Dual-feed orthogonal circular polarized microstrip antenna with front-end parasitic for Inter Satellite Link

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Abstract **- A novel circularly polarized microstrip antenna using dual-feed orthogonal and with front-end parasitic method is proposed in this paper. In the feeding network, a two-way circular-sector power divider is adopted to distribute the current equally to each feed. A method of moments is employed for optimizing the design and achieving a good circular polarization at the center frequency of 2.37 GHz. The simulated values shows that 3-dB axial ratio bandwidth and maximum gain are about 51MHz and 6.39dBic. The narrow bandwidth and reasonable gain indicate that antenna is promising for Inter Satellite Link in S-Band.**

Index Terms **— Circular polarization, dual-feed orthogonal, and front-end parasitic.**

1. Introduction

Although linier polarization has been widely employed for various applications, its usage has a certain limitation in applications related to propagation in the ionosphere, since interaction with electrons and magnetic fields could cause Faraday rotation disturbances [1]. One of possible solution to reduce or eliminate this problem is radiating the microwave in circular polarization (CP) [2]. In the dual feed design for square microstrip antenna, the CP radiation can be achieved by providing current with equal amplitude and mutual phase difference of 90^0 [3]. The antenna performance of this CP antenna, however, was not satisfactory in terms of both 3-dB axial ratio bandwidth and antenna gain. Hence, in the present paper we introduce a novel, compact design of dual feed orthogonal using front-end parasitic square microstrip antenna (SMA). The antenna is designed to operate in S-band (2.37 GHz). The design of the proposed antenna and the results and discussion will be given in Section 2. And the conclusion will be given in Section 3.

2. Design of proposed antenna

The circularly polarized radiation can be realized on a microstrip element by existing two orthogonal modes with equal amplitudes, which have a quadrature phase relationship. The performance of CP antenna is characterized by a parameter called axial ratio (AR), the value of which is defined as the ratio of the major axis to the minor axis of the polarization ellipse, commonly given in units of dB . In addition, the sense of polarization can be classified into two types, namely left-hand CP (LHCP) and right-hand CP (RHCP), indicating the sign of relative phase [4]. In the present design, the CP radiation is produced with a dual-feed orthogonal SMA. The CP radiation can be achieved by providing current with equal amplitude and mutual phase difference of 90^0, so as to give the best AR smaller than 3dB. The geometry design of the proposed antenna is shown in Fig. 1. The antenna is simulated on three layers of dielectric substrate, each having thickness h = 1.6 mm, dielectric constant $\varepsilon_r = 4.3$, conductor thickness m_t =35 μm, and. Other parameters of the RMA are listed in Table 1. Based on, the length (L) of the square patch antenna design required to work at frequency center is given by equation [5].

$$L = \frac{c}{2f_c\sqrt{\varepsilon_{eff}}} \qquad (1)$$

Where c is the speed of light (3.10^8 m/s).

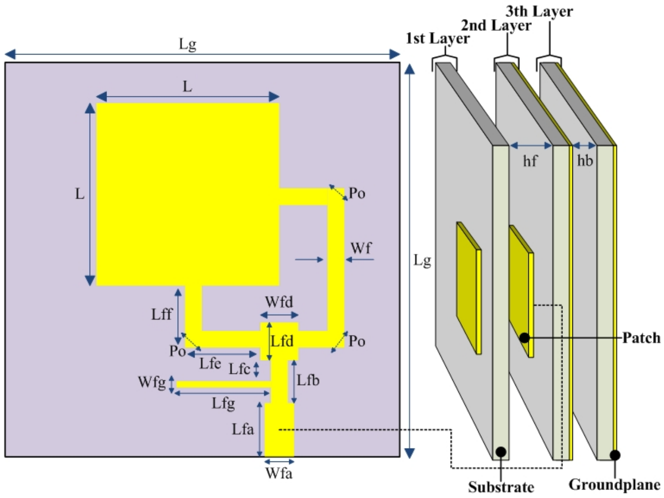

Fig. 1. Geometry of Dual-fed orthogonal RMA second layer top view, and side view.

Then, vector current distribution of the designed RMA can be indicating the RHCP or LHCP.

Table 1
Dual-feed orthogonal parameters,

Parameters	Lg	L	Lfa	Lfb	Lfc	Lfd	Lfe	Lff
Size (mm)	65	28.5	8	10	6	5.6	13.2	5.6
Parameters	Wf	Wfa	Wfd	Wfg	Po	hb	hf	Lfg
Size (mm)	1.6	4	3	0.3	0.5	13	17	14.2

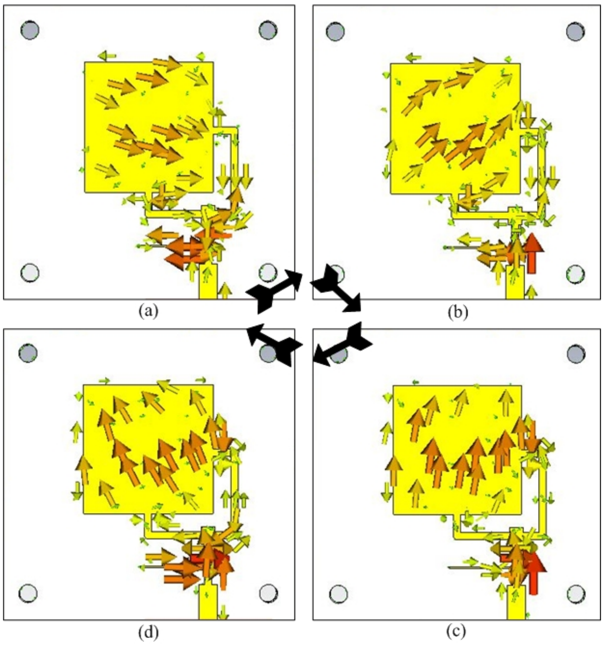

Fig. 2. Vector current distribution of designed RMA for various source phase: (a) $\varphi_s = 0^\circ$;(b) $\varphi_s = 45^\circ$;(c) $\varphi_s = 90^\circ$, and (d) $\varphi_s = 135^\circ$

The sense of polarization (RHCP or LHCP) can be determined by turning the sequence of phase shift in the feeding network. Fig. 2 shows the vector current distribution of the prototype antenna for various source phases (φ_s). Furthermore, it can be seen that rotation of vectors is in the anticlockwise direction, indicates the sense of polarization. Fig. 3 shows the radiation pattern. The 3-dB beam width (HPBW) simulated of elevation axis results of 77.3^o and azimuth axis results of 79.2^o at the operating frequency (2.37 GHz), the reflection coefficient of the simulated value is –47.46dB as seen in Fig. 4.

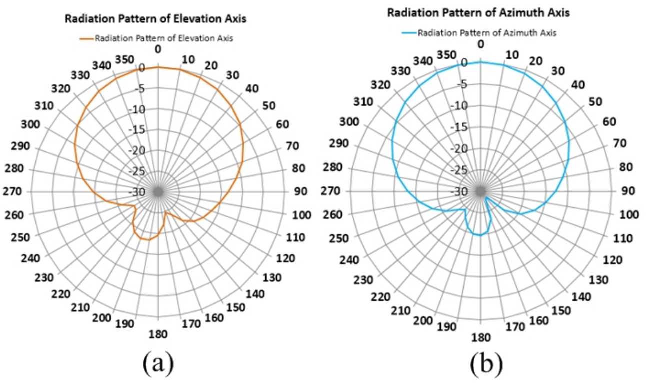

Fig. 3. (a) Simulated radiation pattern of elevation axis; and (b) simulated radiation pattern of azimuth axis

A good agreement in –10dB impedance bandwidth of 172,2MHz is obtained for simulated results. The simulation result is about 6.4dBic at 2.37 GHz. The increasing height of front-end parasitic affects the antenna gain [6]. The relation between the AR and frequency is shown in Fig. 4. In the simulation result, 3-dB AR bandwidth is 51MHz. When the

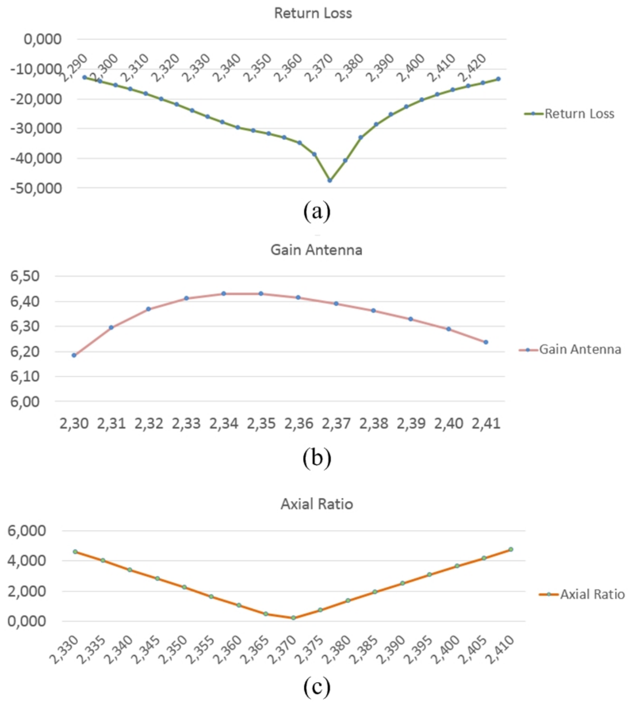

Fig. 3. (a) Simulated reflection coefficient ;(b) simulated gain ;(c) simulated axial ratio

network feeding length is increased or decreased, ultimately it will affect the characteristics of the AR.

3. Conclusion

A novel dual-feed orthogonal RMA has been proposed for the generation of circular polarization radiation. Good CP performance has been attained over a 3-dB axial ratio bandwidth of 51 MHz, with fairly high gain of about 6.39dBic in the operating band (2.37 GHz). In general, numerical analysis using the method of moments can lead to a good agreement with experimental result. With its good performance, this novel antenna design will be useful for Circularly Polarized Inter Satellite Link in S-band.

References

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