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Research paper

Design and Measurement of Performance Parameters of Micro strip Patch Antenna used for Wi - Max and C-Band Applications

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Abstract

In this paper the design of Multi-Band patch antenna is discussed. This Multi-Band operation is achieved by cutting few slots on the radiating patch. Co-axial feeding technique is employed in the design and FR4 is taken as the dielectric substrate. The simulation results along with different antenna parameters such as Return loss, VSWR are plotted. The designed antenna resonates at 3.8GHz, 6.1GHz, 7.1GHz, 8.6GHz and 9.1GHz frequencies with increased bandwidth and this antenna can be used in WI-MAX and C band applications.

Keywords: *Multi-Band, FR4 substrate, slot, Co-axial feeding, HFSS (High frequency structure simulator), Return loss.*

1. Introduction

The need for multifunction systems is growing with the increasing number of technologies related to communication devices which in turn necessitates research in field of antenna and the quest for new structures capable of responding to multiple frequencies depending on the requirement. Lately, there has been a focus on the research of Ultra Wide Band (UWB) antennas, which are broadband antennas, in the order of several GHz [1]. These communication systems have the potential of exhibiting very high bandwidth, less amount of fading from multipath and low power requirements. Replacing multiple antennas by a single antenna leads to decrease in size and weight. Wide band antennas can be easily created with large slot width [2]. Various investigates have led us to the designing of multiband antennas by crafting multiple slots which possess different dimensions are applied. In [3], wide-band L-shape slot with band-rejecting strips has been made to create a multiband slot antenna. By using slotting technique, the Bandwidth of the antenna at resonating frequencies can be increased [4]. The designed antenna works at 3.8GHz, 6.1GHz, 7.1GHz, 8.6 GHz and 9.1GHz frequencies with a return loss of -17.6dB, -10.1dB, -25dB, -20dB, -23.2dB. This Multi-Band operation is achieved by different techniques. One of the primary methods is by cutting few slots depending on the requirement and then optimizing the slot dimensions and the feed point location. The impedance of feed is matched to 50 ohms with the patch. The design and simulation are done in HFSS. In this paper, a compact design of dual-band antenna consisting of multiple slots is proposed for WI-MAX and C-Band applications.

2. Methodology

Initially, a Rectangular Patch antenna is designed with dimensions of substrate as 5x50x1.6mm, the substrate used is FR4 with a dielectric constant 4.4 and the rectangular patch has dimensions L= 29.45mm; W= 38.16mm which operates at 3.4Ghz is designed in HFSS [5]. To make it resonate, a different frequencies slotting technique is employed. In this method slots are cut on the patch and optimization of slot dimensions and slot placement is changed to make it operate at multiple frequencies, we employ trial & error method to get the slot dimensions and the co-ordinates of the slot. Fig .1 shows the step by step procedure of designing a Multi-Band micro strip patch antenna.

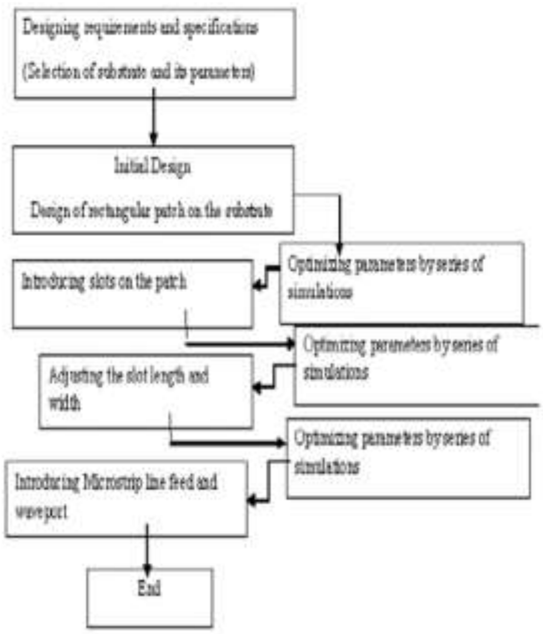


Fig. 1: Design procedure of antenna Figures

A slot of dimensions 13x10mm is cut on patch with the slot centred at (13.5, 0, -1.6) on x-axis. Similarly, another slot is cut on patch symmetrical to the above slot on other side of y-axis. A radiation box is taken along the boundaries of the antenna to capture the radiations; the radiation box length along y-axis is 6.6mm starting from the input pin [6]. Now, the co-axial feed point has to be optimized by series of simulations to get an input impedance of around 50Ohm's. The designed antenna is shown in Fig 2

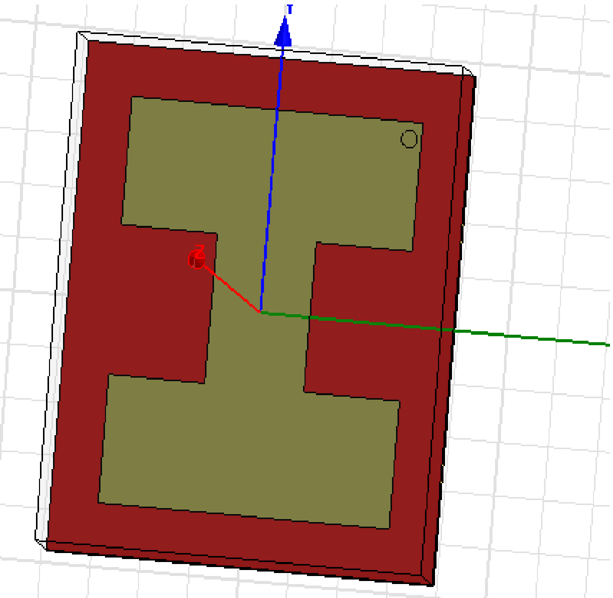


Fig. 2: Final Design of proposed antenna

If the impedance is matched properly, the results obtained will have good return loss of around -10dB to -35dB and a VSWR in between 1-2dB. In HFSS the far field radiations are also shown by plotting the Radiation pattern in 2D or 3D. HFSS uses Finite Element Method, with adaptive meshing, and good graphics to give best results for all of the 3D EM problems [7].

3. Results

After the completion of design part of the antenna we observe the simulated results of the proposed antenna which includes return loss (S11 parameter), VSWR, 3D radiation pattern in HFSS. Once the simulation is done, go to results and plot S11, VSWR and 3D radiation pattern.

3.1. Return loss

S11 parameter is the return loss of antennas. Return loss is defined as the ratio of reflected power to input power of the antenna. The return loss is expected to be -10dB to -30dB for good communication. Antennas usually radiates efficiently at certain range of frequencies. It indicates the amount of power consumed by the load. Fig 3 shows the Return loss plot.

From Fig. 3 it is noted that the antenna is operating at 3.8GHz, 6.1GHz, 7.1GHz, 8.6GHz and 9.1GHz with a return loss of -17.6dB, -10.1dB, -25dB, -20dB, -23.2dB

3.2. VSWR

Voltage standing wave ratio is a function of reflected electric wave and is also function of power reflected from the antenna. It is a function of the reflection co efficient. From Fig. 4 it is observed that at 3.8GHz, 6.1GHz, 8.6GHz and 9.1GHz the VSWR is 2.07dB, 5dB, 1.77dB, 1.201dB..

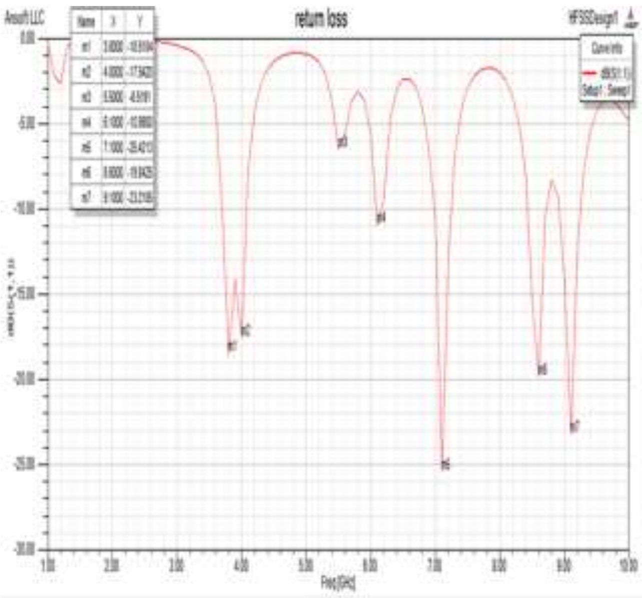


Fig. 3: Return loss VS Frequency plot in HFSS

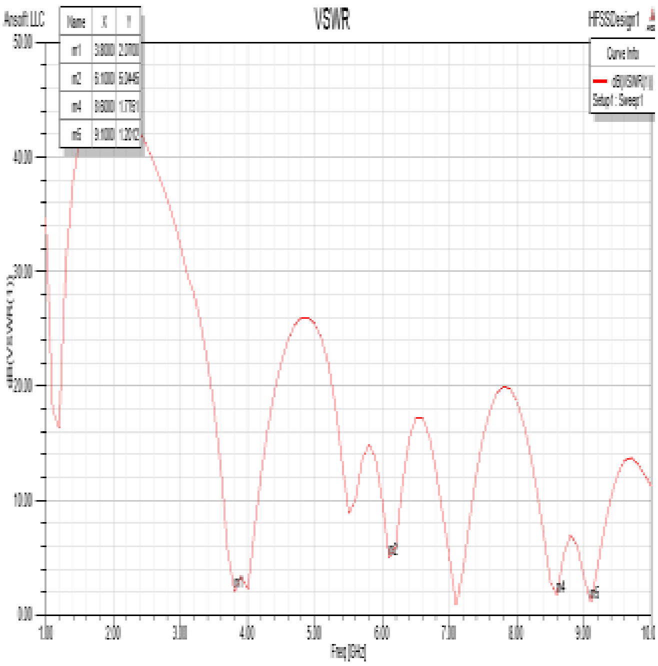


Fig. 4: VSWR plot

3.3. Radiation Pattern

It is a plot of the far-field radiation properties of an antenna. It is written as a function of the spatial co-ordinates which are given by the elevation angle (θ) and the azimuth angle (φ). The radiation pattern can be a 2D or 3D plot. Fig. 5 shows the 3D radiation pattern plot of designed antenna using HFSS.

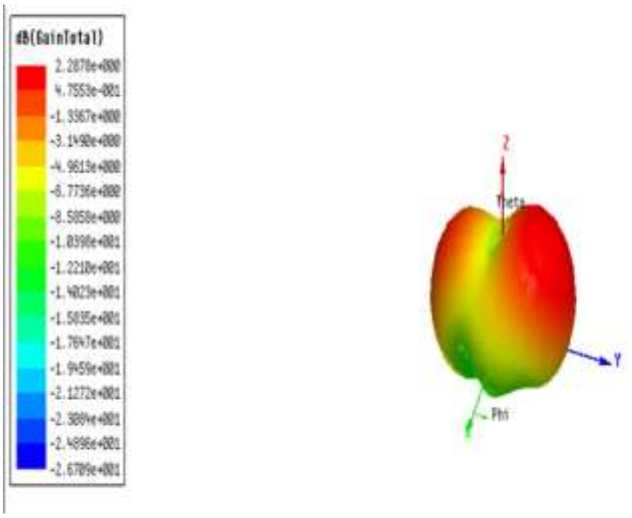
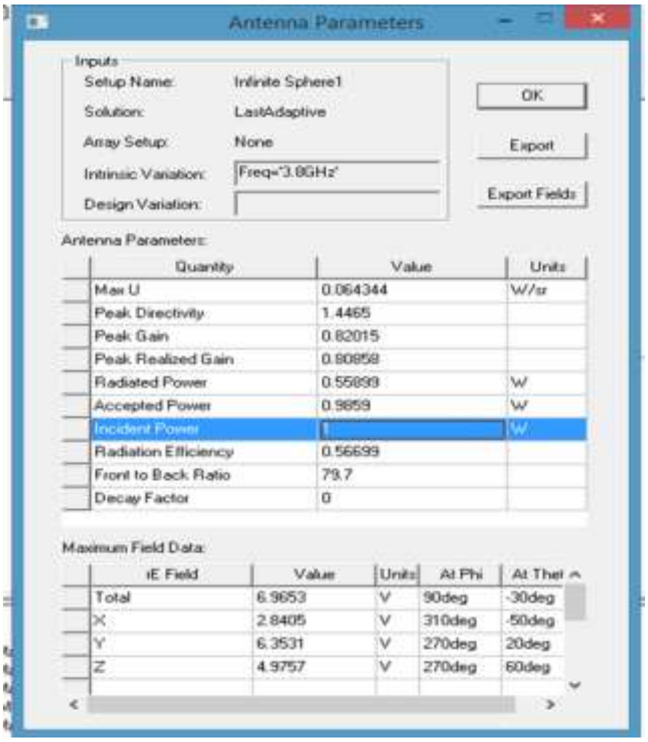


Fig .5: Radiation pattern

3.4. Other parameters of designed antenna

In the results tab, select on calculate parameters to show different antenna parameters at various simulated frequencies. Simulation is done in HFSS and antenna parameters at different frequencies are given in Fig. 6, Fig. 7, Fig. 8 and Fig. 9.



Antenna Parameters

Inputs

Setup Name:	Infinite Sphere1
Solution:	LastAdaptive
Array Setup:	None
Intrinsic Variation:	Freq='3.8GHz'
Design Variation:	

OK | Export | Export Fields

Antenna Parameters:

Quantity	Value	Units
Max U	0.064344	W/sr
Peak Directivity	1.4465	
Peak Gain	0.82015	
Peak Realized Gain	0.80858	
Radiated Power	0.55893	W
Accepted Power	0.9859	W
Incident Power	1	W
Radiation Efficiency	0.56693	
Front to Back Ratio	79.7	
Decay Factor	0	

Maximum Field Data:

rE Field	Value	Units	At Phi	At Thet
Total	6.9653	V	90deg	-30deg
X	2.8405	V	310deg	-50deg
Y	6.3531	V	270deg	20deg
Z	4.9757	V	270deg	60deg

Fig. 6: Antenna parameters at 3.8GHz

Antenna Parameters

Inputs

Setup Name:	Infinite Sphere1
Solution:	LastAdaptive
Array Setup:	None
Intrinsic Variation:	Freq='6.1GHz'
Design Variation:	

OK | Export | Export Fields

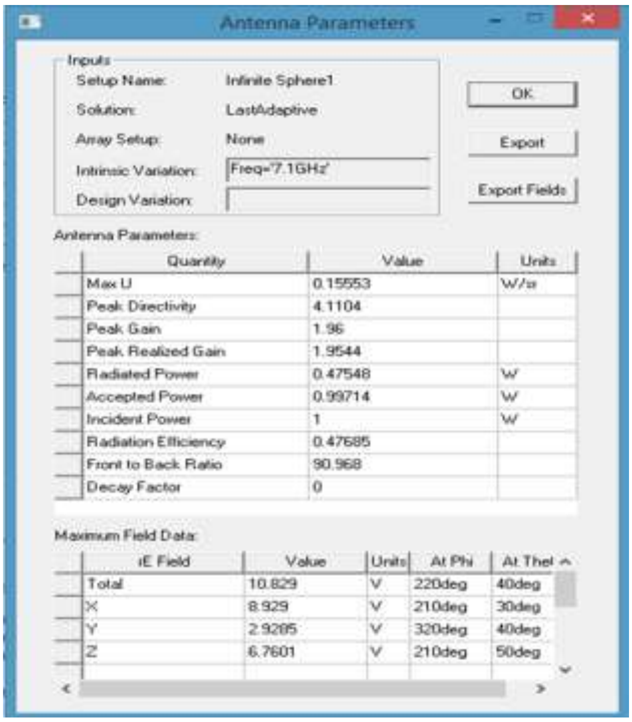
Antenna Parameters:

Quantity	Value	Units
Max U	0.11702	W/sr
Peak Directivity	2.0057	
Peak Gain	1.598	
Peak Realized Gain	1.4705	
Radiated Power	0.5096	W
Accepted Power	0.9202	W
Incident Power	1	W
Radiation Efficiency	0.55379	
Front to Back Ratio	37.000	
Decay Factor	0	

Maximum Field Data:

rE Field	Value	Units	At Phi	At Thet
Total	9.3931	V	90deg	30deg
X	3.5437	V	320deg	40deg
Y	8.5565	V	90deg	20deg
Z	6.0289	V	90deg	50deg

Fig .7: Antenna parameters at 6.1GHz



Antenna Parameters

Inputs

Setup Name:	Infinite Sphere1
Solution:	LastAdaptive
Array Setup:	None
Intrinsic Variation:	Freq='7.1GHz'
Design Variation:	

OK | Export | Export Fields

Antenna Parameters:

Quantity	Value	Units
Max U	0.15553	W/sr
Peak Directivity	4.1104	
Peak Gain	1.96	
Peak Realized Gain	1.9544	
Radiated Power	0.47548	W
Accepted Power	0.99714	W
Incident Power	1	W
Radiation Efficiency	0.47685	
Front to Back Ratio	90.968	
Decay Factor	0	

Maximum Field Data:

rE Field	Value	Units	At Phi	At Thet
Total	10.829	V	220deg	40deg
X	8.929	V	210deg	30deg
Y	2.9285	V	320deg	40deg
Z	6.7601	V	210deg	50deg

Fig. 8: Antenna parameters at 7.1GHz

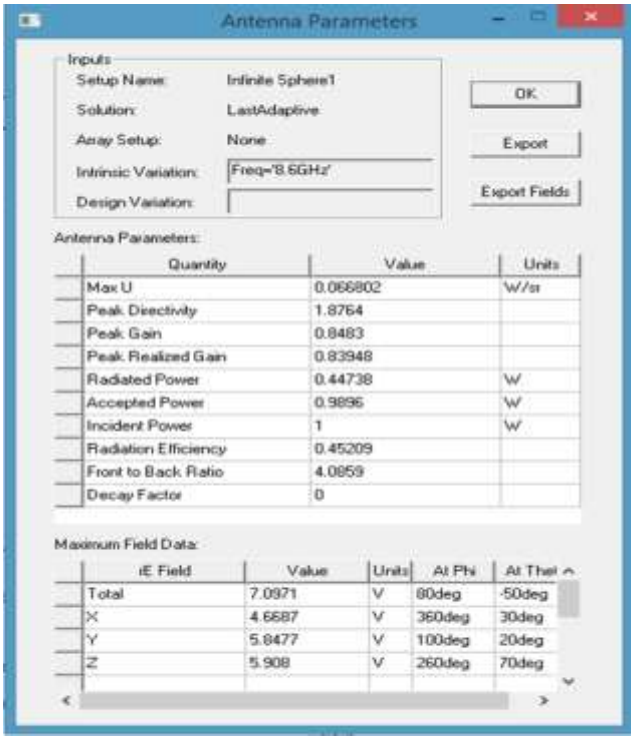


Fig. 9: Antenna parameters at 8.6GHz

4. Conclusion

The proposed antenna resonates at 3.8GHz, 6.1GHz, 7.1GHz, 8.6GHz and 9.1GHz with a return loss of -17.6dB, -10.1dB, -25dB, -20dB, -23.2dB. The designed Multi-Band antenna has been simulated using simulation software and for this antenna a sufficient bandwidth is also presented via the co-axial feed line at the desired resonant frequencies is achieved. The projected antenna is a low contour antenna, thus it is very solid and is fed using a coaxial wire with inner conductor radius of 0.5mm. The designed antenna a suited for WI-MAX (3.2-3.9GHz) and C band (4-9GHz) applications.

Acknowledgement

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