Design of Four Stack Millimeter Antenna for Medical Applications

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Abstract - *A millimeter wave antenna is designed for medical applications using stacked microstrip antenna. Due to its high frequency and directivity, it is highly preferred for high speed Data communication. Medical applications have been growing very rapidly over the past decades. Due to high frequency, it identifies cell-growth, proliferation rates, activation of enzymes and genetic apparatus. The proposed antenna is designed as four stacked microstrip antenna with the dimension of about 1.2mm X 1.2mm X 0.08mm which uses FR-4 Epoxy as a dielectric material and it works at 30-65GHz. Millimeter wave antenna is designed with the help of ANSYS HFSS 19.0 Version. Antenna performance is analyzed by using simulated results such as reflection coefficient, VSWR, gain, bandwidth and directivity, Input impedance, Aperture, Radiation pattern, Antenna Polarization, Radiation Intensity, Return loss.*

Keyword: Millimeter wave antenna, microstrip patch antenna, ANSYS HFSS 19.0 version tool.

I.INTRODUCTION:

Microstrip patch antennas are currently used by many people. Due to its low profile, light weight, compact and price effective. At present wireless communication systems, with specified bandwidths are utilized for a worldwide system for mobile communication, digital communication system, personal communication system, and universal mobile telecommunication system. Various designs are proposed within the literature to enhance the bandwidth, gain of microstrip patch antenna which incorporates the use of thicker substrates, different shape patches and probes, addition of substate [1]–[8]. In our case we are presenting various useful bandwidth enhancing stacked configuration of patch antennas which are ready to provide broad gain.

II. LITERATURE SURVEY

Stacked Multiple Slot Microstrip Patch Antenna for Wireless Communication System

Stacked probe fed is inverted with multiple slot microstrip patch antenna is designed. This combination of stacked patch antenna and multiple patches provides high gain and low profile of antenna element. parameters such as gain, return loss, bandwidth, impedance and radiation patterns are simulated results were discussed. The gain obtained is 11.33db. It achieves the requirement of base station in communication system. The resonant properties of the proposed antenna are predicted and optimized using a frequency domain three dimensional full wave electromagnetic field solver (HFSS). The two closely excited resonant frequencies at 1.85 GHz and at 2.1 GHz as shown within the figure gives the measure of the wideband characteristic of the patch antenna. At the frequency of 1.82 GHz to 2.22 GHz the bandwidth is 19.8% and the VSWR is less than 2 with 10 dB return loss.

EXISTING METHOD:

TWO STACKED MICROSTRIP ANTENNA

The stacked microstrip antenna has particular characteristics, like a high gain or a good bandwidth. When the size of the microstrip patch is nearly equal to the fed patch, and the distance between the fed patch and the microstrip patch is approximately 0.1 wavelengths, the bandwidth is increased. 2 inset-fed directional microstrip patch antenna is proposed for the economic, scientific and medical (ISM) waveband. The proposed antenna is designed at 48.5GHz for commercially available substrate FR Epoxy having thickness 0.02 mm and relative dielectric constant 3.48.

An antenna is an electrical transducer wont to convert electric power to radiowaves or vice-versa. Their applications are in wide areas such as broadcasting of ratio signals, receivers in communication system, cell phones and so on. A microstrip patch antenna is used quite often because of its low cost, simplicity of fabrication, lightweight etc.

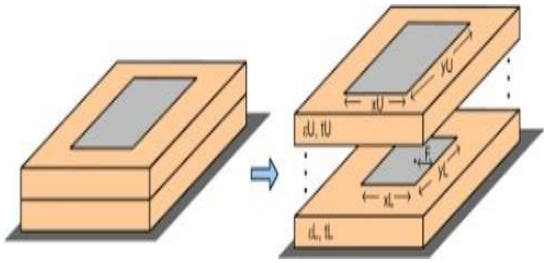

Figure 1 Two stacked microstrip antenna

PROPOSED METHOD:

FOUR STACKED MICROSTRIP ANTENNA

Additional strength of the antenna is gained by stacking one antenna on the top of other antenna and also we get a better reception. One-and-a-half times more signal voltage is brought by a 4 properly stack antenna than a single antenna. Generally Stacked microstrip antenna has some particular characteristics, like a high gain or a large bandwidth. The signal voltage is doubled for 4 stack antenna than a 2 stacked antenna. The antenna parameters like radiation diagram, gain, directivity, efficiency and VSWR are analysed for the planning of microstrip patch antenna. In the antenna's far field report the power variation as a function of arrival angle. Antenna efficiency is especially depending upon the dimensions of an antenna which is measured in terms of wavelength and for MSA, if the peak is increased, efficiency starts to degrade. Impedance matching and return loss of an antenna is based on the value of Voltage Standing Wave Ratio (VSWR).

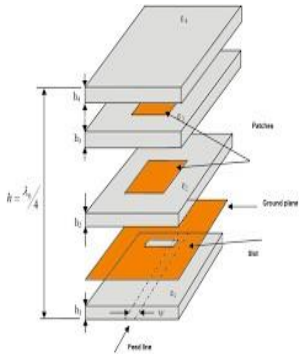

Figure 2 Four stacked microstrip antenna

III. ANTENNA DESIGN:

A microstrip patch antenna has dielectric substrate on one side and ground plane on the other side. FR-4 epoxy is used as a substrate whose dielectric constant, 3.9 – 4.7, 4.4 and it provides mechanical support to the antenna. The main advantage of using microstrip patch antenna is it can be directly printed in the circuits. The proposed antenna consists of 4 stacked microstrip patch antenna. The MSA antenna is fabricated on the FR-4 epoxy substrate and it is stacked over the initial antenna in a vertical direction yields finally 2 stacked and 4 stacked microstrip patch antenna configuration. This stacked set up will operate in the frequency range 0-400GHz. Generally, the stacked antenna is placed in a substrate after that common ground and feed line are given to the antenna. Electric field is sent through the feed line and this electric field reaches the patch it will converted into electromagnetic field and emits radiation. By this way we can get our desired output.

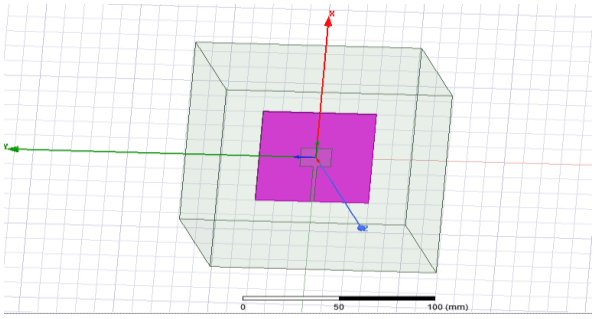

Figure 4 shows a Substrate of Microstrip patch Antenna

The dielectric substrate provides a stable support for the conductor strip and patches that make up connecting lines, resonator, and antennas. By increasing the thickness of substrate it enhances antenna bandwidth.

A. Design Equations:

To design a microstrip patch antenna, we've to pick the resonant frequency and a dielectric medium. The parameters are to be calculated. Width (W): The width of the patch is calculated using the subsequent equation.

$$W = \frac{c}{2f_r}\sqrt{\frac{2}{\varepsilon_r + 1}}$$

$$f_c \approx \frac{c}{2L\sqrt{\varepsilon_r}} = \frac{1}{2L\sqrt{\varepsilon_0 \varepsilon_r \mu_0}}$$

This equation shows that length of the antenna is equal to one half of a wavelength within the dielectric material(substate).

B. Results and Discussions:

The simulation and the experimental studies of the antenna are done using Ansys HFSS tool and their parameters like radiation pattern, directivity, VSWR and gain are analyzed and compared based on Finite Element Method (FEM) analysis.

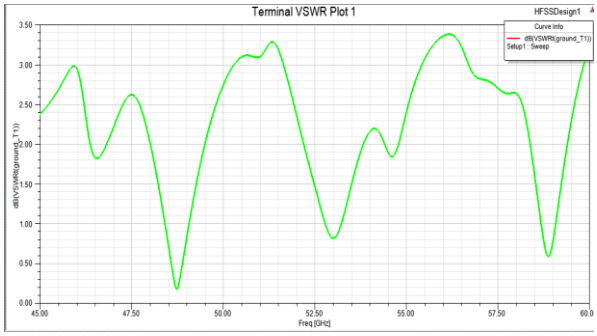

Figure 5: VSWR plot for 4 Stacked MSA

Figure 5 shows the VSWR plot is designed for 4 Stacked MSA. From the graph, VSWR value for 4 Stacked MSA is 2.48. This value satisfies the nominal value of VSWR for MSA. Figure 6 shows the S parameter plot for the same frequency 59 GHz at 29dB and it is maximum that of other frequency ranges.

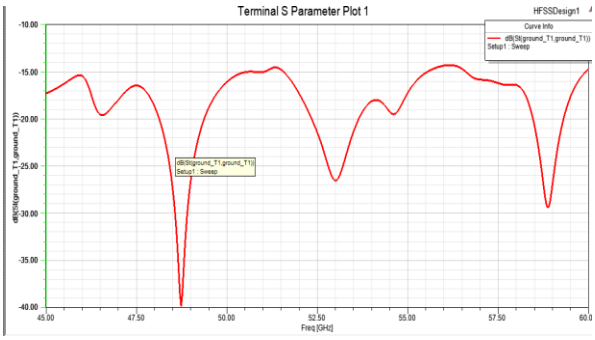

Figure 6: S Parameter for 4 Stacked MSA

Gain of an antenna decides the direction of the radiation. If the gain is low it emits radiation in all direction, where as if it's a high gain radiation flows in a particular direction. Figure 6 shows the results of directivity and gain plot for Two stacked Microstrip Patch Antenna and gain value obtained for designed antenna is 1.82dB. For that particular gain value, directivity is 5.76dB(maximum). It was known that gain is directly proportional to the directivity, when the efficiency is 100 percent.

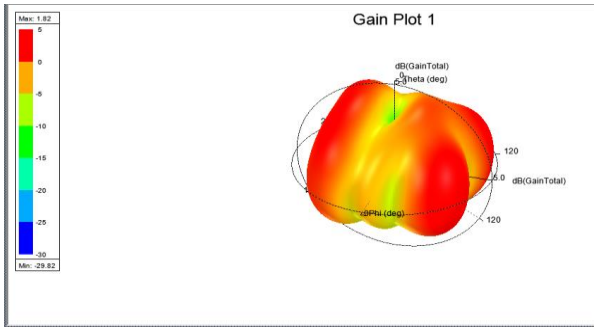

Figure 7: Directivity and Gain of 4 Stacked MSA

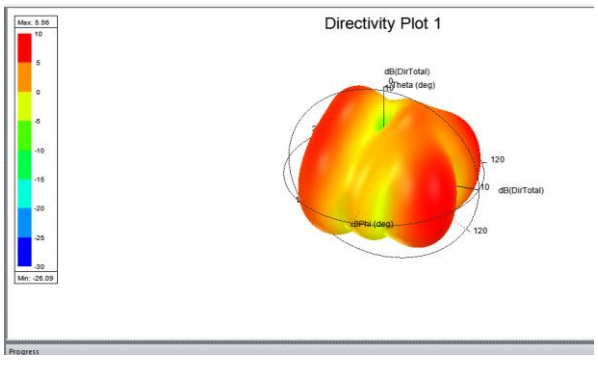

Figure 8 shows the impedance chart of 4 Stacked MSA

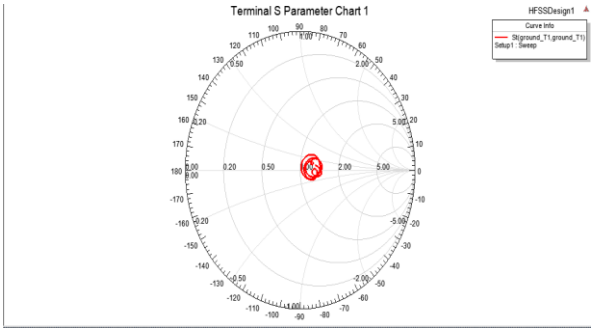

Figure 8: Impedance chart of 4 Stacked MSA

Table 1: Comparison chart for single stacked MSA and 4 stacked MSA.

Parameters	Single Stack MSA	4 Stacked MSA
Frequency	48.5 GHz	48.5 GHz
Gain	3.56dB	1.82dB
Directivity	4.67	5.76
VSWR	1.05	2.48
S Parameter	x-57.1 y-18.1	x-48.95 y-40

From the Table 1, it is clear that, with the same value of frequency, directivity and efficiency increases and the return loss decreases. Also, it is understood that designed of 4 stack MSA has higher efficiency compared to other stacked MSA.

By this formula $f = c/\lambda$, when there is increase in the frequency, the size will be increased simultaneously, and the size of antenna will be reduced. From the analysis that the performance of 4 Stacked micro strip antenna is better for the identification of cell growth and activation of enzymes.

IV CONCLUSION:

In this project, stacked microstrip patch antenna has been designed for medical applications. The proposed antenna was simulated using ANSYS HFSS version 19.0 software. Two and Four stacked microstrip patch antenna is designed and simulated at the frequency of 48.5 GHz. When the stacking is increased from two stacked to four stacked the gain value from 3.56 to 1.82 and it increased the directivity to 4.67 to 5.76 The Four stacked antennas produce greater bandwidth while compared to two stacked antenna and Single antenna.

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