Miniaturization of Microstrip Patch Antenna

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Abstract—In this letter, the miniaturization design of microstrip patch antenna is presented and analyzed. By creating notch and adjusting VSWR , the size of the original antenna is reduce from 24X30 mm^2 to 20X16 mm^2. Experimental result indicates that the antenna gives working bandwidth of 415MHz with VSWR<2. 3DRadiation pattern is observed. The MPA antennas are small in size, has good radiation characteristics, wide bandwidth to fulfill today's wireless communication.

Index Terms—MPA, slot , miniaturization, VSWR, Directivity.

I. INTRODUCTION

Antenna is a electrical device which radiates signal and it act as a tranducer which converts electrical energy into electromagnetic energy. A MPA antenna (also known as a rectangular MPA) is a type of radio antenna with a low profile, which can be mounted on a flat surface. It consists of a flat rectangular sheet or "patch" of metal, mounted over a larger sheet of metal called a ground. The commonly used microstrip antenna is a rectangular patch which are like a microstrip transmission line.

When feed of antenna is excited, then the antenna will emit radiation distributed in space in particular direction. Antenna having various parameters like radiation pattern, input impedance, return loss bandwidth directivity and gain, beam width, side lobes, polarization etc. [1].

There several type of antenna used for communication like horn. Dipole, slot, parabolic .MPA have merits like low-profile, low weight, low cost, easy to fabricate and installation, and integrable with other microwave devices. Due to these merits, this are used in mobile radio and wireless communication systems, radars, missile applications, etc. Therefore, antenna miniaturization is an important aspect in wireless communication systems. Hence the requirement for reduced antenna size has increased hugely over the past years [2]-[4].

Examples of the microstrip antenna miniaturization such as slotting, using half cut and high dielectric material substrate. Also using DGS, EBG technique, the miniaturization of patch antenna can be done [5]-[6].

II. DIAGRAM

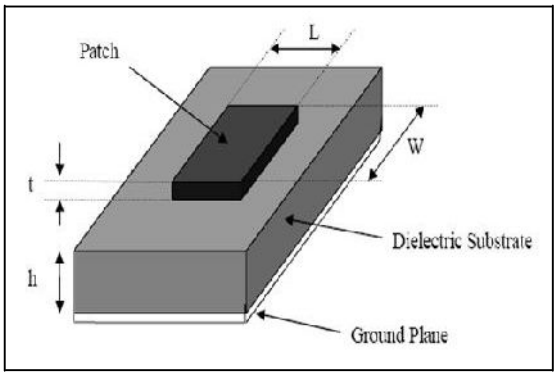


Fig-1: Construction of microstrip patch antenna

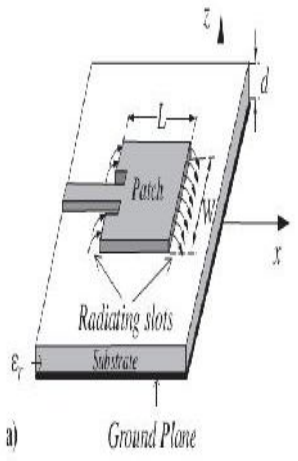


Fig-2: Structure of microstrip patch antenna

For a rectangular patch, the length L of the component should be $\lambda 0/3 < L < \lambda 0/2$. Where, $\lambda 0$ is the free space wavelength. The patch is chosen to be thin such that $t << \lambda 0$ (where t is the patch thickness). The height h of the dielectricsubstrate is typically $0.003\ \lambda 0 \leq h \leq 0.05\ \lambda 0$. There are various materials that can be used as substrate of microstrip antenna and their dielectric constants should be of $2.2 \leq \varepsilon r \leq 12$.

III. DESIGN

Patch shape	Rectangular
Frequency	5.5GHz
Dielectric constant	4.4
Height substrate	1.6mm
Feeding method	Line feeding
Polarization	Linear

Table -1:Element of MPA

A. Theoretical design

Step 1: Calculation of the Width (*W*):

The width of the Microstrip patch antenna is given as:

$$W = \frac{C}{2f_r\sqrt{\left(\frac{\varepsilon_r + 1}{2}\right)}}$$

Where;

c - Free space velocity of light, 3 x 10^8 m/s

fr - Frequency of operation

ε_r - Dielectric constant

Step 2: Calculation of Effective dielectric constant (ε_{reff}):

The effective dielectric constant is:

$$\varepsilon_{reff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left\{1 + 12\frac{h}{w}\right\}^{-1/2}$$

Where;

ε_r - Dielectric constant

h - Height of dielectric substrate

W - Width of the patch

Step 3: Calculation of the Effective length (L_{eff}):

The effective length is:

$$L_{eff} = \frac{C}{2f_r\sqrt{\varepsilon_{reff}}}$$

Where;

c - Free space velocity of light, 3 x 10^8 m/s

f_r - Frequency of operation

ε_{reff} - Effective dielectric constant

Step 4: Calculation of actual length of patch (*L*):

The actual length is obtained by:

$L = L_{eff} - 2\Delta L$

Where,

L-Actual length of patch.

L_{eff} -Effective length.

ΔL-Small difference between length.

Parameters	Calculation
Operating frequency	5.5GHz
Dielectric constant	4.4
Substrate height	1.6mm
Substrate length and width	20mmX16mm
Patch length and width	12mmX10mm
Feed line length and width	6.5mmX3mm

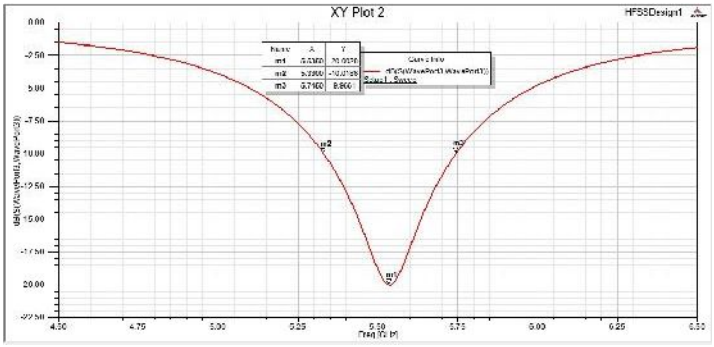
Table -2:Dimension of MPA

IV. SIMULATION RESULTS

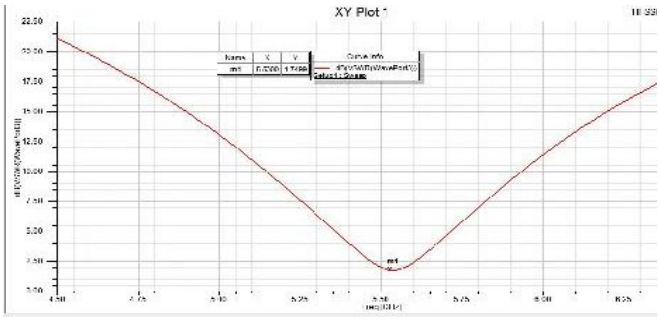
The simulated results of antenna are measured using HFSS version-11. For proper transmission of signal by antenna, the S11 parameter of antenna should be less than -10dB and VSWR Should be less than 2.

1.Simulation result before reduction

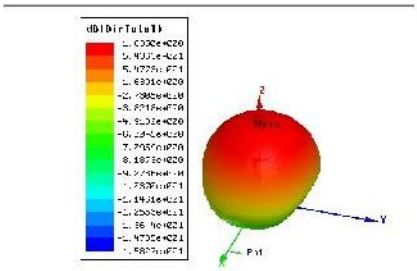
A. Reflection Coefficient-1



B. VSWR



C.Directivity

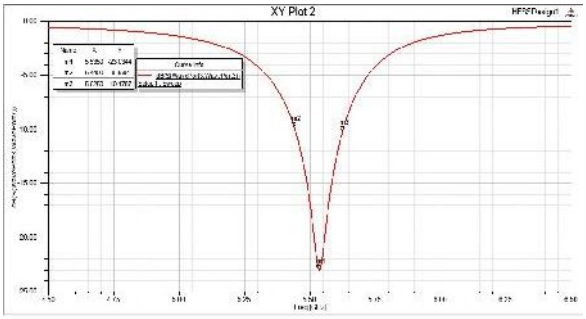


Parameters	Before reduction	After reduction
Return loss(dB)	-20.0028	-23.03
VSWR	1.7	1.2
Bandwidth(MHz)	415	185
Directivity(dB)	1.6350	2.0168
Size reduction(%)	-	37.5

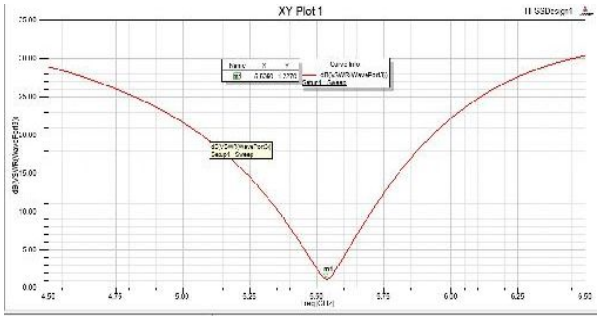
Table -3: Result analysis

2.Simulation result after reduction

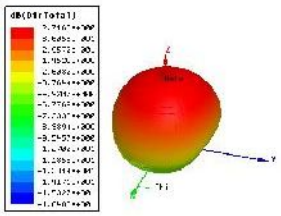
B. Reflection Coefficient-1



B. VSWR



C.Directivity



V. APPLICATION

The MPA used for GPS as well as RADAR. It is also useful in RFID, Wi-Max applications. In satellite and aircraft communication it is widely used. It also used in Bluetooth communication. And also in 3G communication system and for mobile communication this antenna is widely used.MPA with 5.5GHz frequency specially used for WLAN.

VI. CONCLUSION

Original size (16X12mm^2) and miniaturizes size (12X10mm^2). Thus ,on modifying microstrip patch antenna at 5.5 GHz possible to reduce size up to 37.5% with enhancement in directivity.

VII. REFERANCES

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