

Orthogonal Linear Polarization Detection Slot-ring Antenna

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1. Introduction

The emerging planar array antenna technology covers a wide range of applications such as point to point and point to multi point wireless communication systems, radar systems, remote sensing, GPS, ITS etc. [1-6]. The polarization detection of the received signal for many applications such as polarimetric sensors, MIMO, satellite remote sensing, ITS, radars etc. is becoming important in recent years. In a word, if the detection of the polarization characteristics and the wireless propagation conditions of the received signals are possible, the above application modules and systems will be advanced and expanded much more effectively. For instance, polarization detection antenna can be a vital element for the realization of the anti-jamming technology of radar systems [3]. To meet this requirement, the authors have reported an orthogonally polarized microstrip array antenna for linear polarization discrimination [7], where ± 45 deg. linear polarizations of the received signal can be discriminated at the array antenna design frequency. The array antenna was realized by 12 patch antenna elements and a double balanced RF multiplier. However, there was an impedance mismatch between the antenna elements and the feed lines. As a result, the output voltage for the polarization detection was low in spite of the 12 elements array antenna.

In this paper, a single slot-ring antenna for linear polarization detection is proposed. The slot-ring antenna consists of four zero bias diodes which are loaded in every 45 deg. physical location on the slot-ring. The experimental output voltage of the single slot-ring antenna is observed higher than the 12 element array antenna of [7]. Therefore, the proposed slot-ring antenna is extremely simple with better performance compared with [7]. The diodes are loaded on the slot-ring in such that, it acts slot-ring antenna/ amplitude detector at the design frequency. When the ± 45 deg. polarized signal is received, the output voltage of the antenna is either positive or negative according to the diode orientation. Needless to say, the output voltage depends on the diode orientation. The experimental results confirm the orthogonal polarization detection ability successfully.

2. Structure of the Proposed Antenna

The structure of the slot-ring antenna which also can be considered as a co-planar antenna is shown in Fig. 1. The slot-ring antenna design frequency is 5 GHz. The length and width of the slot-ring are 42.72 mm and 0.2 mm respectively. The slot-ring antenna is loaded on one side of the Teflon glass fiber substrate. The thickness of the substrate is 0.8 mm with the relative dielectric constant ϵ_r of 2.15 and $\tan\delta$ of 0.001. Four diodes (MSS20 146 B-10D: Aeroflex) are integrated with the slot-ring to realize the polarization detection. The diodes D1 and D3 are inward to the slot-ring and make a pair for +45 deg. linear polarization detection and the diodes D2 and D4 are outward to the slot-ring and make a pair for -45 deg. linear polarization detection. A copper wire is connected at the center of the slot-ring antenna for receiving the output voltage V_{det} . The other end of the copper wire is connected with a co-axial connector via co-planar line.

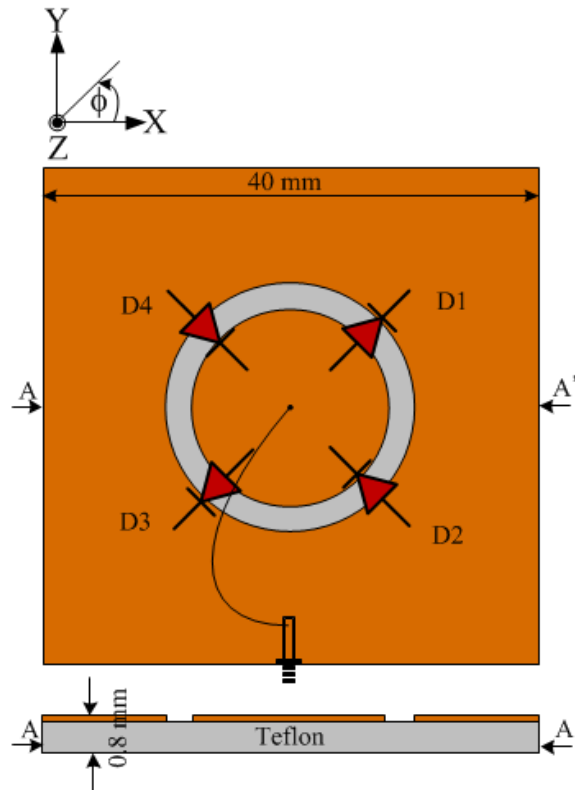


Figure 1: Structure of the proposed slot-ring antenna

3. Basic Behaviour

The basic behavior of the slot-ring antenna is shown in Fig. 2. The circumference of the slot-ring is taken to be one wavelength i.e. λ_g at the slot-ring antenna design frequency. The output voltage of the slot-ring antenna depends on the polarity of the four diodes and the diodes are loaded on the slot-ring at every $\lambda_g/4$ interval at the slot-ring antenna design frequency. When +45 deg. polarized signal is received, the diodes D1 and D3 detect the received RF signal and the output voltage $V_{det.}$ is positive value according to the diode polarity. When -45 deg. polarized signal is received, the diodes D2 and D4 detect the received RF signal and the output voltage $V_{det.}$ is negative value.

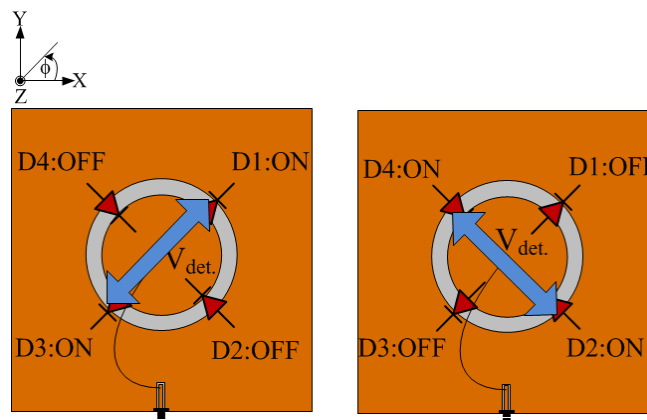


Figure 2: Basic behaviour of the slot-ring antenna

The received RF signals are in a high frequency band and then concentrate on the slot line. On the other hand, the slot-ring output $V_{det.}$ is low frequency signals, and can be easily obtained from the center conductor of the slot-ring without interference with RF signals.

4. Experimental results and discussion

The experiment of the proposed array antenna was performed in an anechoic chamber. A horn antenna (11966 double ridged waveguide horn antenna by Agilent) is used as the transmission antenna and the proposed array antenna is put at 1.5 m distant from the horn antenna. The signal generator output power is set to be +20 dBm. The frequency of the horn antenna is varied from 4 GHz to 6 GHz and the output voltage $V_{det.}$ of the antenna is measured by using digital multi meter (Agilent 34401A multimeter). Fig. 3 shows the output voltage $V_{det.}$ of the antenna. From the Fig. 3, it is found that the output voltage $V_{det.}$ is +50.24 mV and 43.67 mV at 5 GHz for +45 deg and -45 deg. polarized wave respectively. In addition, for zero deg. and 90 deg. polarizations, the output voltage is almost zero due to the amplitude detector principle. The directivity of the slot-ring antenna at 5 GHz is shown in Fig. 4. The absolute maximum voltages are found at 0 deg. The polarization detection is possible from -60 deg. to +60 deg. which is very wide range compared with [7]. Therefore, from the experimental data, it is evident that, the slot-ring antenna can be used for the ± 45 deg. linear polarization detection. According to the paper [7], the maximum output voltage was at best 28.9 mV for the ± 45 deg. received wave. Therefore, comparing with [7], the proposed single slot-ring antenna is extremely simple with better performance.

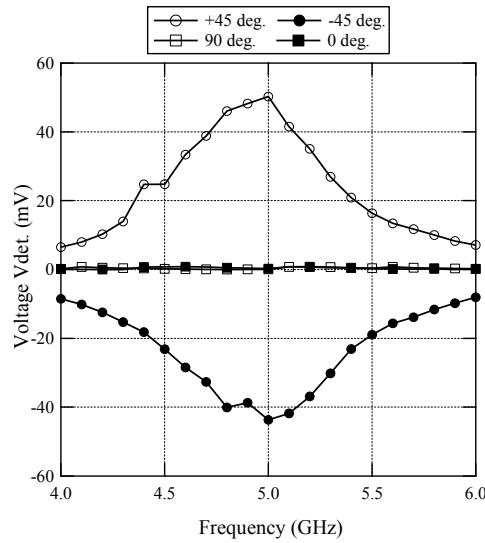


Figure 3: Output voltage of the slot-ring antenna

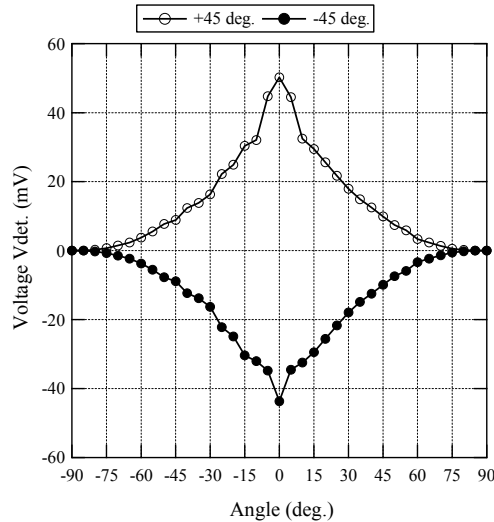


Figure 4: Directivity of the slot-ring antenna at 5 GHz

5. Conclusion

In this paper, a single slot-ring antenna for linear polarization detection is proposed. The slot-ring antenna consists of four zero bias diodes. The experiment results of the proposed array antenna confirm the orthogonal linear polarization detection ability. Excellent design flexibility and performance of the proposed array antenna makes it a very attractive candidate for various wireless applications especially, for RF sensors and advanced wireless communication systems. Furthermore, the proposed slot-ring antenna can be used for the short range data transmission for the wireless communication.

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