Design of a Stacked Triangular shape Microstrip Patch Antenna for Microwave C band Applications

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ABSTRACT

The aim behind making this paper is to design a Stacked Triangular Shaped Microstrip Patch Antenna [STSMPA] for obtaining high bandwidth and gain. This antenna is suitable for C-band applications. The impedance bandwidth of the conventional triangular microstrip patch antenna is 9.81% which is improved after stacking to 18.6%. Stacking also leads to the gain improvement of 4.251 dBi from 2.38 dBi of the triangular antenna. Other parameters such as antenna input impedance, the Voltage Standing wave ratio (VSWR), Return Loss, Gain and Bandwidth are also simulated for the antenna.

Keywords*: C- band, Stacked, STSMA*

1. INTRODUCTION

This research paper deals with the designing of a stacked triangular shaped microstrip patch antenna for wider bandwidth and modern communication system applications. It has been designed to get better performance over conventional antenna. Compared to other antennas microstrip patch antennas have more advantages and better prospects. They are lighter in weight, small in dimensions, low volume, low profile, ease of fabrication and conformity. Moreover, these antennas have dual as well as omni directional polarizations, dual frequency operations, frequency agility and feed line flexibility[1]. The proposed antenna can provide robust wireless applications that can deliver the performance necessary to support emerging applications

An antenna is designed to transmit or receive electromagnetic waves, which is just similar to that of the working of a transducer.A microstrip patch antenna is very simple in construction using a conventional microstrip fabrication technique. Microstrip antennas consist of a patch of metallization on a grounded dielectric substrate[3].

Since microstrip patch antenna has enormous advantages over the conventional antennas, they are preferably used in both commercial as well as defense applications. These antennas are easy to fabricate and integrate with solid state devices. Like any other devices microstrip patch antenna also havesome disadvantages such as low bandwidth and low gain. Since the antenna has a dielectric as it’s substrate, it is therefore responsible for the radiation pattern and impedance bandwidth.The increase in dielectric constant leads to the decrease in antenna bandwidth.

The rectangle and circular shape antennas are quite common, but the antenna which has attracted the attention is the triangular shaped microstrip patch antenna.

2. RECTANGULAR PATCH ANTENNA

Rectangle is the most common and the standard configuration of microstrip patch antenna which is required for high bandwidth design. It consists of a sandwich of two parallel conducting layers separated by a single thin dielectric substrate.The lower

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conductor functions as a ground plane and the upper conductor represent the antenna radiating part. This configuration is simple and rugged but it is limited in its bandwidth.

3. TRIANGULAR MICROSTRIP PATCH ANTENNA

The conventional rectangular antenna has a limitation of low gain and low bandwidth. For the purpose of enhancement in the bandwidth of the rectangular patch, the geometry of patch has to be modified.The patch has been modified by cutting a triangular shape out of the rectangular patch.

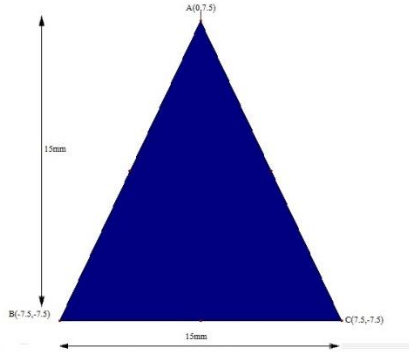

Fig.1: Triangular Microstrip Patch Antenna

The return loss of the conventional triangular antenna turns out to be 22dB which is shown in figure2 .

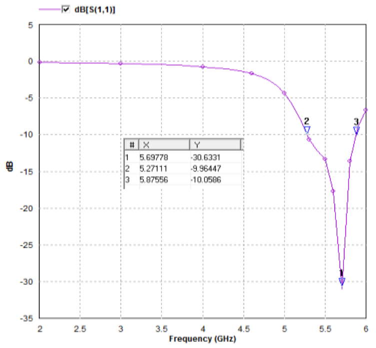

Fig.2:Variation of return loss versus frequencies of TMPA

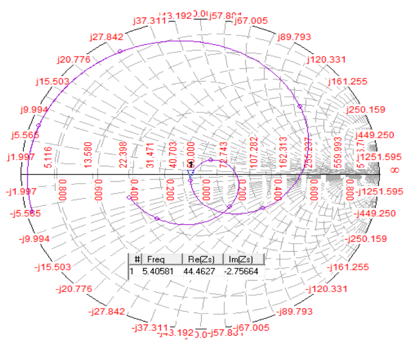

Fig.3:Variation of input impedance of TMPA

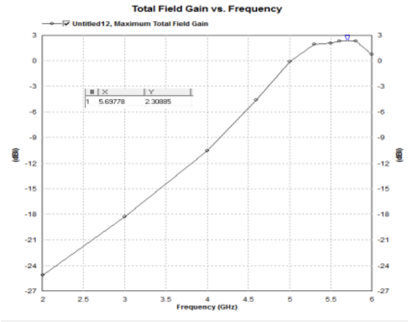

Fig.4: Variation of gain versus frequencies of TMPA

The gain obtained from the triangular microstrip patch antenna is 2.38dB at a resonating frequency 5.4GHz which is still low as shown in figure.

For further improvement in gain and bandwidth of the antenna, another level of modification is done in form of stacking.

4. STACKED TRIANGULAR PATCH ANTENNA

The gain and bandwidth of the antenna has been improved by overlapping an additional patch over the conventional patch by keeping the air medium in the gap between the two. This method of overlapping is known as Stacking and the resultant antenna is known as Stacked Triangular shaped Micro strip Patch Antenna(STSMPA) Both the patches must have the same material, shape, dimension, thickness and properties so that distortion can be limited. Keeping air medium having zero loss tangent, dielectric constant is 1.

Table 1: Stacked Triangular Shaped Microstrip Patch Antenna (STSMPA) design parameters

S. No.	Parameters	Design Considerations
1.	Patch dimensions	L=15mm W=15mm
2.	Dielectric substrate (FR4)	tanδ= 0.025, εr=4.4
3.	Substrate height	1.6mm
4.	Probe Radius	0.62mm

The research methodology deals with the conventional triangular antenna designed by taking triangular patch and stacking over it. For this we are using IE3D simulation software and analyze different parameters with the help of this software[1]. At first a triangular shape is cut from a rectangular patch and then stacking is done.

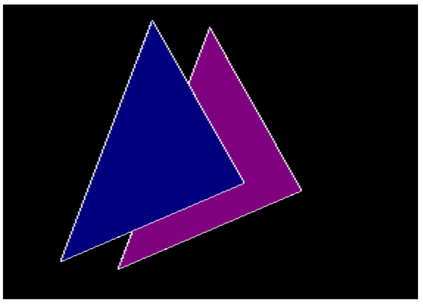

Fig.5: Stacked Triangular Shaped Microstrip patch antenna

The antenna is designed with dielectric constant of 4.4 and loss tangent of 0.025. Thesubstrate thickness of antenna is now increased to analyze the variation in bandwidth

After applying modification for stacking technique, we received better results in terms of bandwidth, gain and at the same time desired frequency bands for broadband applications. The figure2 shows the variation of return loss with frequency. It shows that design considerations of the final modified antenna are resonating at 5.29 GHz.

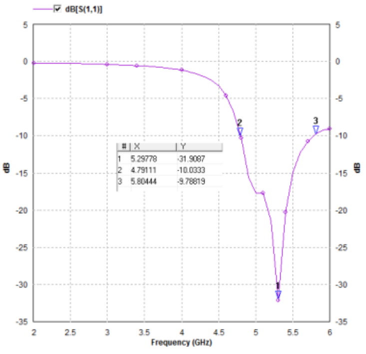

Fig.6: Variation of Return loss versus frequencies of STSMPA

The minimum value of return loss is 32dB which is clearly shown in figure 3.

The impedance bandwidth of the antenna is increased to 18.6%, corresponding to the central frequency 5.28GHz.

The simulated results also show that the input impedance at the resonating frequency is close to 50 ohm impedance of the feed line considered in the present work. These results, as per figure 2 indicate that simulated antenna is nicely matched with the feed line and very little reflections are taking place at the feed location .

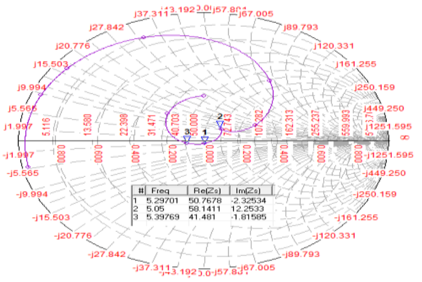

Fig.6: Variation of input impedance of STSMPA

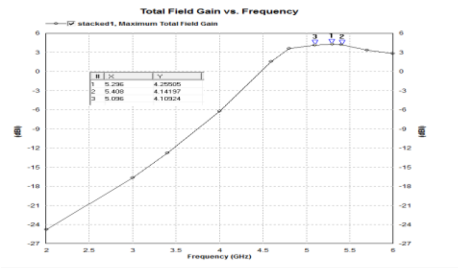

Fig.7: Variation of Gain versus frequencies of STSMPA

The gain of stacked triangularshaped microstrip patch antenna [STSMPA] is 4.25dBi at resonating frequency 5.29 GHz as shown in figure 5.

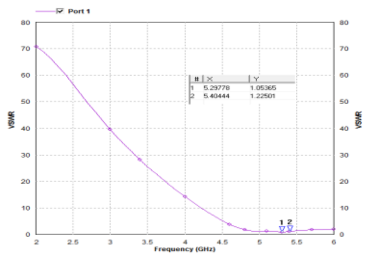

Fig.8: Variation of VSWR versus frequency of STSMPA .

The simulated VSWR for the considered resonating frequency is 1.05 , which is close to unity.

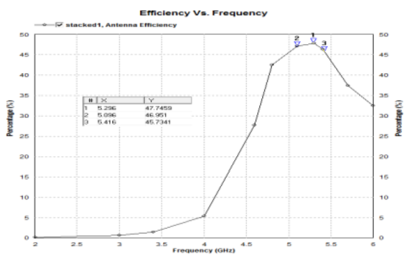

Fig.9: Variation of Efficiency versus frequencies of STSMPA

The efficiency of the proposed antenna is found to be 47.74% as shown in figure 6

5. RESULTS

The bandwidth of the conventional triangular antenna was 9.81% which is further improved to 18.6% after stacking. The gain of 2.38 dBi has been increased to 4.25 dBi. The return loss becomes 32dB after stacking. Along with gain and bandwidth all other parameters have also been improved.

6. CONCLUSION

The Stacked Triangular shaped Microstrip Patch Antenna is designed and simulated in this research work. This antenna is suitable for Microwave C-band applications[4].The bandwidth of conventional triangular antenna was 9.81% which was increased by 18.6%

after stacking. Along with Bandwidth, Gain and Return Loss also improved due to stacking.

7. ACKNOWLEDGEMENT

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