Novel Efficient Micro strip Antenna Design for Satellite C-band Downlink Applications

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Abstract—This paper presents a novel microstrip patch antenna design for C-band satellite downlink communication applications. In the proposed antenna design, the substrate is of FR4 (Flame Retardant 4) material having dielectric constant 4.4 and the patch and ground are of copper material. The proposed antenna is resonant at 4.2 GHz and has bandwidth of 727.3 MHz (3.74 GHz - 4.46 GHz) which can be used for reception of C-band satellite downlink signals at earth station. The proposed antenna has a return loss of -71 dB at resonant frequency of 4.2GHz. The antenna has a gain of 5.68 dB and directivity of 5.55 dBi at resonant frequency of 4.2GHz. The performance of the antenna has been analysed in terms of return loss (dB), directivity (dBi), gain (dB), smith chart and VSWR.

Keywords—micro strip patch antenna, C-band, satellite communication, downlink, FR-4, dB, dBi, GHz.

I. INTRODUCTION

Micro strip patch antenna also termed as patch antenna, is usually fabricated on a dielectric substrate which acts as an intermediate between a ground plane at the bottom side of substrate and a radiating patch on the top of substrate [1]. The patch is usually made of copper with high electrical conductivity. The patch can be designed in many shapes like rectangular, circular, triangular, elliptical, ring, square and any more but most commonly, rectangular shape is widely used because of the simplicity associated with the design. The selection of substrate is the most important parameter while designing an antenna[1]. The substrate consists of dielectric material which perturbs the transmission line and electrical performance of an antenna. The size of an antenna is dependent on the dielectric constant of the substrate. The size of antenna is inversely proportional to dielectric constant i.e. higher is the dielectric constant, lower is the size of antenna[2]. There are varieties of substrates available with different dielectric constants but in this antenna design, Fire Resistant 4 (FR4) material with dielectric constant of 4.4 has been used. The antenna can be fed by various methods like coaxial feed, proximity coupled micro strip feed and aperture coupled micro strip feed [3]. The feeding can be defined as the means to transfer the power from the feed line to the patch, which itself acts as a radiator. The micro strip feed line has been used in MPA designs because it is relatively simple to fabricate [3]. The micro strip antenna has been commonly used for wireless applications because of small antenna size, low cost, light weight, better efficiency, ease of installation, ease of mobility, and is relatively inexpensive to manufacture on printed circuit board (PCB) of specific characteristics and dimensions. However, apart from its numerous advantages, there are some drawbacks of MPA. It handles less power and has limited bandwidth [4]. The bandwidth of MPA can be improved by either using a slotted patch [5][6] or by using reduced ground plane [7] [8]. The slot on the patch can be of any shape like H-slot [9], E-slot [10], circular, rectangular, etc. These techniques can also be used to improve the return loss along with improvement in impedance bandwidth enhancement of an antenna.

II. ANTENNA GEOMETRY

The fig. 1 illustrates the geometry of an antenna consisting of FR-4 as substrate and copper as patch and ground. The substrate (S1) on which the ground and patch are placed has the length of 70mm and width of 60mm with height of 1.5mm as shown in fig. 1. The ground on the bottom surface of the substrate (S1) of the antenna design is reduced and distorted which is shown in fig. 2. The ground has the length of 60mm with width 12 mm. The radiating patch has the dimensions of 41mmx34mm and has been slotted in the middle with a radius of 10mm and the radiating patch has provided with another slot which is rectangular in shape as shown in fig. 3. The feed line is rectangular in shape with dimension of 15mm and 5.2mm which has been shown in fig 3. The stacking has been done on the top surface of patch the by placing substrate (S2) with dimensions same as substrate (S1) on the top of patch surface. The 3D view of antenna is shown in fig. 1.

Fig. 1. Front view of antenna
III. RESULTS

The proposed antenna has been designed and simulated using CST Microwave Studio 2014. The performance of proposed antenna has been analyzed in terms of return loss (dB), directivity (dBi), gain (dB), VSWR and smith chart. The return loss plot of the antenna has been shown in fig. 4 which indicates that the antenna has resonant frequency at 4.2 GHz with bandwidth of 727.3 MHz (3.74 GHz - 4.46 GHz). The directivity of the antenna is 5.5 dBi which has been shown in fig. 5. The antenna has high gain of 5.68 dB as shown in fig. 6. The VSWR plot of the proposed antenna has been shown in fig. 7 which shows that the value of VSWR value lies in the acceptable range of 0 to 2. The smith chart of the antenna has been shown in fig. 8. The proposed antenna can be used for C-band satellite downlink communication applications.

IV. CONCLUSIONS

The proposed antenna has a return loss of -71 dB at resonant frequency of 4.2GHz illustrating that the reflection losses are minimal at 4.2GHz. The antenna has the gain and directivity of 5.66 dB and 5.52 dBi, respectively. The antenna has impedance bandwidth of 727.3 MHz with resonant frequency of 4.2GHz which makes it suitable for C-band satellite downlink communication applications.
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