Design of 16 Stack Micro Strip Patch Antennas Using for Millimeter Wave Applications

Ms. V. Logeswari[1], P. Dhamothar[2], A. Karthikeyan [3], R. Kavinraj[4], E. Viknesh[5], B. Vishnu[6]

[1]Assistant Professor, [2,3,4,5,6]Students,
Department of Electronics and Communication Engineering
Nandha Engineering College.

Abstract- **An antenna is made of dielectric material and fixed on a ground plane, which serves as the structure's support. Feed wires connecting through the patch are also used to excite the antenna. Telemedicine and biomedical applications both allow for the usage of microstrip patch antennas. There are 16 stacks of micro strip patch antennas in this variant. The 16-stack micro strip patch antenna can be installed (or patched) in an insulating substance. The patch can be put in a patchwork pattern on the upper side. Let's say that if there was a technical mistake made when measuring the wave, it could be fixed. Measurements are made of the antenna's VSWR, Gain, Directivity, S-Parameters, and Radiation Pattern. Wave splitting and loss are examined and corrected in the microwave frequency range. AnsysHFSS software programme is used for microwave applications such global positioning satellite (GPS) systems, radio frequency identification, mobile communication, and healthcare to construct 16 stack micro strip patch antennas at 48–60 GHz.**

Keyword: **Millimetre 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 band Width, gain of microstrip patch antenna which incorporates the use of Thicker substrates, different shape patch and probes, addition of substrate [1]–[16]. In our case we are presenting various useful band Width 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

microstrip antennas, this part discusses the literature review on microstrip patch antennas. The research reveals that the several distinguishable benefits of microstrip patch antennas include their light weight, low cost, low profile, planar configuration, simple conformity, greater portability, suitability for arrays, ease of production, and simplicity of integration with external circuitry, among others.

Although the standard microstrip antenna has numerous benefits, it also has three main drawbacks: a narrow bandwidth, poor gain, and a relatively large size. These drawbacks frequently have a negative effect on the efficiency of the antennas.

EXISTING METHOD:

SINGLE STACKED MICROSTRIP ANTENNA

Antennas are based on transmission or reception of electromagnetic waves. Microstrip antennas have several advantages over conventional microwave antenna and therefore are used in a variety of practical.

A microstrip patch antenna (MPA) consists of a conducting (metallic patch on a thin, grounded dielectric substrate) patch of any non-planar or planar geometry on one side of a dielectric substrate and a ground plane on other side. It is a printed resonant antenna for narrow-band microwave wireless links requiring semi-hemispherical coverage. Due to its planar configuration and ease of integration with microstrip technology, the microstrip patch antenna has been widely utilized. The rectangular and circular patches are the basic and most commonly used microstrip antennas.

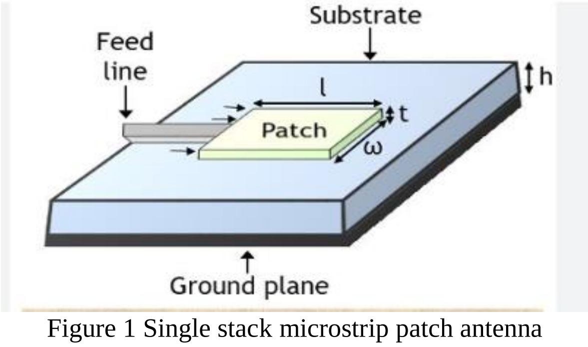


Figure 1 Single stack microstrip patch antenna

FOUR STACK MICROSTRIP PATCH ANTENNA

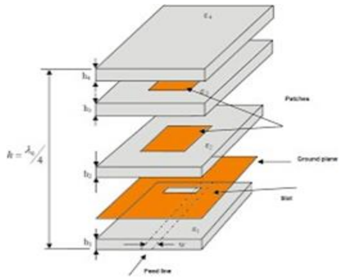


Figure 2 Four stacked microstrip antenna

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).

PROPOSED METHOD:

EIGHT 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. Figure2 shows a 4 stacked microstrip patch antenna.

The antenna parameters like radiation diagram, gain, directivity, efficiency and VSWR are analysed for the planning of microstrip patch antenna. Variation in power radiated in any direction as function is called as radiation pattern. 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).Specification.

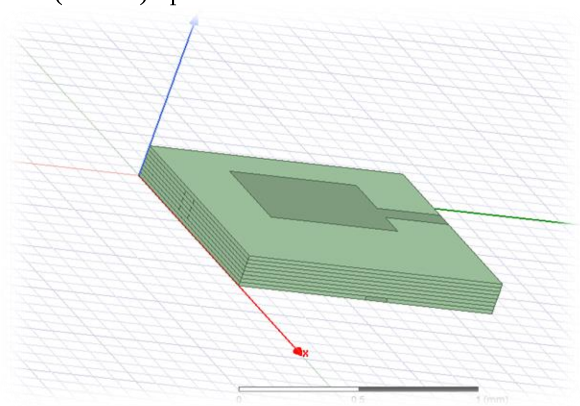
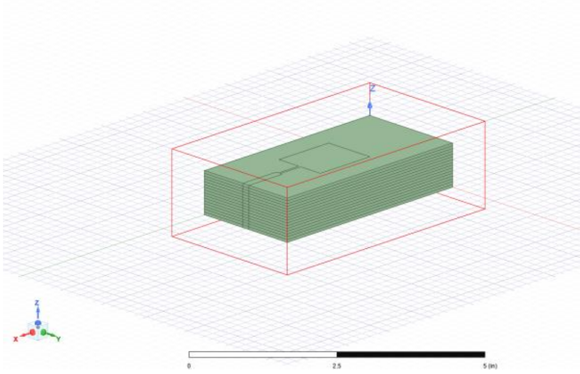


Figure 3 Eight stacked microstrip antenna

16 STACKED MICROSTRIP ANTENNAS

16 Stack Micro Strip patch antenna for medical applications. In order to enhance the bandwidth, antenna losses are contained by controlling those quality factors which can have a significant impact on the bandwidth for a given permittivity and thickness of the substrate. This has been achieved by conformal transformation of the multi dielectric microstrip antenna. For the ease of analysis Transient method is used to map the complex permittivity of a multilayer substrate to a single layer.



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

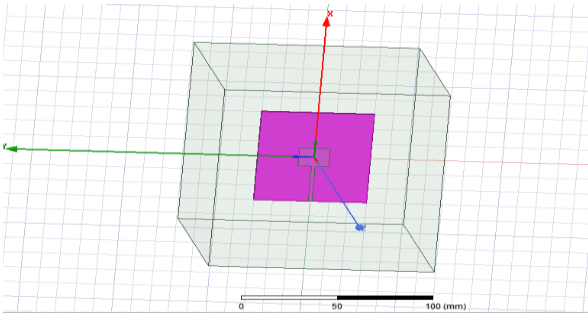


Figure 4: Substrate of Microstrip patch Antenna.

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.

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

where c is the velocity of light, ε_r is the dielectric constant of the substrate and f_r is the resonant frequency of an antenna

Length L has determined by the operation of the patch antenna. Center frequency is identified by the below formula

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

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

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 analysed and compared based on Finite Element Method (FEM) analysis.

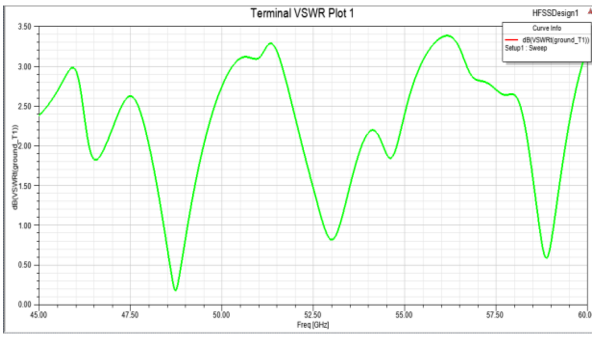


Figure 5: VSWR plot for 4 Stacked MSA

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.

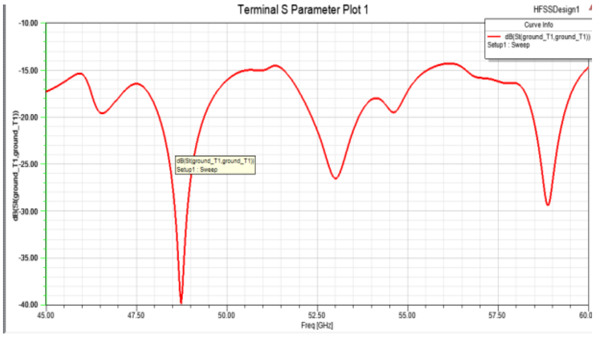


Figure 6: S Parameter for 4 Stacked MSA

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.

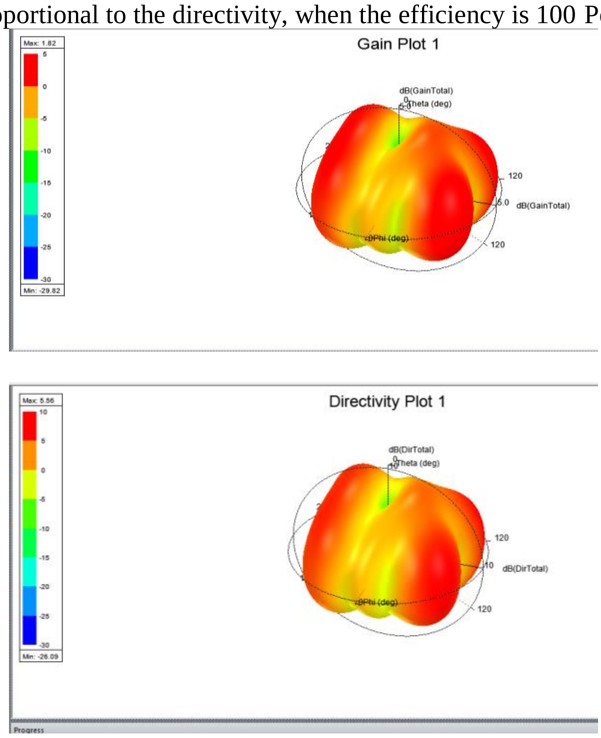


Figure 7: Directivity and Gain of 4 Stacked MSA

Figure 8 shows the impedance chart of 4 Stacked MSA

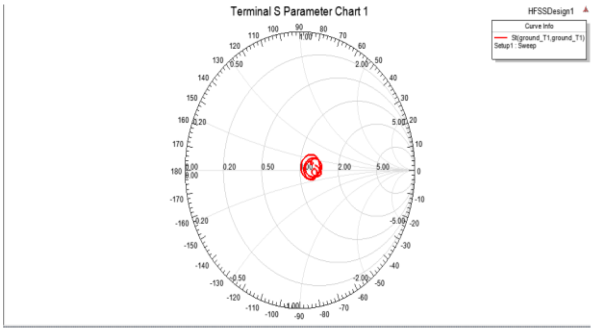


Figure 8: Impedance chart of 4 Stacked MSA

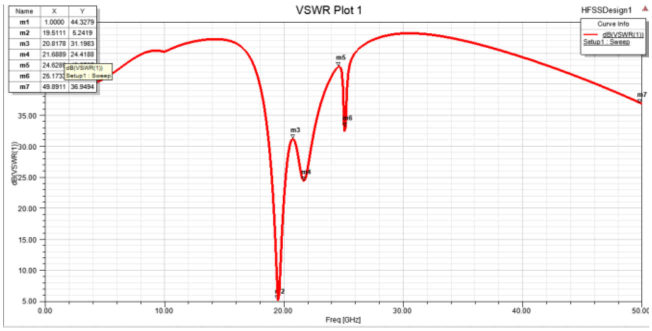


Figure 9: VSWR plot for 8 Stacked MSA

Figure 9 shows the VSWR plot is designed for 8 Stacked MSA. From the graph, VSWR value for 8 Stacked MSA is 3.20.

Figure 10 shows the S parameter plot for the same frequency with result of obtaining for 48.5HZ and it is maximum that of other frequency ranges.

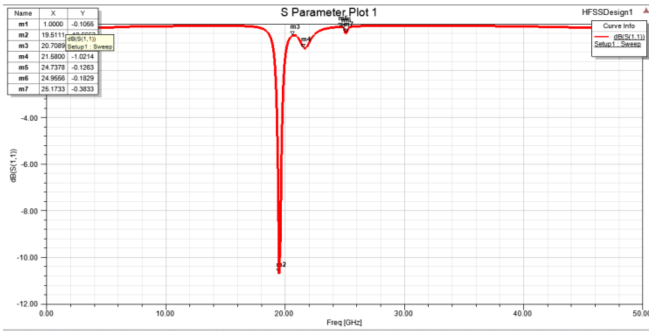


Figure 10: S Parameter for 8 Stacked MSA

Figure 11 shows the results of directivity and gain plot for 8 stacked Microstrip Patch Antenna and gain value obtained for designed antenna is 1.82dB. For that particular gain value, the maximum directivity is 2.74.

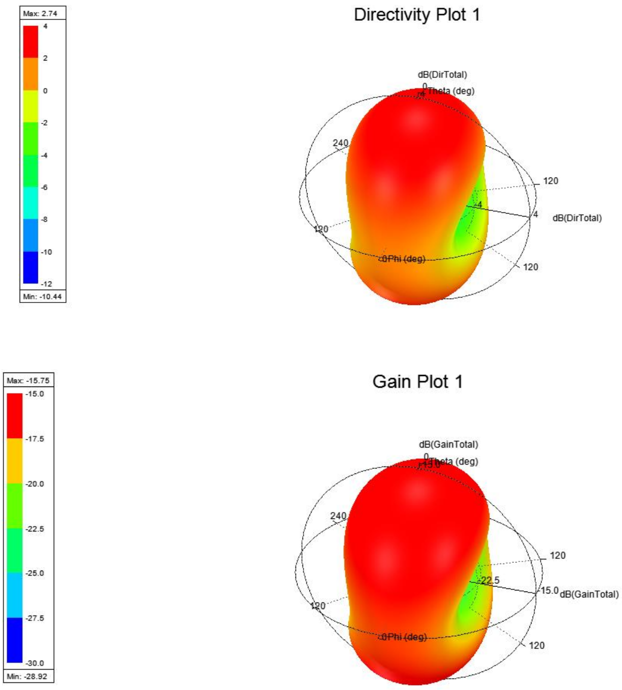


Figure 11: Directivity and Gain of 8 Stacked MSA

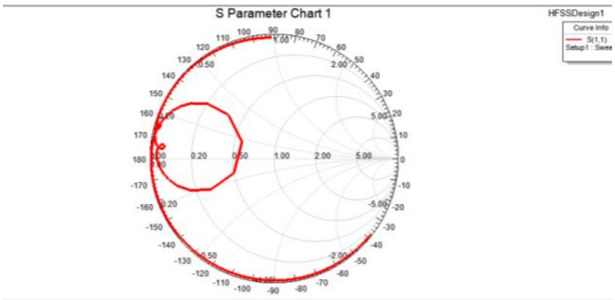


Figure 12: Impedance chart of 8 Stacked MSA.

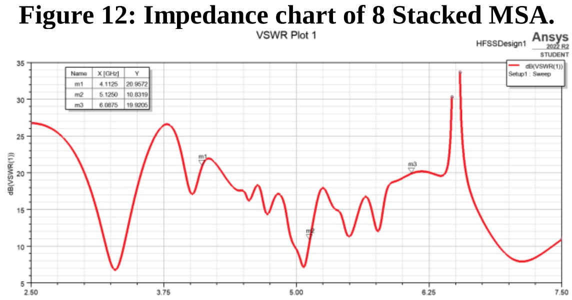


Figure 13: VSWR Parameter for 16 Stacked MSA

Figure 13 shows the VSWR plot is designed for 16 Stacked MSA. From the graph, VSWR value for 16 Stacked MSA is 5.40. This value satisfies the nominal value of VSWR for MSA

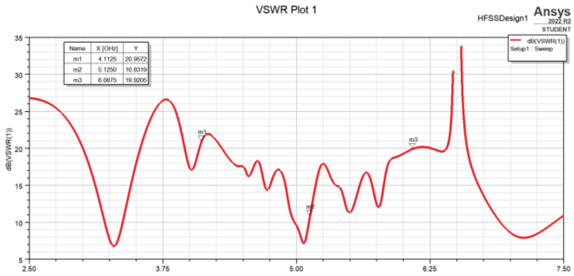


Figure 14: S Parameter for 16 Stacked MSA

Figure 14 shows the S parameter plot for 16 stacked the same frequency 2.4 GHz at 27dB and it is maximum that of other frequency ranges. Figure 15 shows the results of directivity and gain plot for 16 stacked Microstrip Patch Antenna and gain value obtained for designed antenna is 1.08dB. For that particular gain value, directivity is 5.36dB (maximum). It was known that gain is directly proportional to the directivity, when the efficiency is 100 percent..

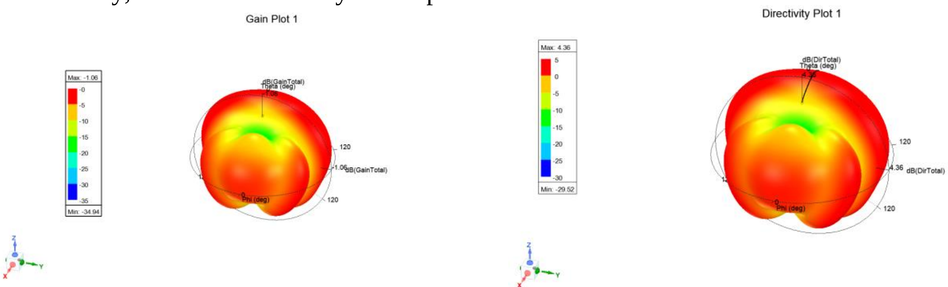


Figure 15: Directivity and Gain of 416Stacked MSA

Table 1: Comparison chart for single stacked MSA, 4 stacked MSA and 8 stacked MSA

parameters	Single Stack MSA	4 Stacked MSA	8 Stacked MSA	16 Stacked MSA
Frequency	2.4	2.4	2.4	2.4
Gain	3.56dB	1.82dB	15.75dB	4.36dB
Directivity	4.67	5.76	2.74	-1.06
VSWR	1.05	2.48	3.20	5.40
S Parameter	X=57.1 Y=18.1	X=48.95 Y=40	X=19.51 Y=10.52	X=3.26 Y=-1.08

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 stacks MSA has higher efficiency compared to other stacked MSA. By this formula f = c/λ, 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 and eight 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 2.89 to 1.82 and the gain for eight stack antenna is 15.75 is increased the directivity is reduced from 5.76 to 2.74. The eight stacked antennas produce greater bandwidth while compared to two stacked antenna and four stacked antenna.

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