Balanced Amplifying Antenna for Circular Polarization

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Abstract— **A balanced amplifier based rectangular microstrip patch antenna is proposed that exhibit circularly polarized radiation. The inherent benefits of good isolation between input and out put ports as well improved matching capabilities of balanced amplifiers provide overall system gain of 5.21 dB. This system will be immune to the spectral impurity, since microstrip patch antenna basically being high Q device posses a narrowband to support any harmonic fruitfully.**

I INTRODUCTION

The balanced amplifying antenna is suggested as an alternative to the push pull antenna due to its better isolation between the input and output ends as well as superior matching properties. We consider an important application for which the balanced amplifying antenna is naturally more suitable than the push-pull amplifying antenna. There are many practical situations, which require circularly polarized antenna. The outputs of the balanced amplifier are 90 degree apart in phase and hence it can be a suitable candidate for active circularly polarized antenna. This concept is discussed in this paper.

II CIRCULARLY POLARIZED ANTENNA

Inherently antenna radiates elliptically polarized waves; linear polarization being a particular case of it. The elliptical polarization is characterized by three quantities: axial ratio, tilt angle and the sense of rotation [1, 2]. For linear polarization, the axial ratio is zero or infinite while the tilt angle gives its orientation. Circular polarization (CP) is obtained for unit axial ratio, where the tilt angle losses its meaning. Thus the quality of circularly polarized wave is determined by the axial ratio [3].

Antennas can give circular polarization if two orthogonal components with equal amplitude but in phase quadrature are radiated. A patch antenna capable of supporting two orthogonal modes in phase quadrature simultaneously as well as an array of linearly polarized patches with proper orientation and phasing are capable of producing circular polarization. This paper considers both these structures simulated using AWR Microwave Office™ and IE3D™. The next section describes a single element circularly polarized patch antenna.

III DUAL ORTHOGONAL FED ACTIVE CP PATCH ANTENNA

A. Rectangular Microstrip Antenna (RMSA) Design

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We consider a square antenna with dual inset feeds on orthogonal sides of the patch. Unlike in conventional passive square antenna with dual orthogonal feeds, the feed structure is not required to introduce the 90-degree phase shift here. The reason for this lies in the amplifying system, which produces outputs, which are 90 degree out of phase. The schematic of the dual fed patch antenna is shown in Fig 1. The physical parameters of the antenna for the design frequency of 2.4 GHz are given in Table I. The S-parameters of the feeding port 1 and the polar radiation pattern of the antenna are shown in Fig 2.

B. Implementing a Power Combiner as a Conceptual Equivalent of RMSA

The S-parameters of this two-port antenna simulated in IE3D™ were stored in a separate file. Then a power combiner was simulated in AWR Microwave Office™ .The S-parameter of the two input ports and the output port were set so that the input impedances at these ports are 50 ohms, 50 ohms and 376.6 ohms respectively. Once this power combiner was designed, its S-parameters were compared with those of the antenna S-parameters at 2.507 GHz for the two input ports. Then the S-parameters of the combiner were scaled to these S-parameters at 2.507GHz frequency. The same procedure was followed for other frequencies in the 2.49 – 2.53 GHz band. Thus the power combiner with the scaled S-parameters can be assumed to simulate the antenna. It is assumed that this antenna has two input ports and one imaginary fictitious output port of impedance 376.6 ohms, through which it radiates to free space.

This power combiner is then used with the balanced amplifier at the output port. The schematic of this simulation is shown in Fig 3 below. The simulated result for the noise figure and the gain of the amplifier are shown in Fig 4. It is observed that the total gain of the system at 2.5 GHz is 5.21 dB. The noise figure at the same frequency is -11.3 dB. It suggests that the noise figure is within the design value of 2dB. In other words the system is working as Low Noise Amplifier (LNA) in this case. The reason for this can be good isolation between the feeding ports to the antenna. This system will be immune to the spectral impurity, since microstrip patch antenna being high Q component posses a narrowband to support any harmonic meaningfully. The problem of spectral purity can arise if a broadband antenna is used instead.

The polar radiation pattern of the antenna for both LHCP and RHCP is shown in Fig 5. Fig 6 depicts the axial ratio in the given band for the dual fed CP patch antenna. It is to be noted that there exists a phase difference of 90 degree between the two feed, inherently due to the balanced amplifying stage preceding the patch. This is the reason for lower axial ratio, which means the antenna is radiating circular polarization wave due to simultaneous radiation from its four edges with proper phasing. Fig 7 shows the variation of antenna efficiency with frequency. It is observed here that the antenna efficiency is around 87% at 2.49GHz, which drops down beyond this frequency. However the radiation efficiency remains almost constant at 90%.

VI CONCLUSION

A novel method of obtaining circularly polarized radiation from Microstrip patch antenna is proposed in this paper. Improved antenna gain with maintenance of spectral purity is some important characteristics of balanced amplifier microstrip patch antenna. The concept is further enhanced to obtain improved axial ratio suitable for circularly polarization application.

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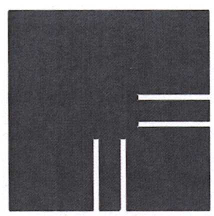

Figure 1 Dual fed Square Patch Antenna

TABLE I
PHYSICAL PARAMETERS OF THE DUAL FED PATCH ANTENNA

Patch Size	Feed length	Feed width	Feed gap	ε_r	$\tan\delta$	Substrate Thickness	Metallization
$1.416\text{X}10^3$ mil	507.1609 mil	75.473 mil	39.37 mil	2.94	0.0025	60 mil	1.4 mil Copper

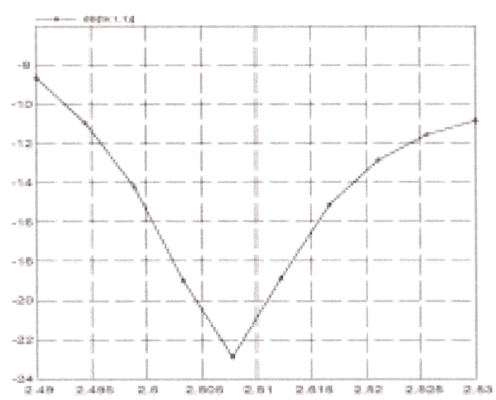

Figure 2 S-Parameter of dual Fed square patch antenna

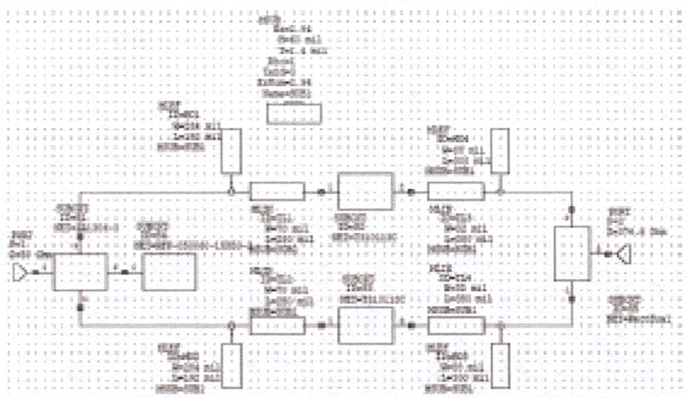

Figure 3 Schematic of the Balanced Amplifying CP Antenna Simulation

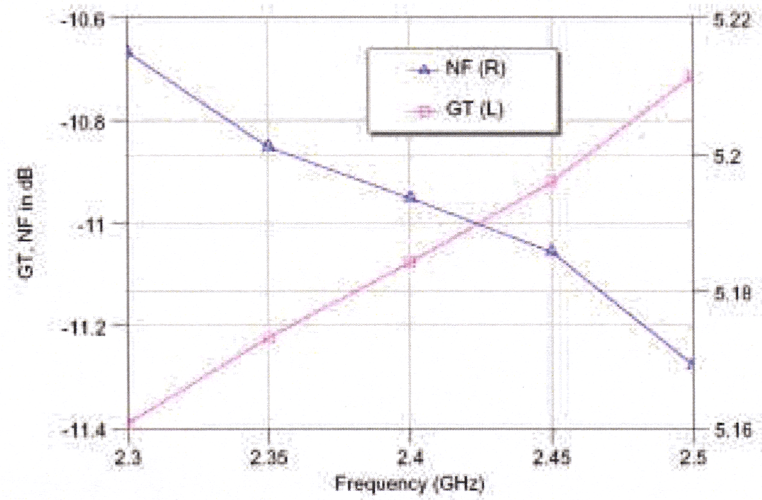

Figure 4 NF and GT of the Balanced Amplifying CP Antenna

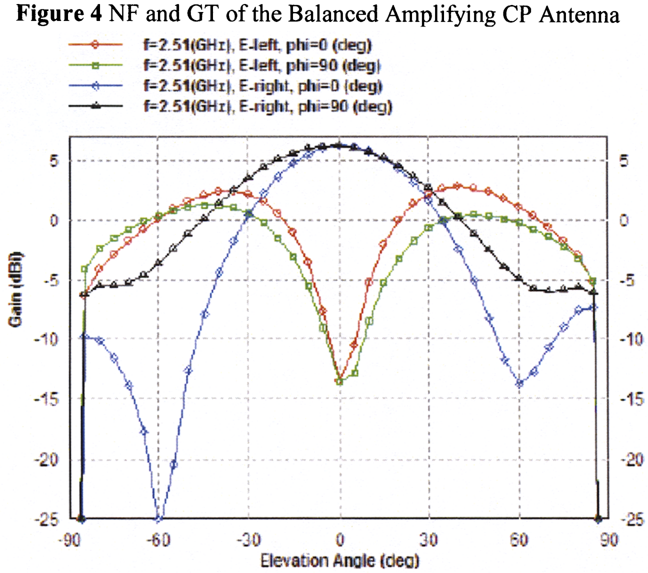

Figure 5 Radiation pattern of the CP antenna

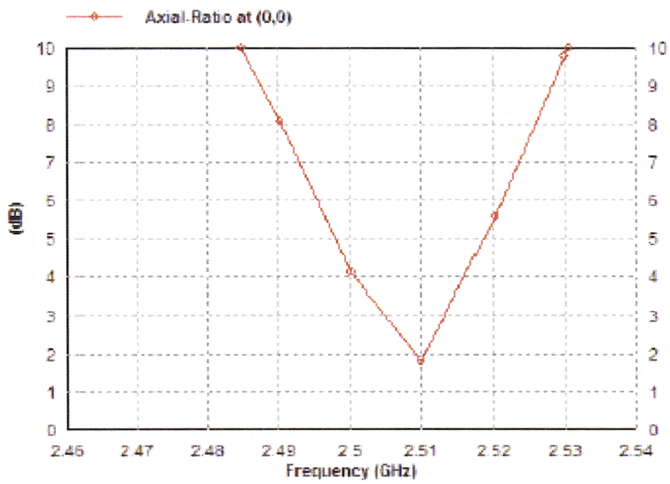

Figure 6 Variation of AR with frequency for dual fed CP antenna

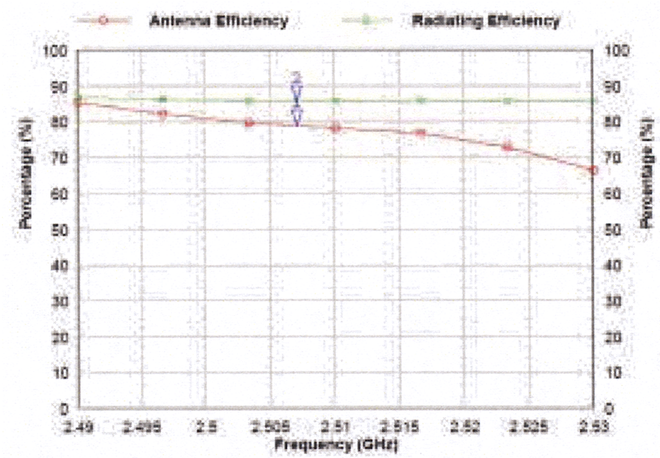

Figure 7 Gain of the stand-alone dual fed antenna for circular polarization.