Microstrip antenna for S-Band Application

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Abstract:

The aim of the paper is to design an inset fed microstrip patch antenna for S band 2 GHz to 4 GHz and study the effect of antenna dimensions Length (L), and substrate parameters relative Dielectric constant (ε_r), substrate thickness (h) and analyze the results like return loss, bandwidth, VSWR and Gain. The proposed antenna is probe fed on a FR-4 substrate with dielectric constant of 4.3. At resonant frequency 3.41 GHz, antenna parameters like Return Loss, VSWR, Axial Ratio and Radiation pattern are verified and simulated on CST Microwave Studio 2018 by CST student edition.

Keywords: Microstrip patch antenna, inset fed, Return Loss, VSWR, Gain, CST Microwave Studio.

1. Introduction

In recent years, the microstrip antenna has emerged as one of the most creative issues in antenna theory and design, and it is increasingly being used in a variety of current microwave systems. [6]. In 1953, Deschamps introduced the MSA concept for the first time. [2]. However, practical antennas were developed by Munson [3]- [4] and Howell [5] in the 1970s. Microstrip antennas (MSA) have a number of appealing characteristics, including low weight, small size, simplicity of manufacture, compatibility with Microwave Integrated Circuits (MIC), and the ability to adapt to the host surface. However, they suffer from low gain, narrow bandwidth, low efficiency, and low power handling capability [7]- [9]. Narrow bandwidths are advantageous in some applications, such as government security systems [7]. The suggested antenna is an inset fed microstrip patch antenna, which is the most common form.

2. Antenna Design

The antenna design could be developed based on the following steps and analyses. Figure 1 illustrates the proposed antenna's architecture. The suggested microstrip patch antenna was designed using traditional formulae. Calculation of the Width (W):

$$W = \frac{c}{2f}\sqrt{\frac{2}{\varepsilon_r + 1}}$$

Where, $C= 3*10^8$ m/s

f_r – resonating frequency

ϵ_r - Dielectric constant

Calculation of effective dielectric constant: +

_ = + +

ε ε

0.5 1 1 1 12 2 2 ε

r r reff

Calculation of length: $L L L = - \Delta_{eff} 2$

Where

h W

+ +

Δ =

0.3 0.264

L h Wh W

( )

ε

reff

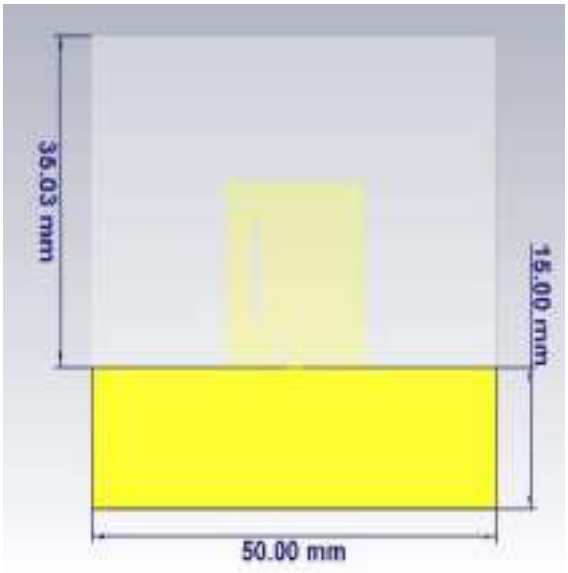

Figure 1b. Back view of proposed antenna

4. Results:

– +

reff

Figure 2 shows Return Loss graph of proposed antenna. The return loss at 3.41 GHz frequency is -26.37 dB. The bandwidth of designed antenna is 1.7496 GHz as shown

0.412

0.258 0.8

( )

ε

h

c reff

2

$L\epsilon_{eff} = \frac{2}{f}$

r reff

3. Proposed Antenna Geometry The proposed antenna is inset fed on a FR-4 substrate with dielectric constant of 4.3. resonant at frequency of 3.41 GHz. The proposed antenna geometry (front view and back view) is shown in figure 1a and 1b respectively. The designed antenna dimensions are also show in figure1.

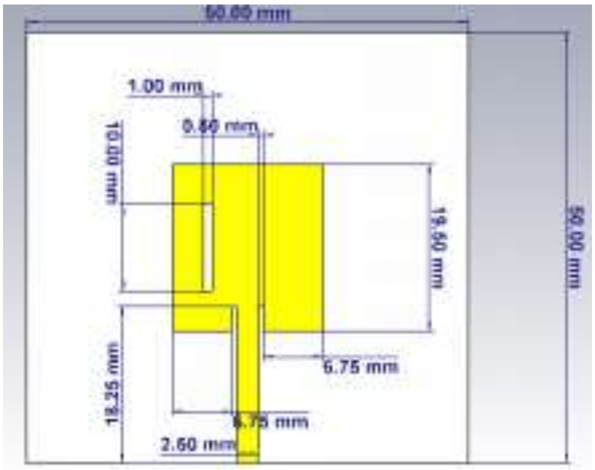

Figure 1a. Front view of proposed antenna

in figure 3. VSWR is shown on in figure 4. VSWR of 1.1 is obtained for proposed antenna. The radiation patterns (E-field and H-field) are shown in figure 5a and 5b respectively. The of proposed antenna is 1.71 dB and it is shown in figure 6.

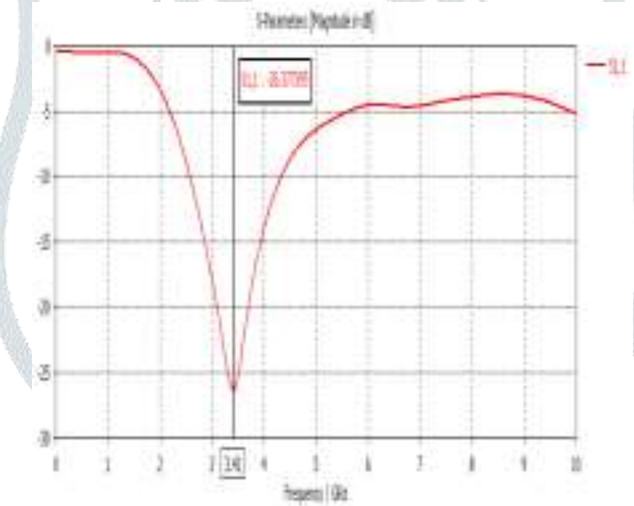

Figure 2: Return Loss graph of proposed antenna

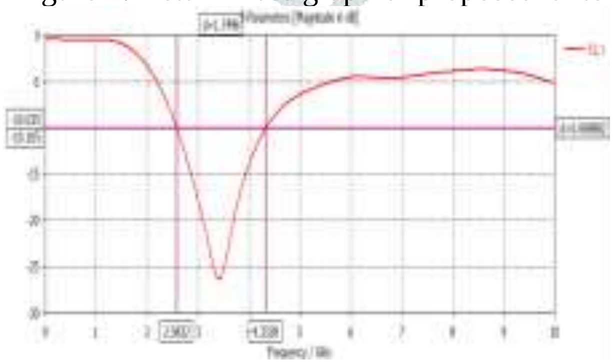

Figure 3: Bandwidth of designed antenna

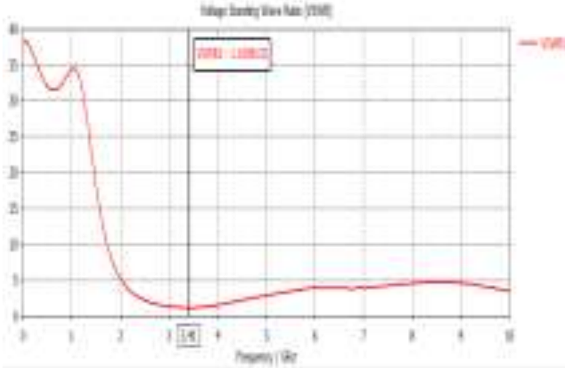

Figure4: VSWR of proposed antenna

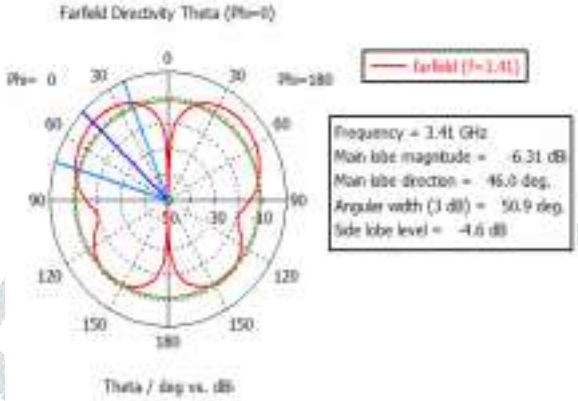

Figure5a: E-field radiation pattern

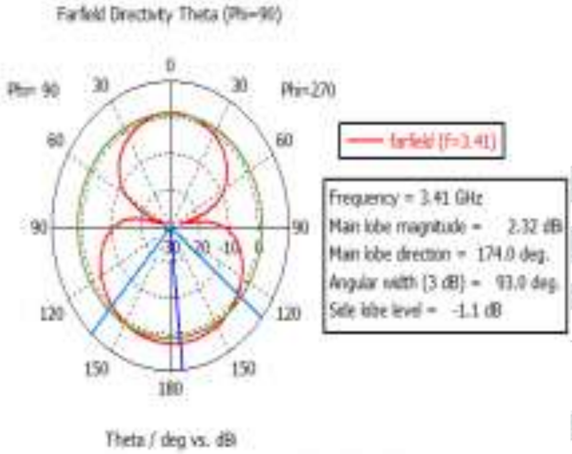

Figure5b: H-field radiation pattern

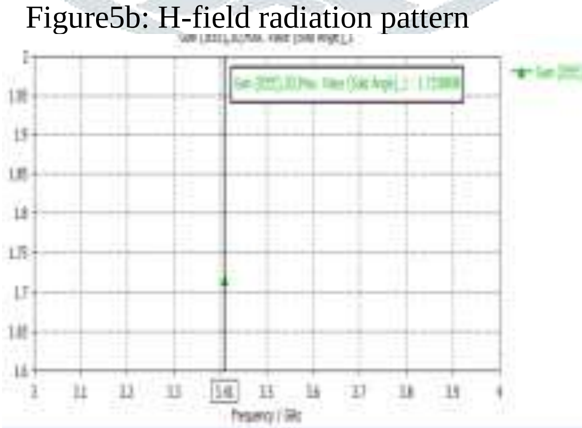

Figure 5: Gain of the proposed antenna

Conclusion:

The proposed antenna is resonating from 2.58 GHz to 4.33 GHz. So this can be employed in S-band applications like weather radar, surface ship radar, and some communications satellites (microwave ovens, microwave devices/communications, radio astronomy, mobile phones, wireless LAN, amateur radio). The proposed antenna return loss is -26.37 dB at 3.41 GHz. The bandwidth is 1.7496, VSWR 1.1 and the gain is 1.71 dB.

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