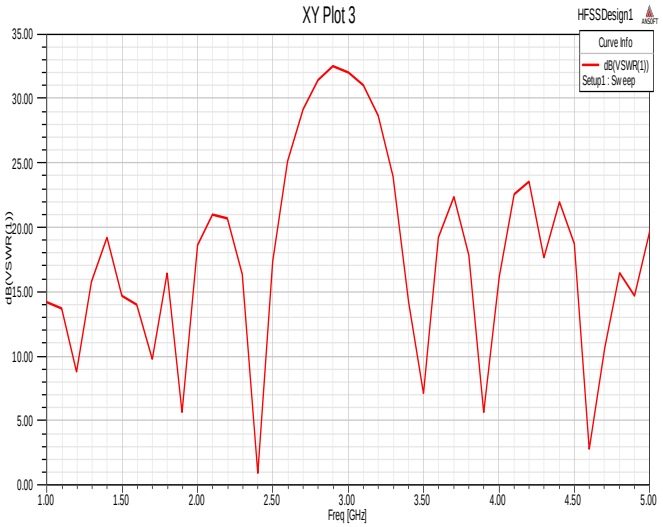

Fig- 4: *VSWR*

Figure 4 shown that VSWR ≥ 1 at oprating frequncy 2.4 Ghz

Radiation pattern and gain in two dimensional plot which is shown in figure 5a,5b.

Gain reduced at around 0^0 and 180^0

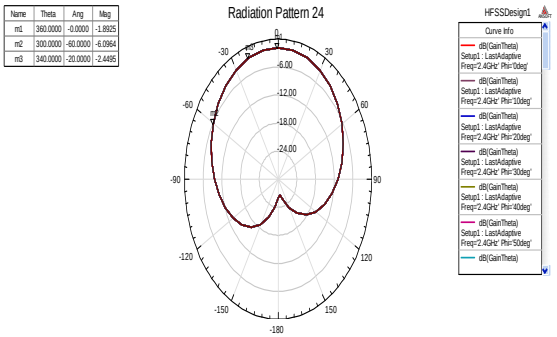

Fig-5a: *Theta/degree Vs dB*

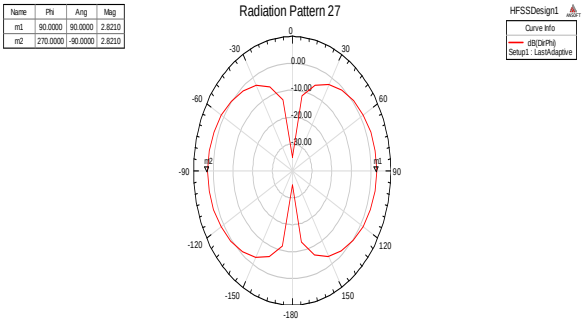

Fig-5b : *Phi/degree Vs dB*

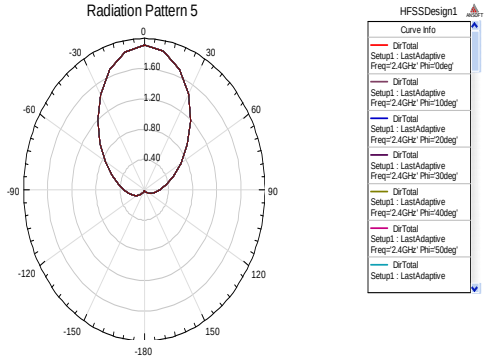

Fig-6: Directivity of antenna

Directivity of antenna which is shown in the figure 6a

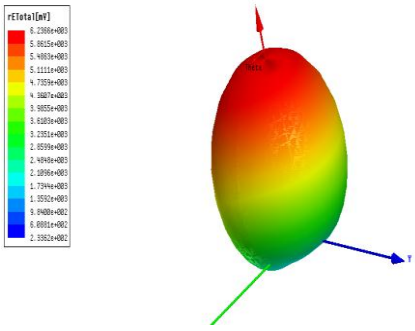

Fig-6b : 3 Dimensional radiation pattern of directivity

Table-3 : Antanna radiation characteristics at resonance frequency

Frequency	Beam width(^{0})	Maxium directivity(dB)
2.4Ghz	85^0	1.95

CONCLUSIONS

In this work, we studied the proposed antenna by using the EM simulated software HFSS, and getting the results of proposed antenna parameters for medical application as per study. The parameters we have seen, that antenna resonate at the 2.4Ghz which is required as per ISM band and omni directional radiation pattern required for on body and off body application. In this we also have seen the radiation pattern which is omni directional and narrow band width which is required for medical applications. In this work we have seen the band width is narrow approximently 160 Mhz. Expected directivity of antenna is atleast 1 and here we can see directivity is approximetly 1. Required VSWR and practicaly VSWR is also less than or equal to 1. So all this parameters of this antenna are useful for medical applications.

As future work we can implement this antenna physicaly and measure return loss in free space and also under skin of fish body, antenna placed inside chicken and fish body changes the dimension of antenna as small as possible .

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