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Design and investigations of a microstrip fed open V-shape slot antenna for wideband dual slant polarization

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ABSTRACT

A dual slant polarized slot antenna is proposed. The antenna is printed on the two sides of a single substrate and has two microstrip feed lines to excite a V-shaped slot formed by the merging of two tilted rectangular step shaped slots. Stepping of the slot sections as well as the feed line improves the impedance matching. A narrow rectangular metallic stub is introduced at the junction of the slot arms to improve the decoupling between the ports. The antenna polarization is $+45^0/-45^0$ with respect to horizontal under alternate excitation and this dual slant polarized nature is demonstrated through aperture electric field plots and far field radiation patterns. The measured return loss bandwidth ($S_{11} < -10$ dB) of the antenna is from 2.3 GHz and extends beyond 12 GHz while the measured isolation bandwidth ($S_{21} < -20$ dB) is from 5 GHz onwards. The time domain characterization of the antenna is also done by calculating the fidelity factor. For evaluating the diversity performance, the envelope correlation coefficients are calculated from the simulated and measured S-parameters. The correlation coefficients are well below the acceptable values. With a peak gain varying between 3 and 5 dBi, the antenna is expected to be useful for wideband dual slant polarized applications.

1. Introduction

Dual Ultra wideband antennas have several applications in fields such as high data rate communication, remote sensing, radar and medical imaging. These antennas can be designed for linear polarization, circular polarization or for dual polarization. Dual and circularly polarized antennas [1,2] have the added advantage of flexible transceiver orientation and resistance to multipath fading. In addition, dual polarized antennas can also be used in a MIMO configuration for enhancing channel capacity or to obtain additional information. Dual polarized antennas can be further classified as dual linear, dual circular or dual slant polarized. It was shown that slant polarization can offer higher diversity gain under certain circumstances [3]. Several dual slant polarized antennas have been proposed in the literature but most of them have complex or three dimensional structures.

A crossed dipole structure in conjunction with a parasitic element was proposed in [4]. The antenna has an impedance bandwidth from 2.5 GHz to 2.69 GHz while the isolation is better than 38 dB. A dual slant polarized antenna consisting of four magneto electric dipoles was proposed in [5] for a bandwidth of 22.2% at the center frequency of 2.4 GHz. The isolation achieved was less than 26 dB. In [6], a travelling wave sub-array is presented with 3:1 impedance bandwidth and isolation of around 28 dB. In [7], 12 patch elements and a double balanced multiplier were used to form an array to discriminate $\pm 45^0$ slant polarization in three frequency bands. In [8], four cross shape slots are embedded on a patch which is excited using a probe for operation at 900 MHz the isolation achieved is better than 35 dB. An array antenna with ten elements for operation from 1.71 GHz to 2.69 GHz was proposed in [9]. The elements were bow-tie shaped. The design of a bifilar helix antenna was given in [10], a metallic dielectric parallelepiped was given in [11] and the design of crossed dipole elements printed on a cylinder was given in [12].

In this paper, a V-shape slot antenna is proposed. The arms of the slot are narrow rectangular in shape and when excited using

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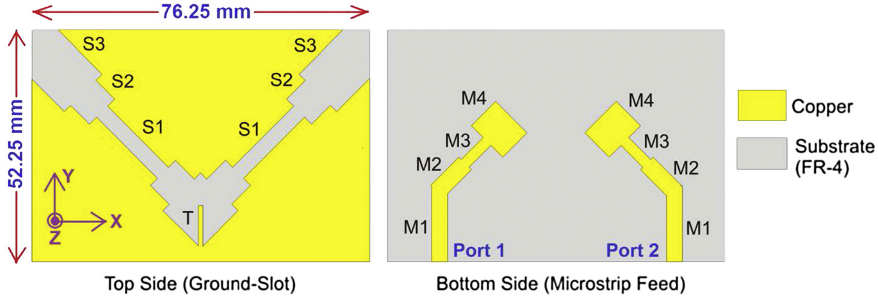

Fig. 1. Proposed antenna configuration.

microstrip feed produce orthogonally directed electric fields which are responsible for the dual polarized nature of the antenna. To achieve ultra wide impedance bandwidth the rectangular slot sections as well as the microstrip feed sections are stepped.

2. Antenna geometry

The configuration of the proposed antenna is shown in Fig. 1. On one side of an FR-4 substrate of size 76.25 mm × 52.25 mm, the ground plane is printed and on which a V-shaped slot is etched. The sections of the slot are stepped rectangular in shape and denoted by the labels S1, S2 and S3. It is further noted from the figure that the two extremes of the slot are open at the upper end. The slot sections are excited using two microstrip feed lines whose ends form the two ports of the dual polarized antenna. Like the slot sections, the feed line is also stepped for better impedance matching. The steps in the feed line are denoted by M1, M2, M3 and M4. The arrangement of the feed is such that the section between M3 and M4 lies exactly in the middle of the slot section S1. A short narrow rectangular metallic strip is introduced at the junction of the two slot arms for providing the decoupling between the two sections. The values of all the parameters are listed in Table 1.

Table 1
Optimized dimensions of the antenna (in mm).

Label	S1	S2	S3	M1	M2	M3	M4	T
Length	19.5	6.0	12.0	17.0	9.0	7.0	7.8	9.1
Width	3.5	8.0	12.0	3.6	4.0	2.5	12.0	1.0

3. Measured and simulated results

The design and optimization of the proposed antenna were carried out using the commercial electromagnetic solver CST Microwave Studio. The antenna was then fabricated and measured results for the fabricated antenna were obtained from a Rohde and Schwarz Vector Network Analyzer (R&S ZVA-40). A comparison plot of the measured and simulated S-parameters is shown in Fig. 2. In general, a good agreement is seen between the simulated and measured results. It can be seen that the impedance bandwidth as

Table 2
Comparison of proposed antenna with published work.

Reference	Size	Bandwidth	Isolation
4	60 × 60 × 37 mm^3	2.5 GHz–2.69 GHz	>38 dB
5	200 × 200 × 29 mm^3	1.92 GHz–2.85 GHz	>26 dB
6	225 × 255 mm^2	1.7 GHz–2.7 GHz	>28 dB
8	67 × 67 mm^2	Near 900 MHz	36 dB
9	1300 × 105 × 37 mm^3	1.71 GHz–2.69 GHz	>35 dB
Proposed	76.25 × 52.25 × 1.6 mm^3	2.25–12 GHz	>20 dB

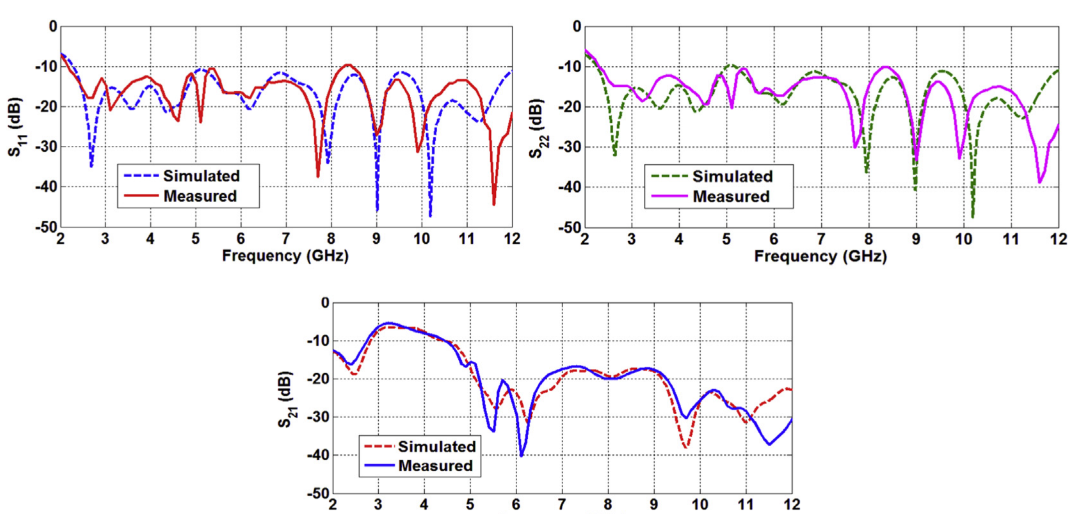

Fig. 2. Measured and simulated reflection coefficients at the two ports and isolation.