Analysis of Dual Band Pyramidal Serrated Antenna

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ABSTRACT:
A novel design of Dual band pyramidal serrated microstrip patch antenna was designed and Simulational results are presented in this paper. Equal spaced serrated pyramidal shapes are etched on four sides of the patch and its performance characteristics are simulated using commercial software HFSS. The current model is resonating at dual band with moderate gain. Return loss, radiation patterns, input impedance and other antenna parameters like electric, magnetic and surface current distributions are simulated and analyzed in this present work. Simulated results show that the proposed antenna achieved broadsided radiation pattern with linear polarization characteristics.

Keywords: **Dual Band, Pyramidal Antenna, Serrations, Surface current distribution.**

I. INTRODUCTION:
Microstrip antennas are the most rapidly emerging area in the antenna field in the most recent years due to their light weight, low volume, thin profile configuration and low fabrication cost. Because of these advantages they are extensively used in the communication systems such as personal communication systems, mobile satellite communications, wireless communication systems, direct broadcast television, wireless local area networks etc.. On the other hand, MSAs suffer from very narrow impedance bandwidth (1-2%) with respect to center frequency [1-4]. This poses a design challenge for the antenna designer to meet size reduction with acceptable bandwidth and gain characteristics [5-6]. The present trend of wireless application system also needs to have multiple functionality that presents challenges to have dual-frequency antenna in a simple manner. There are several methods to obtain dual frequency, size reduction with improvement in bandwidth and gain by the use of thick substrate, cutting a resonant slot inside the patch, the use of a low dielectric substrate, multi- resonator stack configurations, the use of various impedance matching and feeding techniques, and the use of slot antenna geometry [7-8].

II. ANTENNA DIMENSIONS AND DESIGN:

The present antenna is designed on RT-duroid substrate of thickness of 3mm. the outer boundary of the patch is having pyramidal serrated designs of equal separation. The dimension of patch is about 22X17mm and that of substrate is of 60X60mm. For optimum impedance matching the feed location along y-axis is chosen at 5mm distance from the center. The coaxial feeding is applied to this model with coaxial inner radius of 0.4mm and outer radius of 1.5mm. The feed length from patch to the outer part is about 4mm. the total size of the antenna is 60X60X10mm.

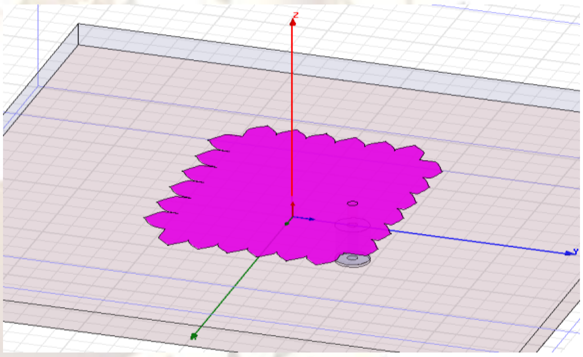

Figure (1) Pyramidal Serrated Patch Antenna

III. RESULTS AND ANALYSIS:

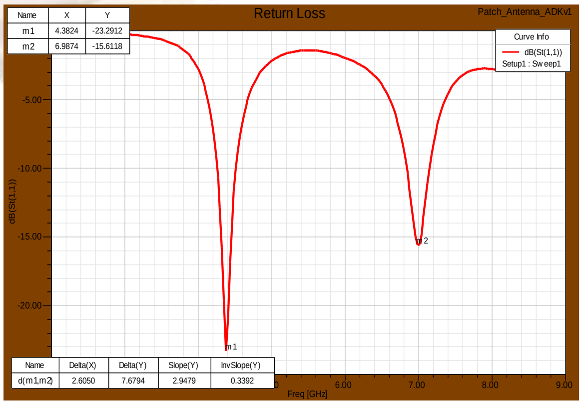

Figure (2) Return Loss Vs Frequency

The dual band resonated return loss curve is shown in figure (2). From the return loss curve we got the value of return loss -23.2dB and -15.61dB at 4.3 and 6.9GHz. This is showing excellent value of return loss <-10dB at both the frequencies.

The input impedance of an antenna is critical to achieve proper matching to the transmitting device to which it is attached. Most transmission lines have an impedance of 50Ω, while the impedance of an antenna changes with frequency. At some frequencies a given antenna will not be matched to the transmission line, and will not accept or radiate power, while at those frequencies where the antenna is designed to operate, the impedance of the antenna will allow the electromagnetic energy to pass into the structure and radiate into the surrounding space.

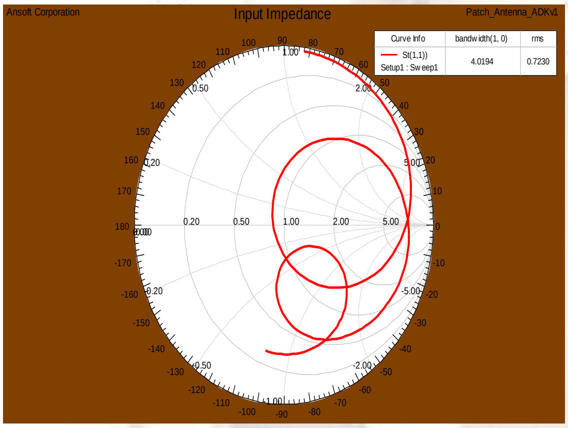

Figure (3) Input Impedance smith chart

These frequencies would be deemed to be inside the antenna's impedance bandwidth. Figure (3) shows the input impedance smith chart. The rms of 0.72 and impedance bandwidth of 0.85% is attained from the current design. In many wireless systems an antenna is designed to enhance radiation in one direction while minimizing radiation in other directions. This is achieved by increasing the directivity of the antenna which leads to gain in a particular direction. The gain is thus "the ratio of the radiation intensity, in a given direction, to the radiation intensity that would be obtained if the power accepted by the antenna were radiated isotropically" (that is, equally in all directions). In the case of a receiving antenna, an increase in gain produces increased sensitivity to signals coming from one direction with the corollary of a degree of rejection to signals coming from other directions. Antenna gain is often related to the gain of an isotropic radiator, resulting in units dBi. Figure (4) shows the two dimensional pattern for gain and the proposed antenna is giving the maximum gain of 6.27dB.

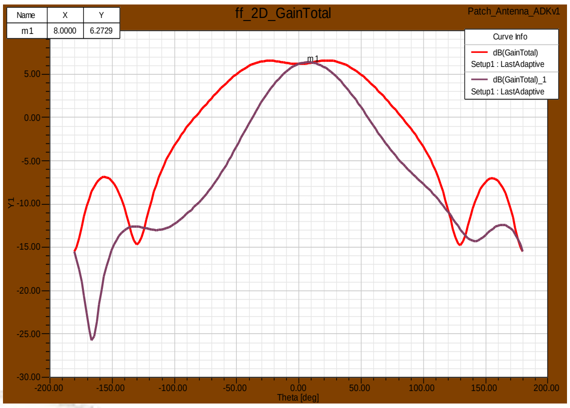

Figure (4) 2D gain

The radiation of the antenna is expressed in terms of the field strength E (in V/m), and then the graphical representation is called field strength pattern or field radiation pattern. Similarly if the radiation of the antenna is expressed in terms of the power per unit solid angle, then the graphical representation is called power radiation pattern. Figure (5), (6) shows the radiation pattern of the antenna. The far-zone electric field lies in the E-plane and far-zone magnetic field lies in the H-plane. The patterns in these planes are referred to as the E and H plane patterns respectively. Figure (5) shows the radiation pattern of E-plane(y-z plane) in 3-Dimensional view. Figure (6) shows the radiation pattern of H-plane(x-z plane) in 3-Dimensional view.

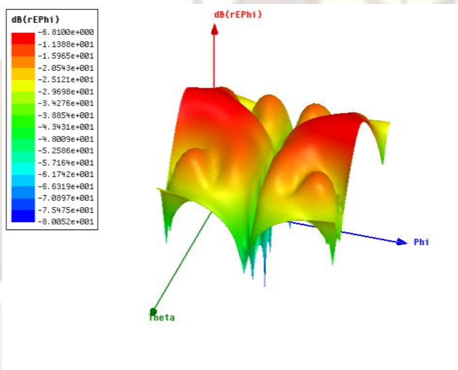

Figure (5) Radiation Pattern in Phi direction

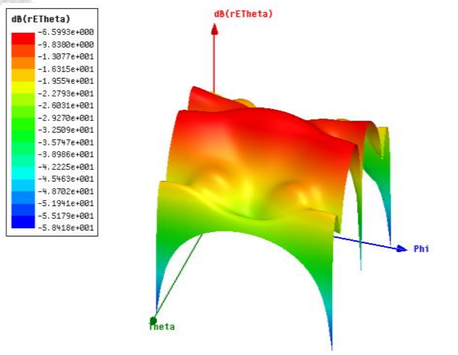

Figure (6) Radiation Pattern in Theta direction

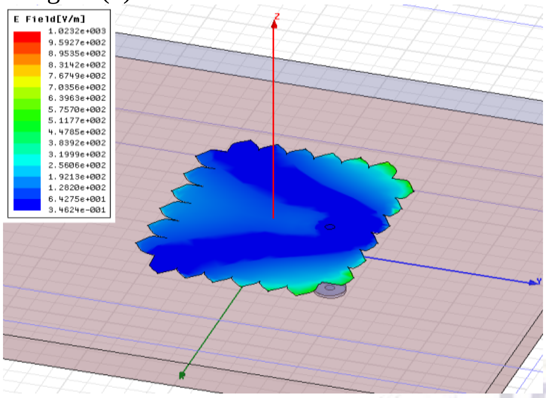

Figure (7) Electric Field distribution

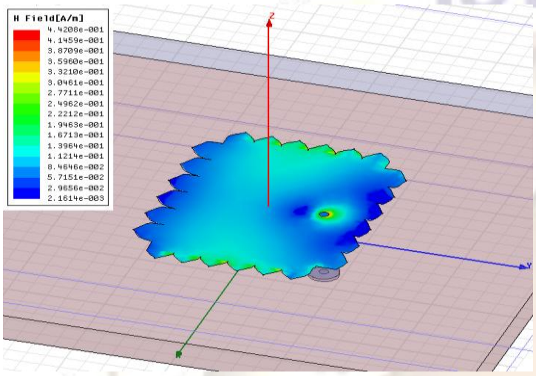

Figure (8) Magnetic Field distribution

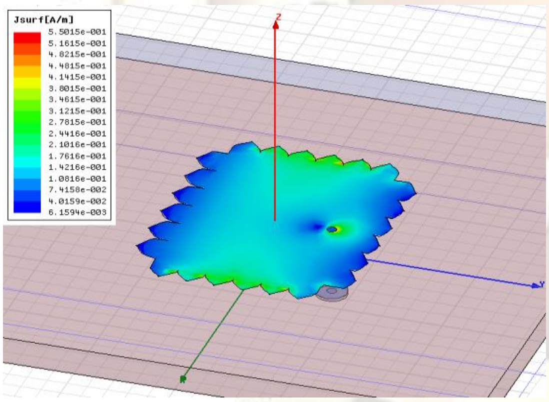

Figure (9) Surface Current Field distribution

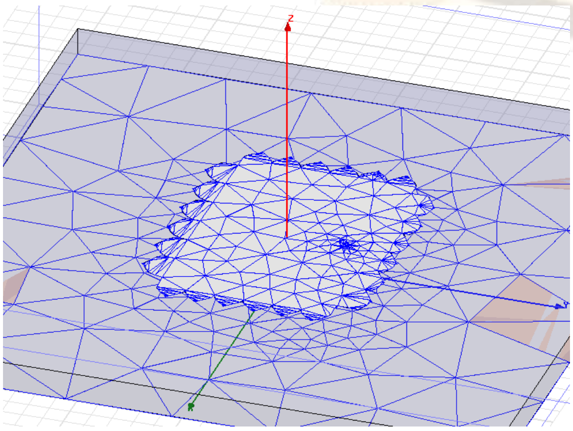

Figure (10) Mesh generation

Antenna Parameters:

Quantity	Value	Units
Max U	0.00030352	W/sr
Peak Directivity	4.4904	
Peak Gain	4.4338	
Peak Realized Gain	1.3041	
Radiated Power	0.00084942	W
Accepted Power	0.00086026	W
Incident Power	0.0029247	W
Radiation Efficiency	0.9874	

Maximum Field Data:

rE Field	Value	Units	At Phi	At Theta
Total	0.47838	V	0deg	24deg
X	0.2894	V	180deg	32deg
Y	0.46461	V	85deg	6deg
Z	0.27418	V	170deg	56deg
Phi	0.45656	V	180deg	0deg
Theta	0.46777	V	90deg	8deg
LHCP	0.46544	V	5deg	-28deg
RHCP	0.46669	V	175deg	-28deg
Ludwig3/X dominant	0.35612	V	175deg	40deg
Ludwig3/Y dominant	0.46777	V	90deg	8deg

Table (1) Antenna Parameters and Maximum field data

Table (1) shows additional antenna output parameters like Peak Gain, Peak Directivity, Radiated Power, Radiated Efficiency etc and radiated field data at Phi and Theta angles.

IV. CONCLUSION:

Dual polarized Pyramidal serrated antenna was designed and simulation results are presented in this work. This antenna is resonating at 4.3 and 6.9 GHz with return loss of -23.2 and -15.6 respectively. The gain of the antenna is about 6.27dB and bandwidth of 0.85% is achieved from the current model. Peak directivity of 4.49 and peak gain of 4.43 is attained with radiation efficiency of 0.98 from the simulated results. The current distribution showing that the edge of the patch is having high concentration of field over the other parts of the patch due to the fringing fields at edges. The simulation results showing the applicability of this antenna in the wireless communication.

V. ACKNOWLEDGMENT:
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VI. REFERENCES:
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