Design of a Curved FSS providing stable response with variation of incident angles

Nurnihar Begam, Snehasish Saha, Poulami Sammadar, P.P Sarkar, D. Sarkar

Abstract— In this paper transmission responses of a band pass cylindrical Frequency Selective Surfaces (FSSs) at various incident angles are investigated using Method of Moment(MOM) based software. Circular slots are used to design the FSSs. The dielectric substrate is considered as air. In case of circular slot type curved FSS when periodic distance between two elements is 28mm, stable response has been achieved for 0 degree, 15degree, 30 degree and 45 degree incident angle. Theoretical investigations have been done by FEKO simulator.

Index Terms—***aperture*** , ***circular slot, Cylindrical,Frequency Selective Surface, Method of Moment, incident angle ,FEKO simulator .***

1 Introduction

FSS is formed by a two-dimensional array of metallic patterns printed on a dielectric substrate or by an array of slots or appertures within a metallic sheet.[1]. The Aperture type FSS, performs similarly to a band-pass filter [2],[3]. To analyses different types of FSS structures theoretically, basically three methods are used – Finite Difference Time Domain (FDTD) method, Finite Element Method (FEM) and the Method of Moment (MoM). Among these three, Method of Moment is the most complicated but its accuracy is the best[4]. The characteristics of an FSS is highly sensitive to the thickness of dielectric substrate[5]. In the proposed work air has been considered as a dielectric substrate to avoid these problem. A band stop miniaturized planner FSS with thin substrate exhibits a stable transmission characteristics at 0deg,30 deg and 60 deg incident angles. [6]. Xueyan Song et. al presented a square loop planner FSS combined with a hexagon patch which is surrounded by a hexagonal ring. A stable performance for incident angles upto 50 deg for TE and TM polarization has been reported [7].A bandpass hemispherical curved FSS loaded with tripole elements has been analyzed by P. Samaddar et. al. A good pass band (8GHz-10GHz) and sharp roll off has been achieved [8].

Now in this paper a curved aperture type FSS with circular slots has been designed and investigated on the transmission responses at various incident angles.Planer FSS is not used in some required shapes. So the concept of curved FSS arises in the microwave communication field.

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2 Design Of Fss

Curved aperture type FSSs are designed by cutting circular slots in periodic distances 24mm, 26mm and 28mm .The FSSs are shown in fig.1, fig. 2 and fig. 3 . FSSs are designed by CAD and FEKO simulation software. Diameter of each circular slot is 20mm throughout the design. All curved FSSs are 300mm in length having diameter 200mm. Here thin alluminium foil paper is used as a metal element and air is considered as a dielectric substrate with dielectric constant 1.

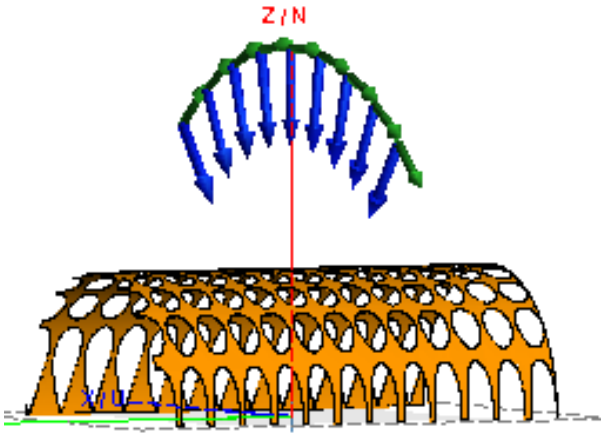

Fig. 1.: Aperture type curved FSS with circular element (Periodic distance 24mm

EM wave is incident on curved FSSs at various angles for diffrent stuctures with different periodicities.The transmission charecteristics of all the cases are noted down and are presented in fig .4 ,fig 5 and fig.6 .

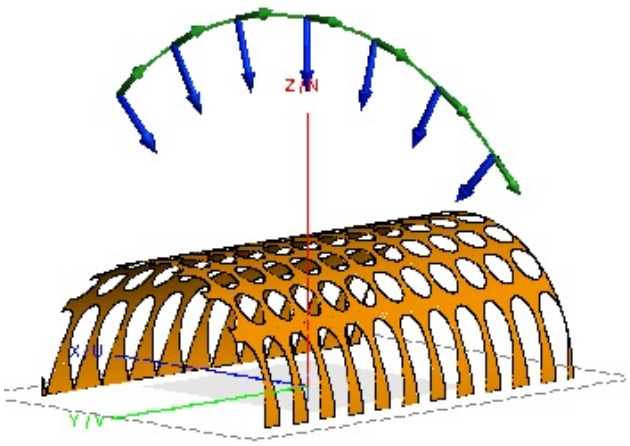

Fig. 2.: Aperture type curved FSS with circular element (Periodic distance 26mm

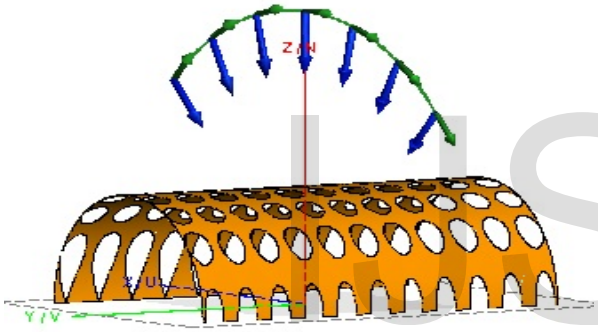

Fig. 3. Aperture type curved FSS with circular element (Periodic distance 28mm)

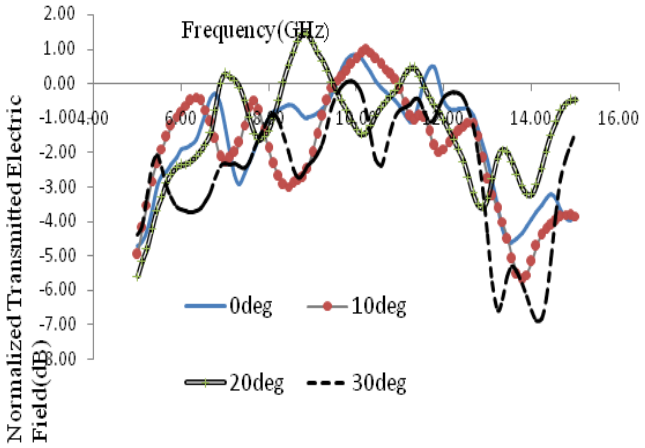

Fig. 4. Transmission Characteristics for circular shaped slot curved FSS with Periodicity of element 24mm

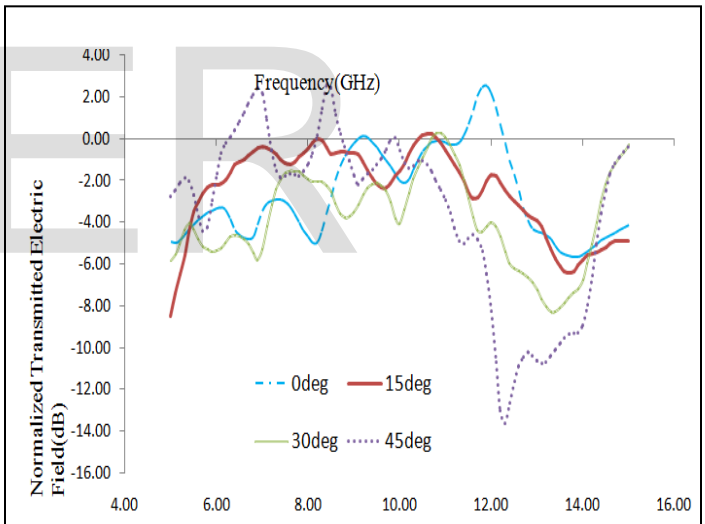

Fig. 5. Transmission Characteristics for circular shaped slot curved FSS with Periodicity of element 26mm

3 RESULTS

The transmission characteristics of fig.1, fig.2and fig.3 are shown in the fig .4, fig.5 and fig.6 respectively. A good pass band nature of the curved FSSs are achieved in all designs.The nature of transmission charecteristics are good with the variation of incident angles. There are almost same nature of responses which is shown in fig. 4 upto 30 degree incident angles at 24mm periodic distances of circular slots. It has been observed from fig 5 that there is a small variation of response at incident angle 45 degree w.r.t other angles .But when the periodicity of circular slots in the curved FSS is 28mm , then good stable response has been achieved for 0 degree, 15degree,30 degree and 45 degree incident angles which are shown in the fig.6.

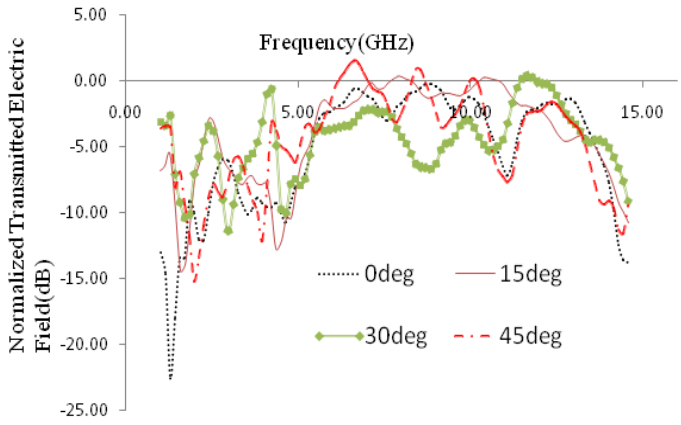

Fig. 6. Transmission Characteristics for circular shaped slot curved FSS with Periodicity of element 28mm

4 Conclusion

It has been observed that, for the curved FSS better stable transmission responses are obtained in the periodic arrangement of circular slot when periodicity is 28mm . There were many works on the angular stability of planer FSS.But it is quite challenging to get a stable responses with incident angle variation of Curved FSS. It can be concluded that almost stable responses has been acheived for the curved FSS which is shown in fig .3.So a curved FSS can be used in communication field for different angles of incident wave without variation of transmission responses .

References

[1] R. Mittra, C. H. Chan, and I. Cwik: "Techniques for analyzingfrequency selective surfaces-A review", IEEE Proc., vo1.76,Dec. 1988, pp.1593-1615.

[2] Ben A. Munk," Frequency Selective Surface—Theory and Design".2000.

[3] S. Baisakhiya1, R.Sivasamy2, *,M. Kanagasabai2, and S.Periaswamy2, "Novel Compact Uwb Frequency Selective Surface For Angular And Polarization Inde-Pendent Operation", Progress In Electromagnetics Research Letters, Vol. 40, 71-79, 2013.

[4] A. Chatterjee, S. Biswas, D.Chanda (Sarkar), P. P.Sarkar, "A Polarization Independent Compact Multi-band Frequency Selective Surface", INSTITUTE OF TECHNOLOGY, NIRMA UNIVERSITY, AHMEDABAD – 382 481, 08-10 DECEMBER, 2011, 978-1-4577-2168-7/11/$26.00 ©2011 IEEE.

[5] Deng, X. Yi, and W. Wu, "Design and performance of a double-layer miniaturized-element frequency selective surface,"IEEE Antennas and Wireless Propagation Letters, vol. 12,pp. 721–724, 2013

[6] In-Gon Lee and Ic-Pyo Hong "Scalable Frequency Selective Surface with Stable Angles of Incidence on a Thin Flexible Substrate", International Journal of Antennas and Propagation Volume, Article ID 6891065, page 1-6 F,2016.

[7] Xueyan Song, Zehong Yan, Tianling Zhang, Chuang Yang, and Ruina Lian "Triband Frequency-Selective Surface as Subreflectorin Ku-, K-, and Ka-Bands" IEEE ANTENNAS AND WIRELESS PROPAGATION LETTERS, VOL. 15, pp 1869-1872, 2016

[8] P. Samaddar, S.Sarkar, S.De, S. Biswas, D.C. Sarkar and P.P.Sarkar, "Bandpass Planer and Hemispherical FSS comprising of Tripole Element," Journal of Physical Scienc es, Vol. 18, 14-18,2014.