Evaluation & Comparison between Plus Sign Slotted and U-shaped Microstrip antennas for Wi-MAX application using IE3D

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Abstract. In this paper, a slotted patch antenna of Microstrip antenna (MSA) type has been put forward. The enrichment in gain is realized by cutting slots of suitable dimensions in the rectangular patch using the technique of probe feed. Optimum feed providing the required outcome is found. Simulation of the two projected antennas had been carried out by means of IE3D software. Performance assessment would be grounded on altering the patch dimensions, the acquired results are compared especially in gain, the efficiency of the antenna, the pattern of radiation, VSWR, and return loss with a U-shaped patch antenna.

Keywords: Radiation Pattern, Bandwidth, Impedance, Matching

1. INTRODUCTION

In the past few years, a small antenna’s demand for communication through wireless techniques has augmented the curiosity of designing compact antennas among communication engineers [1-6][7]. Since they are simple & congenial with printed Circuits (PC) these MSA are popularly utilized in the spectrum of the microwave. MSA can be of any profile fabricated above the grounded dielectric substrate. MSA possesses lightweight, is cheap to manufacture, and planar. These antennas might be utilized in a varied range as in the mobile industry for communication and in satellite communication. The goal of this paper is to decrease antenna dimensions along with increasing the bandwidth. Suggested MSA (substrate with εr= 2.2) has a gain of 7.56 dB. The simulated work is done using IE3D software which uses the method of moments [8]. Owing to its small dimension, cheapness & light mass this antenna is a decent contestant to be utilized for S-Band wireless communication. A slotted patch antenna is aimed at in this paper can be utilized in an application involving WLAN at 3.5GHz [9]. The outcome thus attained presents an effective MSA to be absorbed in the above-mentioned application.
2. ANTENNA DESIGN

The suggested antenna is planned by making a U slot & plus sign shape of permanent sizes. Marking this slot in said antenna design intensifies the current which augments the intensity of current that results in increase deficiency and preferred parameters are found. The pivotal factors of a slotted antenna are W=32mm, L=28mm, Ground plane length=40mm, Ground plane width=44mm. The four-sided slotted antenna is fabricated on glass assembly with ε<sub>r</sub>=2.2, d, altitude above the plane of ground=2mm, and loss tangent=0.0009. The antenna design is shown in figure (1-2) at a frequency of 3.5GHz. Procedure for finding the patch measurement [10]

A) **Width Measurement (W):** The formula of width this:

\[ W = \frac{c}{2f_0\sqrt{\left(\frac{\varepsilon_r+1}{2}\right)}} \]  

Putting \( c=3*10^8 \text{m/s} \), \( \varepsilon_r=2.2 \) and \( f_0=3.5 \text{GHz} \), we get: \( W=0.03331\text{m}=33.31\text{mm} \)

B) **Patch effective dielectric constant (ε<sub>reff</sub>):**

\[ \varepsilon_{reff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2} \left[ 1 + \frac{12h}{W} \right]^2 \]

Putting \( \varepsilon_r=2.2 \), \( W=33.31\text{mm} \) and \( h=2\text{mm} \) we get: \( \varepsilon_{reff}=2.3870 \)

C) **Computation of Effective patch length (L<sub>eff</sub>):**

Computing effective patch length as:

\[ L_{eff} = \frac{c}{2f_0\sqrt{\varepsilon_{reff}}} \]

Putting \( \varepsilon_{reff}=2.3870 \), \( c=3*10^8\text{m/s} \) & \( f_0=3.5 \text{GHz} \)we have: \( L_{eff} = 0.02779\text{m} = 27.79 \text{mm} \)

D) **Length Extension (L):** The computation is done as:

\[ \Delta L = 0.412h \frac{(\varepsilon_{reff} + 0.3)(\frac{W}{h} + 0.264)}{(\varepsilon_{reff} - 0.258)(\frac{W}{h} + 0.8)} \]

Putting, \( \varepsilon_{reff} = 2.3870 \), \( W=33.31\text{mm} \) & \( h=2\text{mm} \) we have: \( L=1.00\text{mm} \)

E) **Patch actual length Calculation (L):** The patch length is:

\[ L = L_{eff} - 2\Delta L \]

Putting, \( L_{eff}=27.79\text{mm} \) and \( L=1.00 \text{ mm} \) we get: \( L=25.79\text{mm} \)

F) **Dimensions ground plane Calculation (Lg and Wg):**

The model of the transmission line is relevant to endless ground planes only. Though, for real-world concerns, the finite ground plane is required. Analogous outcomes for infinite and finite ground planes (GP) may be established if the dimension of the GP is larger than the patch size by almost six folds the width of the substrate in the vicinity of the periphery. Henceforth, for designing such antenna, dimensions would be:

\[ L_g = 6h + L = 6(2) + 28 = 40 \text{mm} \]
\[ W_g = 6h + W = 6(2) + 32 = 44\text{mm} \]
3. ANTEenna COMPARISON AND RESULT

The modeling of the MS antenna is made using IE3D. The VSWR characteristics for a plus sign and U-shaped micro-strip antenna are represented in figure (3-4). The disparity amid antenna and transmission line is indicated by VSWR. For ideal matching, the value of VSWR must be close by unity. For this proposed antenna the VSWR is 1.04. The pattern of radiation in the modeled antenna is presented in figure (5), 3D Radiation pattern of the Patch Antenna with U shaped is shown in figure (6), the graph for the return loss is presented in figure (7-8) and it is -31.35db and -31.33db for a plus sign and U-shaped slotted antenna respectively. Modeled antenna frequency, as well as overall field gain, is shown in figure (9-10), figure (11-12) shows the antenna efficiency & frequency.
Figure 5: 3D pattern of the Proposed Antenna

Figure 6: 3D Radiation pattern of U shaped Antenna.

Figure 7: Proposed ARL = -31.35db at 3.5GHz

Figure 8: U Shaped slotted Patch ARL

Figure 9: Proposed antenna gain & freq.=7.56at3.5GHz

Figure 10: U shaped antenna gain & freq.
4. CONCLUSION

Comprehensive analysis and examination of performance by altering the dimensions of the Microstrip antenna are completed. The simulated and the obtained outcomes are matched specifically in gain, VSWR, antenna efficiency, and return-loss with the U-slotted shaped patch antenna. It is found that slotted MS antennas can be configured capably with a probe feed to produce the aimed outcome. The projected MS antenna can work efficiently & effectively for Wireless operations like Wi-Max and has a compressed size of (28 x 33 x 2). Carrying a comparison between U-shaped patch and sign shaped antenna performance we can see that U-slotted antenna provides slightly improved results than Plus sign antenna. In the future, this design can be augmented in performance by truncating the corners of the patches to achieve the enhancement of bandwidth and return loss. A summary of the comparisons done is presented in table (1).

| Parameter     | Value (U-slotted) | Value (Plus sign slotted) |
|---------------|-------------------|---------------------------|
| Return Loss   | -31.33db          | -31.35db                  |
| VSWR          | 1.04              | 1.04                      |
| Gain          | 7.57dBi           | 7.56dBi                   |
| Efficiency    | 79.8%             | 75.5%                     |

Table 1: Summary of the comparisons

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