DESIGN OF SQUARE PATCH ANTENNA FOR KA BAND

V. CHINNAMMAL¹ & DR. P. JOTHILAKSHMI²

¹Assistant Professor, Rajalakshmi Institute of Technology, Chennai, India

²Professor, Sri Venkateswara College of Engineering, Chennai, India

ABSTRACT

Here, the document comprises of the layout of antenna used for Ka band whose frequency range is from 26-40 GHz. The planned aerial is comprehended by employing a single and dual dielectric substrate material as FR-4 with permittivity of 4.4. The aerial is provided with a microstrip line feed having an impedance of 50 ohms. Generally lots of antenna system employs Microstrip Patch Antenna (MPA) owing to its insubstantial weight, low profile, low cost, easy to fabricate etc. The simulations are done by using CST Simulation Studio tool. The feigned figures of Return Loss, VSWR, Energy of Power and Gain are revealed below

KEYWORDS: Square Patch Antenna, Microstrip Patch Antenna (MPA)

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INTRODUCTION

As the microstrip patch antennas have several good-looking applications like Wireless, Radars, Satellites, mobile communications etc. But it undergoes with the problems like surface waves, narrow bandwidth, large IR loss and low gain. Gain means that the quantity of energy emitted in specific direction in relevance to the energy emitted in an isotropic direction. Therefore to have a progressive gain, the apt option is to use dual layer of substrate patch antennas. So as to attain this, the numbers of practices in use are triple layer of substrate, sandwiched layer of substrate apart from this gain can be enhanced with the help of multiband antennas obtained by fractal geometries, inserting slots into the patch, parasitic elements, discrete multi-loop planar antennas, EBG (Electromagnetic Band Gap) structures, stacked patch antennas etc.

At the present time, multiband patch antennas are examined due to its coverage like GSM, DCS, CDMA and PCS. So the PIN diodes, switches and varactor diodes are utilized for multiband function. These techniques are working with reconfigurable frequency of two states. i.e. ON & OFF. Other than this, slots on the patch are controlled by the switches are also incorporated in it.

A multiband operation could also be attained by adjusting the ground plane, by devising an array, etc. which gives the way to improve bandwidth and gain of the antenna.

Here, a square shaped patch aerial is planned and used for different applications. The planned aerial be capable of working in the range of frequency from 26-40GHz. A VSWR below 2 is achieved for both the substrates (Single FR-4 & Dual FR-4).

ANTENNA DESIGN

The devised antenna has square patch placed on the FR-4 substrate with the permittivity of 4.4, which is revealed in the figure 1. It has a ground plane, FR-4 substrate and conducting patch as the structure of the aerial. Figure 2 illustrates about the planned aerial that has double layer of dielectric substrate FR-4. The aerial is comprehended by microstrip line feed of 50 ohms. On the whole the planned aerial has the size of 13.15 mm x 10.92 mm. Table 1 shows the size of the planned aerial. Based on the resonance frequencies and dimension, the patch antenna's performance is revealed. The Return Loss, VSWR, directivity as well as gain are represented in the results part.

Figure 1: Aerial with Single FR 4 Substrate.

Figure 2: Aerial with Dual FR-4 Substrate.

Table 1: Aerial's Size Parameters

S. No.	Antenna Parameters	Dimensions(mm)
1	W_g	13.15
2	L_g	10.92
3	W_p	6.575
4	L_p	5.46
5	h_s	1.6
6	L_{eff}	2.52
7	ϵ_{reff}	4.53
8	ΔL	0.601

SIMULATION OUTCOME AND REVIEW

The planned aerial is simulated with the help of CST tool which is employing the Finite Integration Technique (FIT). The Time Domain Solver computes the behavior of the aerial in a one run with an arbitrarily fine frequency resolution. The transient analysis of the planned aerial is performed through hexahedral mesh type.

Return Loss

The feigned return loss (S_{11}) for jointly the planned aerial is revealed in figure 3 and figure 4. The planned aerial has the resonance frequency of 25 GHz with return loss of -25.17 dB for single FR-4 and return loss of -24.0 dB for dual FR-4 substrate. The return loss plays a vital role in the impedance matching.

Figure 3: Return Loss for Single FR 4 Substrate.

Figure 4: Return Loss for Dual FR 4 Substrate.

VSWR

The simulated VSWR jointly with the planned aerial are shown in the figure 5 and figure 6. VSWR is needed to decide the characteristics of impedance matching. Generally the VSWR must lie in the range of 1 and 2 for a suitable impedance matching. Thus the planned aerial has the VSWR of 1.24, which might be beneath 2 at 25GHz.

Figure 5: VSWR for Single FR 4 Substrate.

Figure 6: VSWR for Dual FR-4 Substrate.

Radiation Pattern (Directivity)

Antennas do not radiate the energy uniformly in all the directions in practice. The energy representation may be the graphical notation of energy distribution of 3-D mode and it is calculated in far field region. The power of radiation is calculated in relevance to the field strength in reference to a specific level (Main Beam). The directivity of the planned aerial is 6.53 dBi for the frequency 25 GHz which is revealed in the figure 7. Figure 8 illustrates the directivity of the planned aerial with dual substrate which has the directivity of 5.82dBi at 25 GHz.

Figure 7: Directivity of Planned Aerial with Single FR-4 Substrate.

Figure 8: Directivity of Planned Aerial with Dual FR-4 Substrate.

Radiation Pattern (Gain)

Gain depicts the quantity of power to be sent out in the path of max out emission towards with an isotropic source. The gain for the planned aerial at 25 GHz is 4.51 dB which is revealed in figure 11. For the planned aerial of dual FR-4 the gain is 3.78 dB which is revealed in figure 12.

Figure 11: Gain of Single FR4 Substrate.

Figure 12: Gain of Dual FR-4 Substrate.

CONCLUSIONS

The square patch antenna for the single and dual FR 4 substrate is designed and simulated and its parameters like Return Loss, VSWR, Directivity and Gain simulated results are revealed above. The return loss is -24.0 dB for the planned aerial of dual substrate FR-4. VSWR together with the designed antenna is beneath 2. Directivity and Gain for dual FR 4 is 5.82 dBi and 3.78 dB at 25 GHz. Thus the feigned outcomes of the planned aerial find use in Ka band applications.

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