WIDE BAND FREQUENCY SELECTIVE SURFACE USING PATCH ELEMENTS LOADED WITH CIRCULAR RING SLOTS

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ABSTRACT

This work presents a novel proposal for the design of a Frequency Selective Surface (FSS) for wideband applications. The proposed FSS consists of an array of patches with circular ring slots of different widths. The structure is designed with the objective of increasing the bandwidth with circular ring slots on the patch. It is observed that, there is a tremendous increase in bandwidth in case of the final design. Generally bandwidth of an FSS is very narrow. In the field of communication, for high speed data communication broad band communication is extremely necessary. FSS being microwave filter is a part of communication device. So, its bandwidth need to be broad. Efforts have been given to achieve broad band FSS. Simulated results of the transmission coefficients are obtained using the ANSOFT® designer software. Some of the designs are fabricated in order to make a comparison between simulated and measured results for validation of the new proposal. Experimental investigations are done using standard microwave test bench. The maximum bandwidth obtained is 8 GHz.

Keywords- Bandwidth enhancement, Frequency selective surfaces, patch, Resonant Frequency, slot

I. INTRODUCTION

Frequency Selective Surfaces (FSS) are periodic array of patches on a dielectric substrate or apertures of regular or arbitrary geometries within a metallic screen [1-2]. These structures exhibit the property to reflect or transmit electromagnetic waves. So they behave as filters. Patch type FSS acts as Band Reject Filter and aperture type FSS behaves as Band Pass Filter [3]. FSSs have been used in sub reflectors of multi reflector antenna systems, microwaves, radomes and electromagnetic shields [4-9]. For this reason, FSS has been the subject of intensive investigations [10-14]. After going through some papers on broad band FSS, it is observed that some broad band FSSs are reported in [15-18]. Considering all of them, it is found that highest Bandwidth achieved is 4 GHz. In this paper, broad band FSS (8GHz) , which is very useful for communication purpose has been designed. Rectangular patch with one centrally placed circular ring slot is considered as the primary design (Fig.1.).The design has been modified such a way that in first modification unit cell is constituted by a rectangular patch with two types of circular ring slots with a total number of four. In further modification the unit cell has been

constituted by a rectangular patch with three types of circular ring slots with a total number of nine. Staggering effects result in band enhancement of around 8 GHz.

II. DESIGN OF THE FSS's

The FSS Structure consists of two dimensional array of patches. The patches are considered to be present on one side of a thin dielectric slab and the copper coating on the other side of the slab is completely removed. The Primary design is shown in Fig.1 and dimensions in detail are given in Table 1. Results for different dimensions are also noted in Table 1. First modification of the design with a rectangular patch loaded with two types of circular ring slots (total no.4) is presented in fig.2. Results with Various dimensions are again noted in Table 2. Similarly final modification and dimensions are provided in Fig.3 and Table 3.

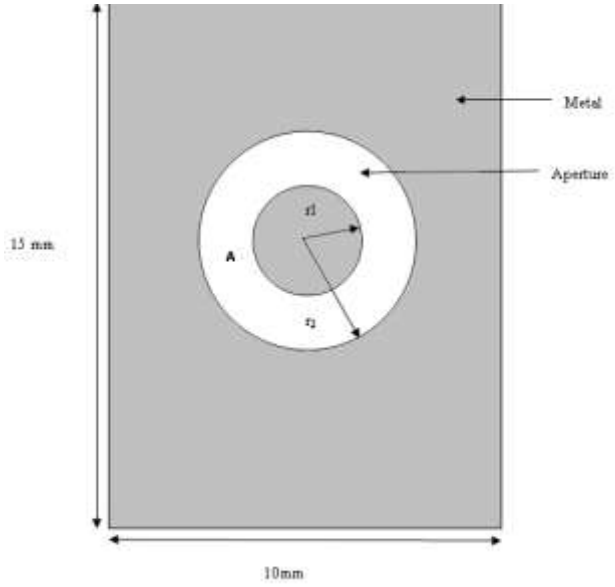

Fig.1. Patch with One Circular Ring Slot under Investigation

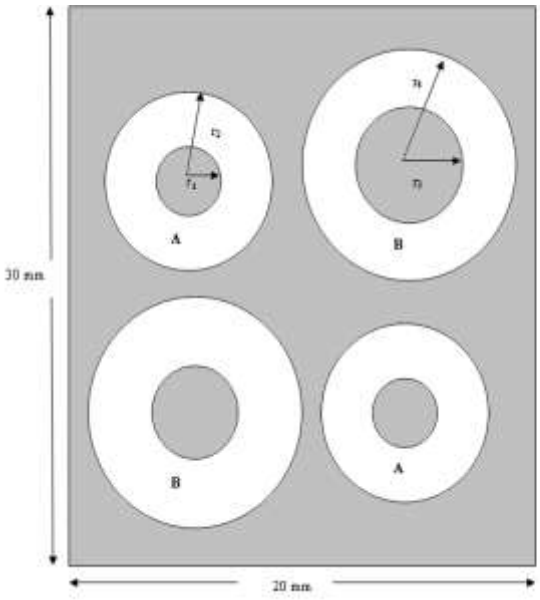

Fig.2. Patch with Two Circular Ring Slots under Investigation

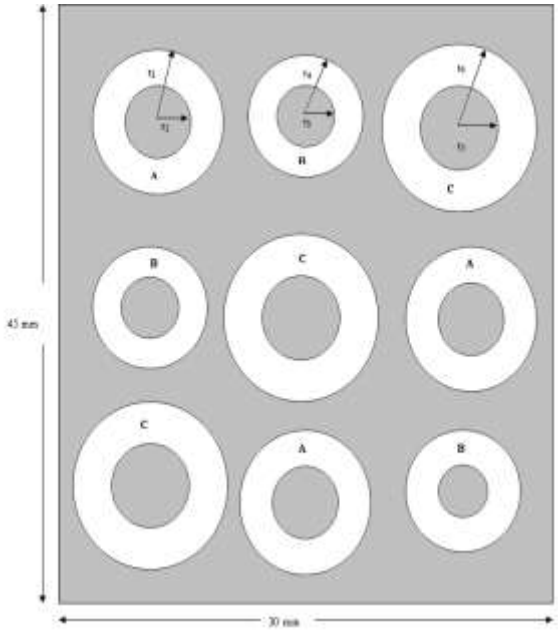

Fig.3. Patch with Three Circular Ring Slots under Investigation

III. MEASUREMENTS

Frequency Selective Structures comprising of rectangular patch loaded with circular ring slots for mentioned three types of designs are tested in microwave laboratory using Agilent made microwave generator, power meter, power sensor etc. Transmission tests are done at S, C, J and X bands. Two horn antennas (one for Transmission and other for reception) are placed at both the sides of the FSS structures. The horn antennas are connected to Agilent Power source and Agilent Power meter to the Transmission and Receiving antennas respectively. Measurements are done for the above mentioned frequency bands. Normalized transmitted electric fields versus frequencies have been plotted for three types of Frequency Selective Structures. Measured and Simulated results are plotted in same figure for same design for comparison.

IV. RESULTS

Simulated and measured data have been plotted, in the Fig. 4, Fig. 5 and Fig. 6. The results are also given in Table1, Table 2 and Table 3.

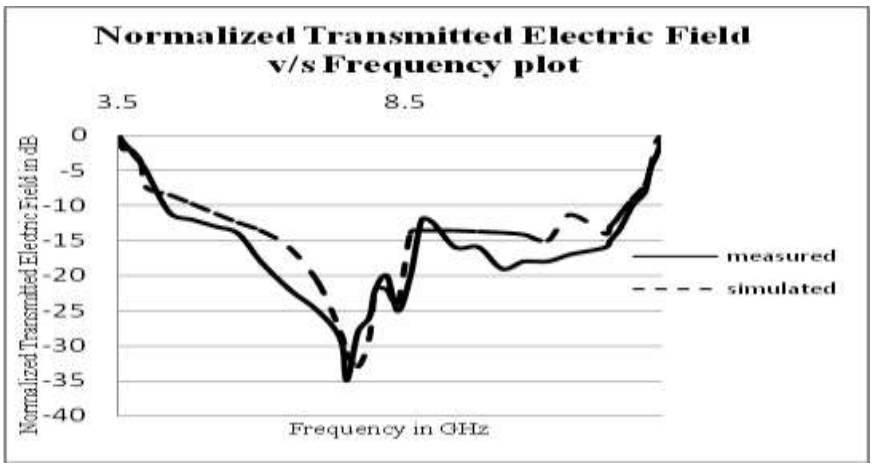

Fig. 4. Graph showing simulated and measured results for the designed FSS comprising of rectangular patch loaded by two circular ring slots (width=1mm and 1.5mm).

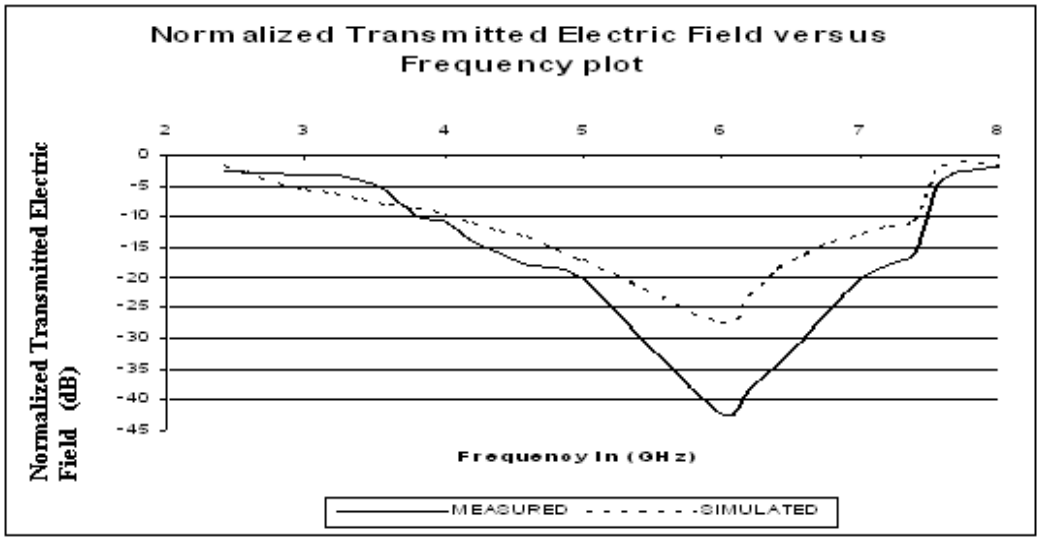

Fig.5. Graph showing simulated and measured results for the designed FSS comprising of rectangular patch loaded by two circular ring slots (width=2.25mm and 2mm)

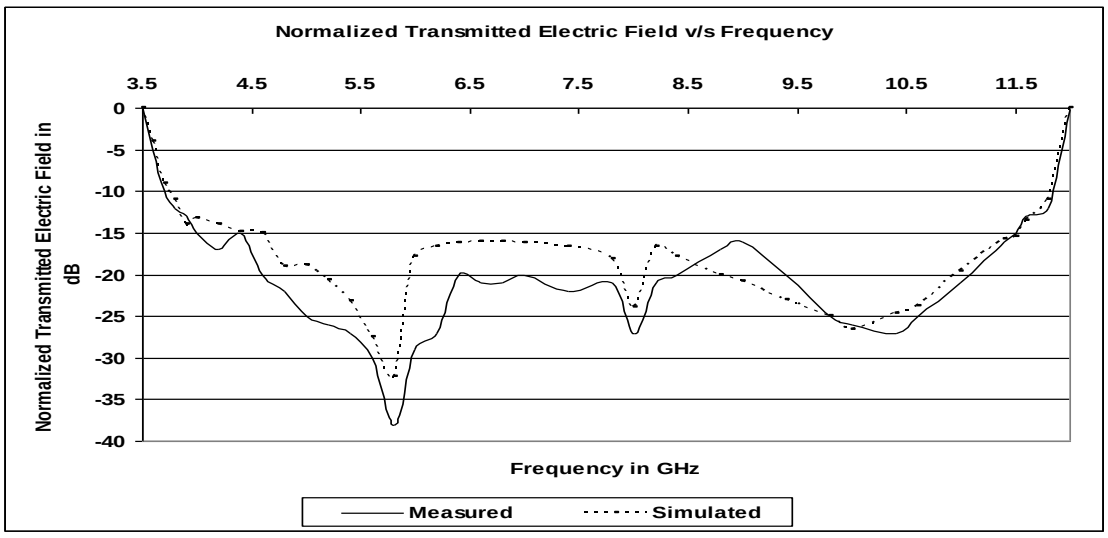

Fig. 6. Graph showing simulated and measured results for the designed FSS comprising of rectangular patch loaded by three circular ring slots (width=1.25mm,0.5mm and 1mm respectively).

Table 1: Patch with One Circular Ring Slot

S.No.	Width of the Circular ring slot (mm) A (r_2-r_1)	Internal radius (mm) A (r_1)	Bandwidth obtained (GHz)
1.	0.5	2	1.15
2.	0.75	1.5	0.8
3.	1	1	1.1
4.	1.25	1.25	2
5.	1.5	1.5	1
6.	2	2	0.73
7.	2.25	2.25	0.64

Table 2: Patch with Two Circular Ring Slots

S.No.	Width of the Circular ring slot (mm) A (r_2-r_1) B(r_4-r_3)		Internal radius (mm) A (r_1) B(r_3)		Bandwidth obtained (GHz)
1.	1.25	1.25	1.25	1.25	4
2.	0.5	0.75	2	1.5	3
3.	1	1.5	1	1.5	4
4.	2.25	2	2.25	2	4

Table 3: Patch with Three Circular Ring Slots

S.No.	Width of the Circular ring slot (mm) A (r_2-r_1)	B (r_4-r_3)	C(r_6-r_5)	Internal radius (mm) A (r_1)	B(r_3)	C(r_5)	Bandwidth obtained (GHz)
1.	1.25	1.25	1.25	1.25	1.25	1.25	3
2.	1.25	0.5	1	1.25	2	1	8

V. CONCLUSION

With the help of the plots and results obtained, It is observed that FSS using patch with one circular ring slot maximum bandwidth obtained is 2 GHz. As two circular ring slots of different widths are loaded on the patch, bandwidth is increased to 4 GHz. When three circular ring slots of different widths are loaded on the patch the bandwidth becomes 8 GHz. This type of broadband FSS is very fruitful for broadband communication.

VI. ACKNOWLEDGEMENT

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