A Superstrate Loaded High gain Circularly Polarized Slotted Waveguide Array

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***Abstract*—In this paper, a Superstrate loaded slotted waveguide is proposed. A polarizer superstrate is kept at an optimized distance above the slot aperture. The analysis and optimization has been done by CST Microwave studio 14.0. The presented antenna resonates at 9.32 GHz. The gain of designed antenna has been achieved up to 8.1dBi. The presented slotted waveguide array is reconfigured to LHCP by rotating the polarized superstrate layer by 90^0.**

Keywords*—*Slotted waveguide; circular polarization; superstrate; waveguide

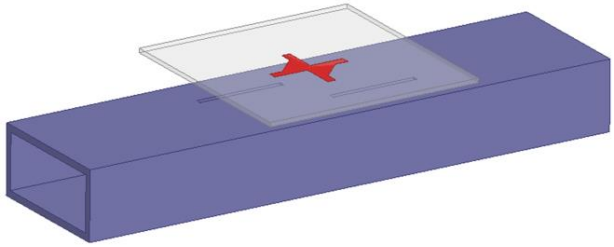
I. INTRODUCTION

In step with the rapid development in wireless technologies, present day wireless systems are becoming multi-functional and prefers polarization and frequency diversity techniques. System that employs polarization diversity technique requires an antenna that can operate at different polarizations at a same time. These techniques are generally used to reduce the effect of multipath fading. Longitudinal or transverse slot provides linear polarizations. Special slot geometry is required to change the linear polarized signal in to circularly polarized waves. Initially in 1973, A. J. Sangster [1] was proposed circularly polarized slotted waveguide array. Then after different types of slots like cross slots, compound slots, L-type had been cut on the broad wall and narrow wall of waveguide to generate the circular polarization [2-4]. A polarization agile slotted waveguide antenna was proposed by G. Montisci et.al [5] in 2003. Next year in 2004, the author [6] extended their work on polarization agile waveguide slot antenna. They presented a tilled slot on the broad wall of waveguide. Polarization reconfigurable antenna was designed by Zhu et.al [7]. In 2017, a SRR loaded high gain dual band dual polarized slot antenna has been presented by Chandra and Das [8]. Three SRRs has been placed in the transverse plane of waveguide to obtain the dual band characteristics. Recently Chandra et.al proposed a CSRR loaded high gain dual band circularly polarized aperture antenna [9].

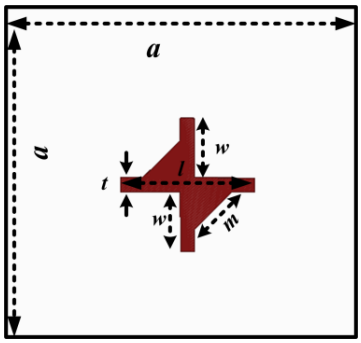
In this paper, a two-element slotted waveguide array loaded with a superstrate layer has been presented. The conventional λ/2 slot is designed over it. The slot width is 1 mm while the offset from slot is 4mm. The depicted slotted waveguide array has been simulated using CST Microwave Studio 14.0. The proposed array has RHCP nature with axial ratio bandwidth of 9.19-9.41 GHz. The gain and radiation characteristics are also discussed in this paper.

II. DESIGN OF CIRCULARLY POLARIZED SLOTTED WAVEGUIDE ARRAY

The schematic view of proposed antenna is shown in Fig. 1(a) while the geometrical view of metasurface superstrate layer is shown in Fig 1(b). It is printed on Rogers RT Duroid 5880 with dielectric constant 2.2 and thickness is 0.787.The design of antenna is started with a two-element slotted waveguide. Initial values of the lengths of the slots are taken as λ/2, where λ is the free space wavelength at the operating frequency of the conventional slot array. In the final stage of antenna development polarizer superstrate layer is kept at an optimized distance 4 mm above the slot aperture.



(a)



(b)

Fig. 1. Geometry of the presented antenna (a) 3-D view of Proposed slot array (b) geometrrical details of superstrate (a = 40 mm, w= 6.25 mm, l = 14 mm, t = 1.5 mm, m = 5.51 mm)

III. RESULTS AND DISCUSSION

The presented slot array antenna has been simulated and optimized using CST Microwave studio (version 14). Frequency response of a slotted array antenna has been plotted in Fig 2. The designed array has resonates at frequency 9.32 GHz with radiation bandwidth from 9.15-9.47 GHz.

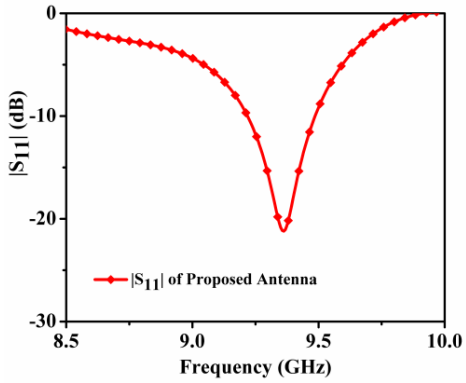


Fig. 2. Simulated S- parameters of the presented circularly polarized slot array.

The 3-dB axial ratio of proposed antenna is plotted in Fig. 3. The figure reveals that it covers the frequency range from 9.19-9.41 GHz. The depicted antenna is right hand circularly polarized while it can be reconfigure to LHCP by rotating the superstrate 90^0.

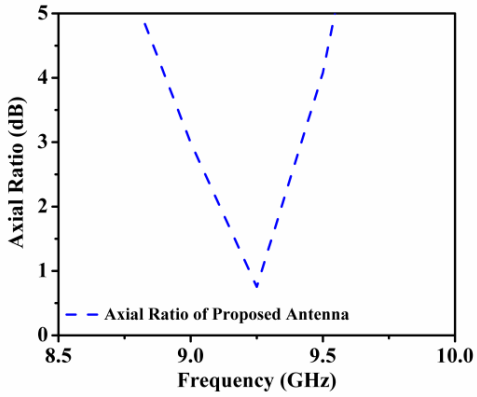


Fig. 3. Axial Ratio of proposed circularly polarized slotted waveguide.

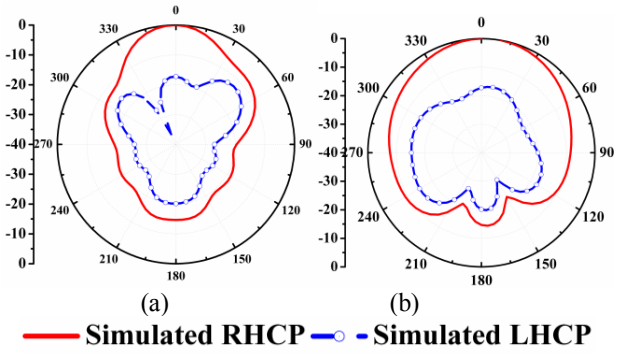


Fig. 4. Normalize RHCP and LHCP patterns of a proposed slotted waveguide (a) *XZ*-plane at frequency 9.3 GHz and (b) *YZ*-plane at 9.3 GHz

The simulated normalized LHCP and RHCP radiation pattern is plotted in Fig. 4 at the frequency 9.3 GHz. It reveals that the RHCP component is greater than 20 dB to LHCP component which also confirms the proposed array is right hand circularly polarized. The gain of two-element circularly polarized slotted waveguide array has been plotted in Fig. 5. The figure reveals that the gain of proposed array at the resonant frequency is 8.1 dBi. Total efficiency of presented antenna is depicted in the

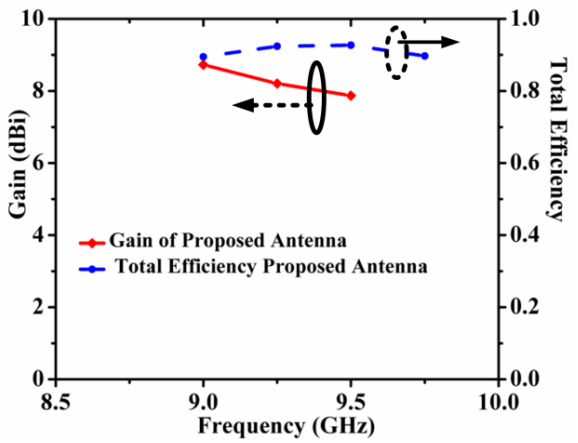


Fig. 5. Gain and total efficiency of proposed antenna.

same figure. It has been observed that the total efficiency of presented slot array is greater than 85% within the radiation bandwidth.

IV. Conclusion

In this paper, a supesrtate is placed at a certain distance above the slot aperture. The presented slotted array resonates at the frequency 9.32 GHz with respective 10 dB return loss bandwidth cover from 9.15-9.47 GHz. The designed antenna is right hand circularly polrized. It can also be reconfigure to LHCP by rotating the superstrate by 90^0.

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