A Novel Penta-Band Frequency Selective Surface

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Abstract
Frequency Selective Surface (FSS) has been designed by combination of two dimensional arrays of square and novel shaped patches. The proposed design has been investigated theoretically and experimentally. This proposed design has been investigated theoretically using ANSOFT® software. The main aim of this design is to make the FSS multiband with good bandwidth and we achieved five bands with percentage bandwidth of (3.95%, 3.85%, 6.4%, 11.94% and 6.05%) and the measured results show good agreement with the simulated ones.

Keywords
Frequency Selective Surface, Patch, Multiband, Bandwidth.

I. Introduction
With the ever increasing demands made on the available radio spectrum, a limited natural resource, efficient frequency reuse has become a very significant issue in radio communications. The Increasing demands on multi functionality of antennas for communications require complex FSS with multiband requirements [1,3,5]. To fulfill this requirement four-band FSS design with the concentric ring elements [2], thin dual-band two-layer FSS [6] etc have been introduced by previous researchers. This paper includes a unique design which makes this FSS having five bands.
Typically, an FSS consists of one or more grids supported by one layer or multiple layers of dielectrics. The grids are thin conducting periodic elements etched on thin substrates. As these grids can be designed to resonate at specified frequencies, the FSS will reflect waves at these frequencies, and pass waves at other frequencies. Experimental investigations on arrays of elements of different shapes like the Jerusalem cross, annular ring, and square loop have been carried out earlier. These different structures were designed to resonate at a single frequency [4]. This paper introduces a design which resonates at five different frequencies in partially C, X and Ku band and the band separation is also good.

II. Design of FSS
In designing a patch type FSS; a square and a novel shaped patch are used as a combined patch which is placed at a distance of 1.5 mm apart. This combined (square and novel shaped) patch is repeated in every row with 3.5mm distance and rows are also 3.5 mm apart with other rows. This makes a two dimensional array of metallic patch. The horizontal periodicity is 29 mm and vertical periodicity is 19 mm. The patches are placed alternately on a glass_PTEF dielectric which has 1.6 mm thickness and 2.4 relative permittivity. Similar rows are repeated to form the two dimensional array. The theoretical investigation is done by ANSOFT Designer / Nexxim software which uses Method of Moment (MOM) process to calculate the results. At the time of theoretical investigation an infinite two dimensional array of patch elements are consider but at the time of experiment a (14cm * 12.5 cm) FSS having eight rows and ten columns is used. Fig. 1 and fig. 2, shows the combined patch and a small part of the FSS and fig. 3, shows the practical FSS.

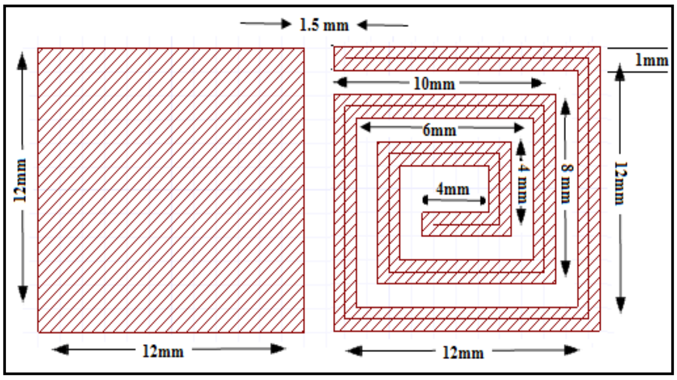

Fig. 1: Combined Patch

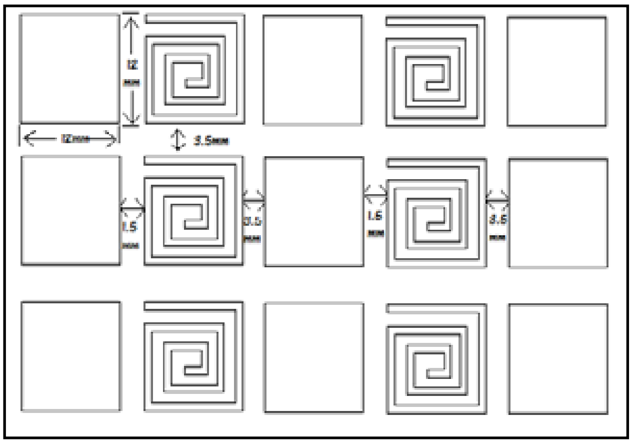
Fig. 2: Frequency Selective Surface

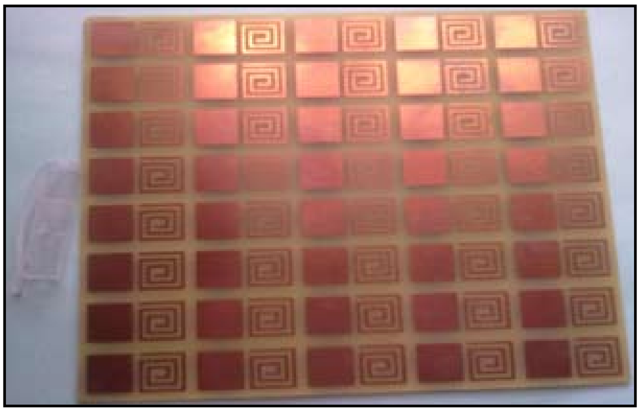
Fig. 3: Practical FSS

III. Result
Table 1: Practical and Theoretical Results

Resonating Frequency (GHz)		Bandwidth (GHz)		Percentage Bandwidth	
Theoretical	Practical	Theoretical	Practical	Theoretical	Practical
6.59	6.5	0.26	0.8	3.95%	12.31%
8.06	8	0.31	0.67	3.85%	8.37%
9.38	9.4	0.6	1	6.40%	10.62%
10.97	11	1.31	2.3	11.94%	20.91%
13.23	14.3	0.8	1.2	6.05%	8.39%

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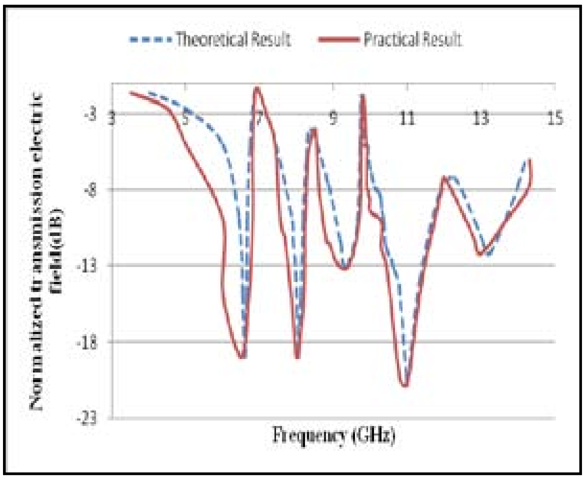

Fig. 4: Frequency Response

IV. Conclution

For the last few years researchers are trying hard for size reduction, multi-frequency operation and bandwidth enhancement of a Frequency selective surface. From the results of various papers it is observed that achievement is any one of the three characteristics. Now our goal is to design such a FSS structure which will exhibit any two characteristic of the above three. In this regard, it can be said that multi-frequency operation and enhancement of bandwidth here achieved simultaneously in our paper. Already the FSS resonates at five frequencies and bandwidth is more than 10% in some cases. This work is really encouraging in this aspect.

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