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Ultra Wideband Slotted Microstrip Patch Antenna for Downlink and Uplink Satellite Application in C band

Tajeswita Gupta and P. K. Singhal

Department of electronics and communication MITS Gwalior
Gwalior, M.P. 474005, India

ABSTRACT: An ultra-wideband slotted microstrip patch antenna has been proposed in this paper for uplink and downlink satellite applications in c band of IEEE 802.11 standards. Various slots have been introduced in the patch to achieve wider bandwidth. Presented work provides a comparative result of the microstrip patch antenna with and without the slots. Fractional bandwidth of the basic antenna is 9% which is increased to 46% after introduction of the slots in the proposed patch antenna.

KEYWORDS: Microstrip, Patch Antenna, Resonating Frequency, Impedance Bandwidth, Return Loss.

1 INTRODUCTION

Microstrip antennas due to their many attractive features have drawn attention of industries for an ultimate solution for wireless communication. A Microstrip patch antenna is a narrowband, wide- beam antenna fabricated by etching the antenna element pattern in metal trace bonded to an insulating substrate. Because such Antennas have a very low profile, are mechanically rugged and can be conformable, they are often mounted on the exterior of aircrafts and spacecrafts, or are incorporated into mobile radio communications devices. This needs very accurate calculation of various design parameters of microstrip patch antennas. Patch dimensions of microstrip antenna is a vital parameter in deciding the utility of a microstrip antennas. Conventional microstrip antennas in general have a conducting patch printed on a grounded microwave substrate [1-2].

Many techniques have been reported to reduce the size of microstrip antennas at a fixed operating frequency. In general, microstrip antennas are half-wavelength structures. The important characteristic of micro strip antennas is their inherent ability to radiate efficiently despite their low profile. The primary source of this radiation is the electric fringing fields between the edges of the conductor element and the ground-plane behind it. Much intensive research has been done in past years to develop enhancement techniques for broadband microstrip antennas. Several bandwidth enhancement techniques are found in literature. Some of these techniques include the use of thick substrates with a low dielectric constant, and stacked or co-planar parasitic patches. The use of thick substrates introduces a large inductance due to the increased length of the probe [3-9].

An antenna, for uplink and downlink application in satellite communication has been presented in this research paper. Antenna is resonating in the C band of IEEE standards. By the addition of various slots in the geometry and defected ground plane the bandwidth of the antenna has been enhanced to provide an ultra-wide band characteristic of the antenna having bandwidth of 1.8 GHz [10-12].

2 ANTENNA GEOMETRY

The geometry of the proposed antenna is shown in Fig.1, was modeled using the classical equations [1] Figure 1 shows the geometry of antenna with and without slots (proposed antenna). A planar antenna includes a rectangular radiator etched

Corresponding Author: Tajeswita Gupta (tajeswitagupta@gmail.com)

with various slots. The antenna has a patch size of 60 × 60 × 1.676 mm^3. The antenna is printed on FR4 substrate (thickness is 1.6 mm relative permittivity 4.4 and loss tangent 0.027) and is fed by 50 ohm microstrip line. On the other side of the substrate ground plane is printed with an area of 60 × 15 mm^2.

Proposed antenna drawn in figure 1 is a novel temple shaped antenna with a microstrip line feed of 50 Ohm. Design specifications of the proposed patch are mentioned in the table 1. The printed patch is of the dimension 30 x 55 mm^2.

Table 1. Design Specifications of the Proposed Antenna

Substrate material	FR4
Relative permittivity	4.4
Thickness of dielectric	1.6 mm
L_1	10 mm
L_2	30 mm
L_3	20 mm
L_4	30 mm
W_1	10 mm
W_2	20 mm
W_3	5 mm
L_4 (length of the feed)	15 mm
Width of the feed	3 mm

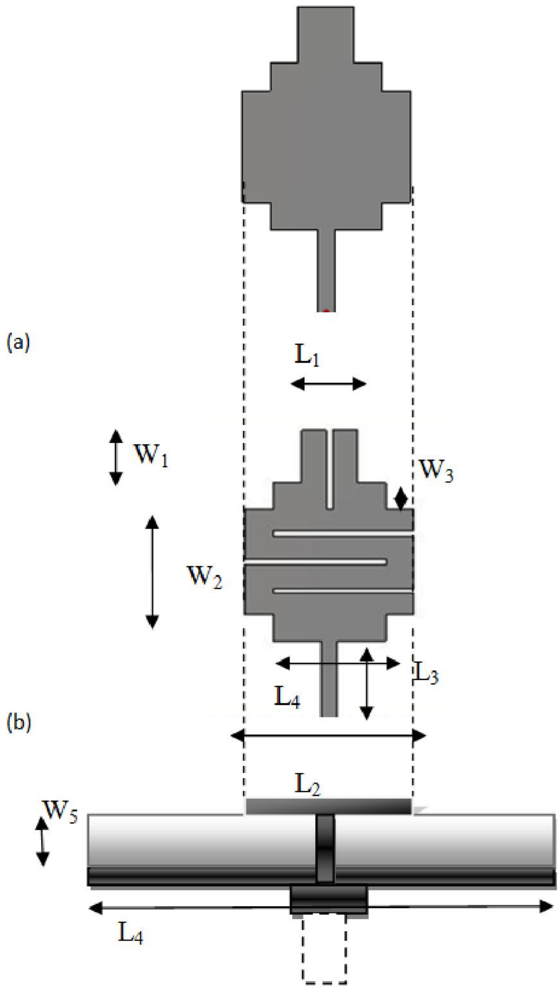

Fig. 1. (a) Basic antenna (b) Modified antenna with slots (proposed)

3 SIMULATED RESULTS

Proposed antenna was experimentally studied and simulated results have been depicted in Figure 2. Simulated result shows the return loss of the patch antenna against the frequency. It is clearly observed that the bandwidth is increased to 1.8 GHz instead of 400 MHz of basic patch antenna. Simulated result shows that the proposed antenna resonates for two band ranging from 3.077-4.9 GHz & 6.98-7.67 GHz.

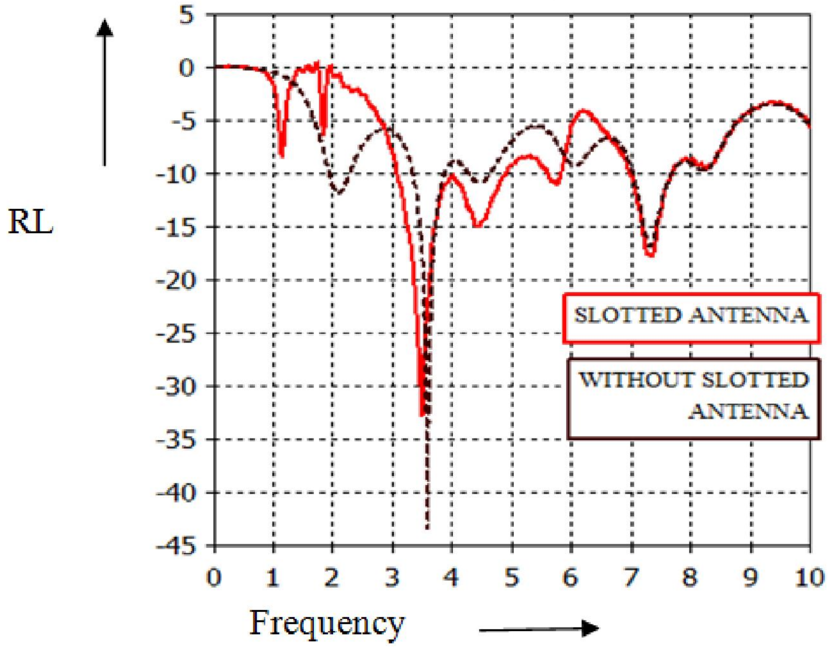

Fig. 2. Return loss against frequency graph

E and H field patterns of the proposed antenna have been depicted in the figure 3 as shown below. Figure 4 shows the directivity of the proposed antenna in both bands. Corresponding directivity is 2.7 dBi and -1.2 dBi with angular width angular 3 dB beam width of 57.7^0 and 36.2^0 and the direction of maximum radiation is 332^0 and 155^0 for uplink and downlink application band respectively.

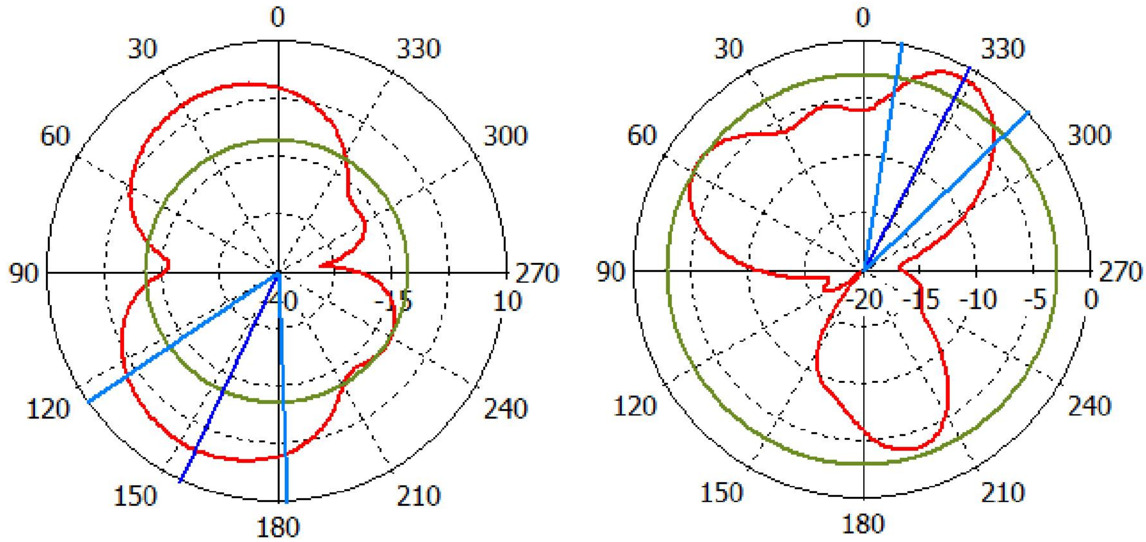

Fig. 3. (a) for downlink application band (b) for uplink application band

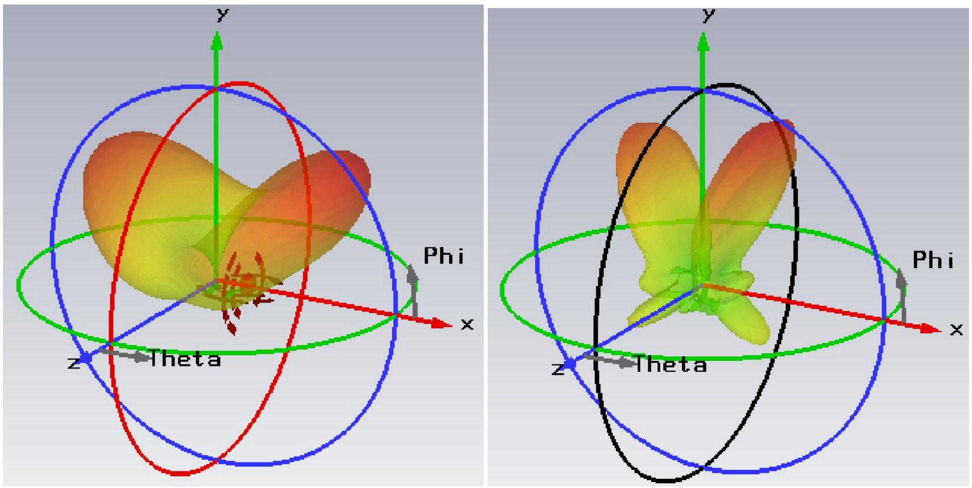

Fig. 4.   (a): directivity of antenna for downlink band (b): directivity of antenna for uplink band

The gain of the antenna in both bands has been drawn in the figure 5 for both uplink and downlink applications. The absolute gain is 1.7 and 0.59 in the direction of maximum radiation for downlink and uplink application bands respectively.

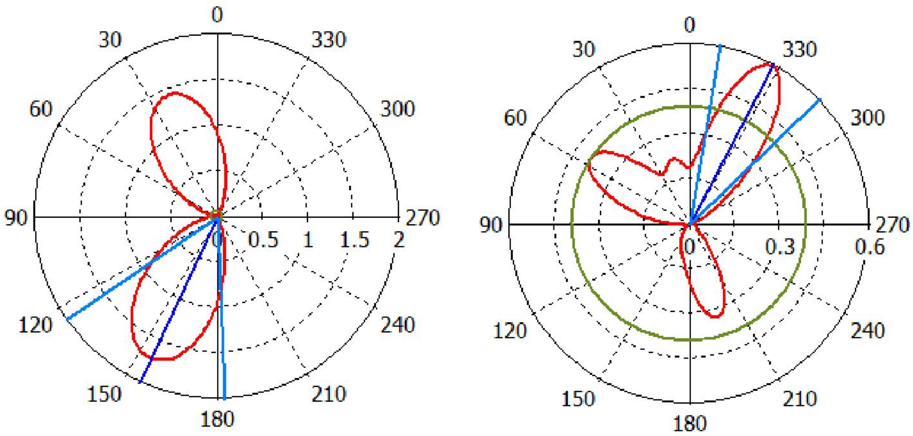

Fig. 5.   (a): gain of the proposed antenna for downlink application (b): gain of the proposed antenna for uplink application

4 CONCLUSION AND REMARKS

A novel temple shaped antenna with various slots has been presented in this paper. Proposed antenna achieves the two bands in the IEEE C band for downlink and uplink applications in satellite communication. The achieved bands are 3.077-4.9 GHz & 6.98-7.67 GHz. The bandwidth for lower band is 1.8 GHz which provides it an ultra-wideband application for the achieved band. The proposed antenna has shown Low Profile characteristic and better impedance bandwidth and Return Loss performance.

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