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Design of patch antenna using water dense dielectric material

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***Abstract*—The design of patch antenna using water dense dielectric material is proposed and designed. The mechanism of operation of the water dielectric patch antenna is observed to be similar with the conventional metallic patch antenna. The bandwidth performance of the proposed antenna can be improved by selecting a suitable thick dielectric substrate between the ground plane and the metallic patch. A maximum directivity of about 6.08dBi can be achieved using the proposed design.**

Keywords—Dielectric; microstrip; patch;directivity; VSWR;

I. INTRODUCTION

Water has the properties of liquidity, transparency and fluidity etc,. Owing to these advantages we have designed a microstrip patch antenna by using water as the dielectric material. Water in distilled form contains no ions and hence acts as a dielectric. Another main advantage of using water as a dielectric is that the dielectric constant of water is 78.4. Owing to the various merits of water dielectric the proposed design can be used for many wireless applications like WiMAX and Wireless Internet Service Provider(WISP).

The microstrip patch antenna is operated in TM_{10} mode. Usually, Water can be of two types- salt water and pure water. Since, there are many ions present in the salt water, so it acts as a conducting material. But in pure water there is absence of ions and hence it will not conduct. So pure water can be best used as a dielectric material. At microwave frequencies, the pure water can be used as a dielectric with high permittivity. As the permittivity of dielectric patch is much larger than that of the supporting substrate, waves can be trapped between the dielectric patch and the ground plane.

II. PROPOSEDDESIGN

A novel patch antenna has been designed by using water(distilled) as the dielectric material. The antenna patch is placed over the dielectric(water) substrate above the ground plane. Both the microstrip patch and the ground plane are made of conducting materials such as copper(annealed). The proposed design operates at the frequency of 2.578GHz. The designed antenna provides better bandwidth and directivity when compared to FR4 Lossy substrate.

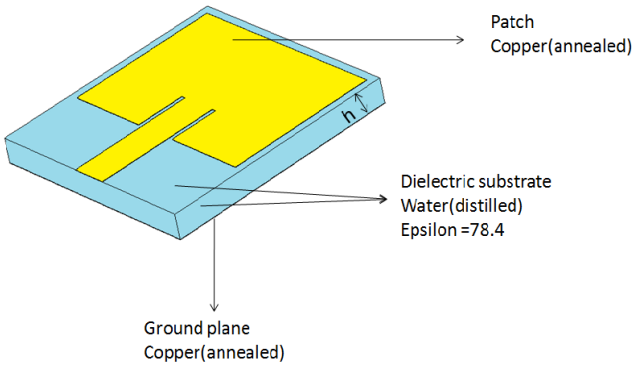


Fig1.(a).Structure of antenna

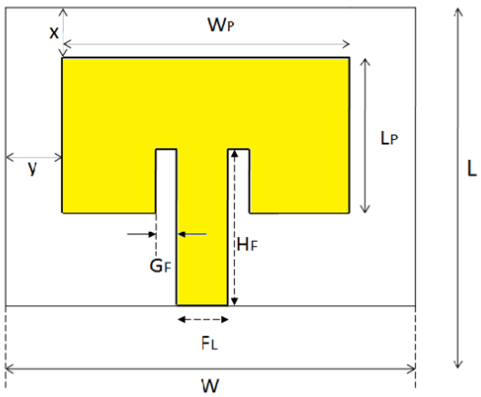
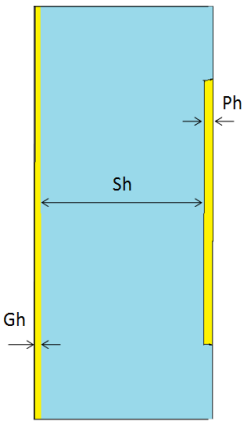


Fig1.(b).Top view of Antenna

SYMBOL	DIMENSIONS (mm)
W	55
L	59
Wp	51
Lp	38
GF	1
HF	31.5
FL	8.7
x	2
y	2
h	6

Fig1.(c).Dimensions of antenna



SYMBOL	DIMENSIONS (mm)
Height of the ground plane (Gh)	0.1
Height of the dielectric substrate (Sh)	6
Height of the patch(Ph)	0.1

Fig1.(d).Side view of antenna

The microstrip patch antenna is designed for the length L of 59mm and the width W of 55mm. The length Lp and the width Wp of the patch are 38mm and 51mm respectively. The length FL of the input feed is 8.7mm and the height HF is 31.5mm. The height of the water substrate is 6mm.

III. Results Of The Proposed Design

The antenna forms a critical component in wireless communication systems. A good design of an antenna can reduce the system requirements and can improve the overall system performance. The performance of an antenna is determined by several factors which are also called as antenna properties.

The proposed antenna operating at the frequency of 2.578GHz provides better impedance matching by achieving the input impedance of 46.76Ω and a VSWR of 1.125. The designed antenna provides better bandwidth and directivity of 6.04dBi.

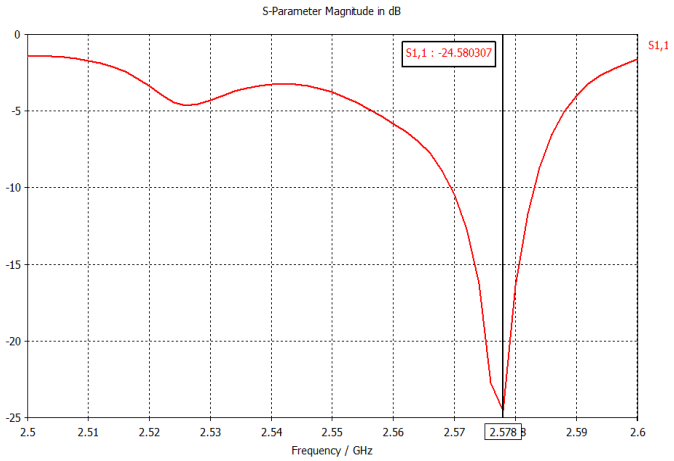
A. Return Loss

Return loss is defined as the loss of power in the signal reflected due to a discontinuity between the transmission line and the antenna.

$$RL=20 \log \left|\frac{Z1+Z2}{Z1-Z2}\right|$$

The return loss is denoted by S and its value is defined in terms of $|S|$ in dB.

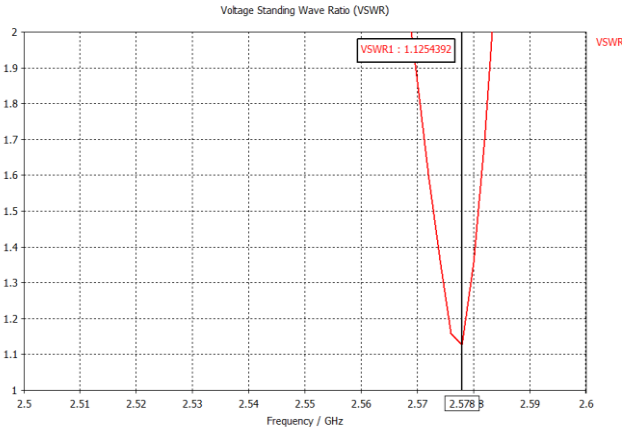
For an ideal antenna the value of return loss should be below -10dB.



B. VSWR

Voltage standing wave ratio(VSWR) is the ratio between the maximum voltage and the minimum voltage of the transmission line. Usually the VSWR of an ideal antenna lies in the range of 1≤ VSWR ≤2.

This proposed antenna has achieved the VSWR of 1.125 which results in proper matching of the antenna and the transmission line.

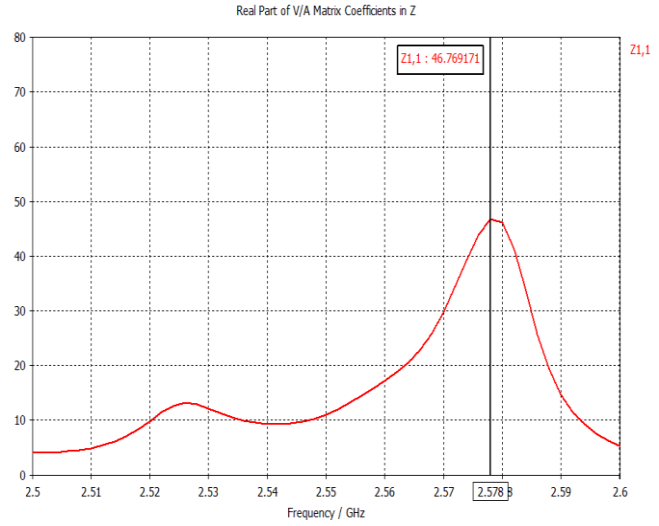


C. Impedance

Input impedance is an important parameter in determining the maximum power transfer between the antenna and the transmission line. Input impedance is a combination of real and complex parts and its general form is:

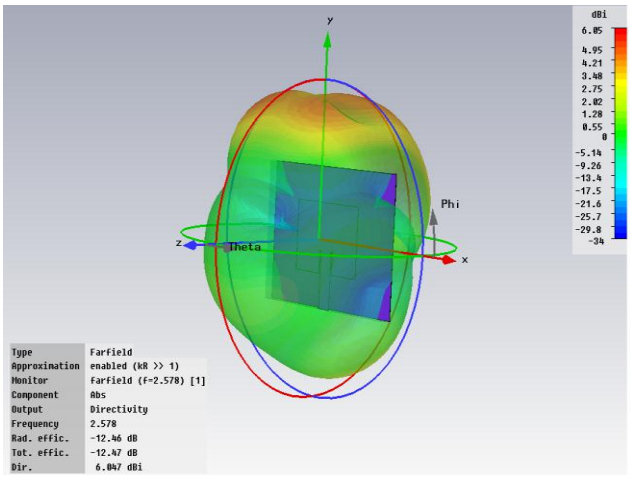
$$Z_{in}=R_{in}+jX_{in}$$

For an ideal antenna the impedance should vary in the range of 30Ω to 60Ω. This proposed design provides the impedance of 46.76Ω thereby providing better impedance matching.



D. Directivity

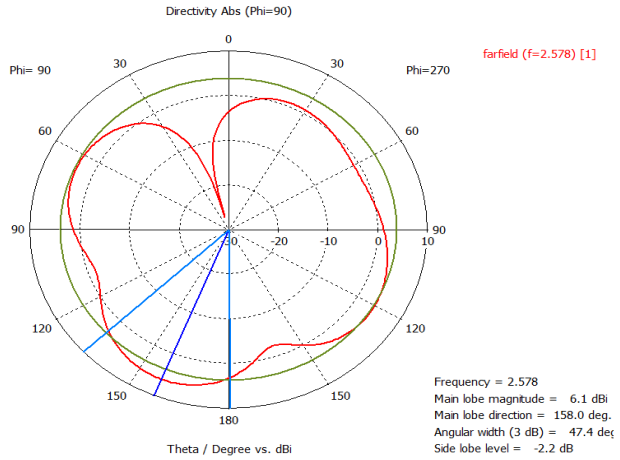
The directive gain of an antenna is a measure of the concentration of the radiated power in a particular direction. Directivity is the ability of the antenna to direct the radiated power in a given direction. The maximum directivity achieved by the water dielectric patch antenna is 6.047dBi.



E. Radiation Pattern

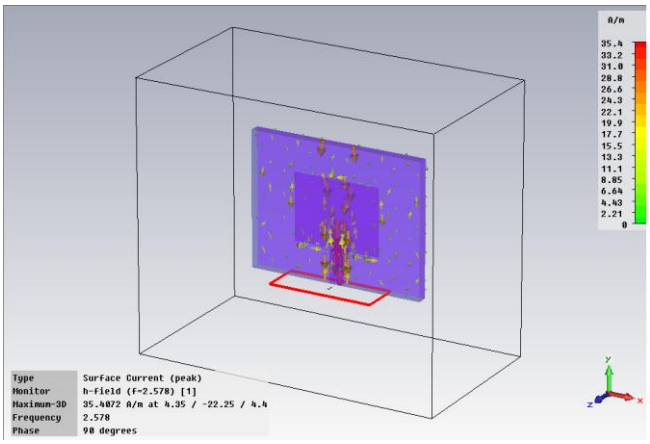
An antenna radiation pattern is a 3-D plot of its radiation far from the source.The proposed antenna has the major lobe magnitude of about 6.1dBi and side lobe level of -2.2dB.

The half power beamwidth of the designed antenna is 47.4 degrees.



F. Surface Current

For the designed antenna operating at 2.578GHz, the surface current flows through the centre of the patch providing maximum directivity in the desired direction.



IV. Conlusion

The proposed design operates at the frequency of 2.578GHz and can be used for a variety of narrowband applications like WiMAX, wireless service provider(WSP) and wireless LAN. The water dielectric antenna has improved results in VSWR,directivity,bandwidth,return loss and impedance matching when compared to the FR4 Lossy dielectric antenna designed for the thickness of 6mm.

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