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Design and Analysis of Compact CPW Fed Elliptical Patch Antenna for UWB Applications

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Abstract: In this paper, a CPW fed patch antenna for UWB applications is designed and its characteristics are analyzed. The effect of the inductive loading in the form of a horizontal conducting strip perpendicular to vertical strip running along the length of the geometry. The simulation based experiment performed a comparative analysis on the effect of various shapes of this loading on the bandwidth of the antenna. The simulation of the antenna is carried out using CST Microwave Studio.

Keywords: UWB, Patch antenna, CPW Fed, Inductive loading.

1. INTRODUCTION

Recently, broadband technology has attracted great attention for wireless applications as it offers advantages of high speed data rate, low power consumption, high capacity, low cost, and low complexity [1–3]. Broadband systems necessitate the use of broadband antennas with desirable features including small physical size, ease of manufacture using conventional fabrication technologies, gain and omni-directional radiation characteristics. Several broadband antenna designs have been recently developed [4–16], such designs include planar monopole antennas that promise wideband performance for wireless communication systems. In this work, designing several types of patches are designed and analyzed using 3D EM Simulator. The proposed antenna is best suitable for UWB applications.

2. CONSTRUCTION OF THE PROPOSED GEOMETRY

The proposed antenna geometry typically consists of a T-shaped radiation stub whose vertical strip is placed between separated ground regions in the same plane. The two ground regions are symmetric in nature. One corner of the typically the right corner of a rectangle is cut. The shape of the cut is a sectoral which results in a curve. The same ground region image is symmetrically on the other side of the strip line. With the vertical line strip and two ground regions on either side with gap, a coplanar waveguide feed is arranged. The ground region is further extended along the border as a thin strip. The patch is etched on a FR 4 substrate with dielectric constant of 4.4 and thickness 1.6 mm. The described geometry is as shown in Figure 1. The so described antenna is further modified in terms of the shape of the radiating stub as well as the gap between the strip bounding on top and the shaped stud.

The earlier geometry is considered as case 1. In the geometry which is considered under case 2 also considers T-stub with a triangular extension on the horizontal strip of the T-shaped stub. This is as shown in Figure 2. Further this geometry is modified to form the geometry in Figure 3. The geometry is case 3 considers as elliptical shape in place of horizontal, rectangular strip in T-shaped stub while the geometry in case 4 considers a sector as shown in Figure 4. The dimensions of the geometry in case 1, case 2 and case 3 are optimized and presented in Table-1.

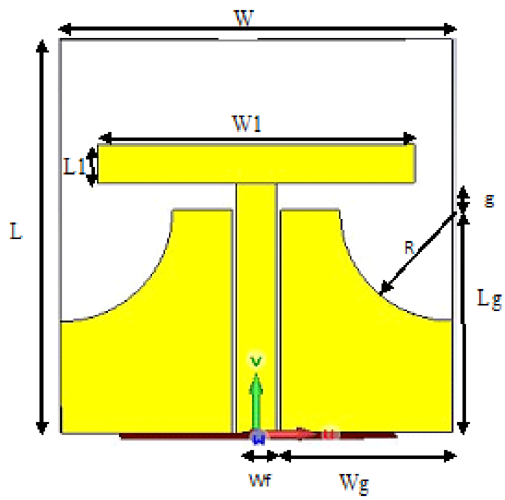

Figure 1: Case 1 geometry

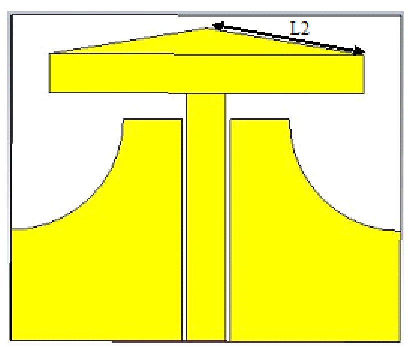

Figure 2: Case 2 Geometry

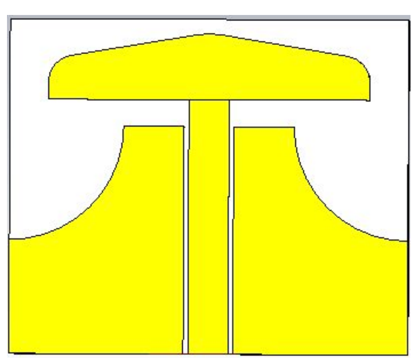

Figure 3: Case 3 Geometry

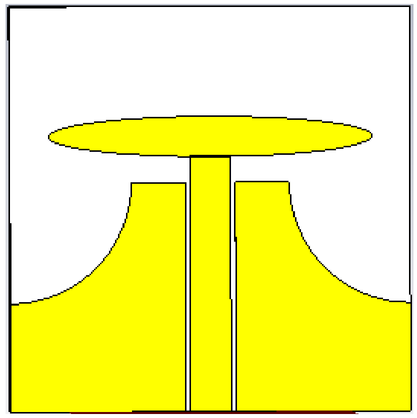

Figure 4: Case 4 Geometry

Table 1
Geometry of the proposed Antenna

S.no	*Parameter*	*Dimension (mm)*
1	W	30
2	L	30
3	W1	24
4	L1	3
5	Wf	3
6	g	3
7	R	8.5
8	Wg	13
9	Lg	17
10	H	1.6

3. RESULTS

Results pertaining to the simulated antenna are presented in this section. The analysis of the antenna is carried out using several simulated reports of radiation characteristics like return loss (S11), voltage standing wave ratio (VSWR). The first opinion on the frequency response and the corresponding resonating frequencies identification are performed with the aid of return loss plots. The coordinates of the S11 plot corresponding to x-axis whose magnitudes on Y-axis are less than −10 dB are referred to as resonating frequencies. Following this, further these resonant frequencies are verified with the corresponding VSWR plot for which the magnitudes at these frequencies are supposed to have less than '2'. Case wise radiation characteristic plots are mentioned in following subsequent sections.

3.1. Case 1

It is evident from the S11 plot given Figure 5. That the resonant characteristics cover the entire UWB range. Starting from 3.16 GHz the antenna exhibited reflection coefficient with a magnitude less than −10 dB up to 10.3 GHz. Similarly the corresponding to VSWR plot is as shown in Figure 6.

The radiation characteristics corresponding to VSWR have similar response within the UWB range. In addition it can also be inferred that a band continuously existing between 4.5 GHz to 7 GHz expressed. Slightly lower gain with optimum return loss which much higher than the other frequencies.

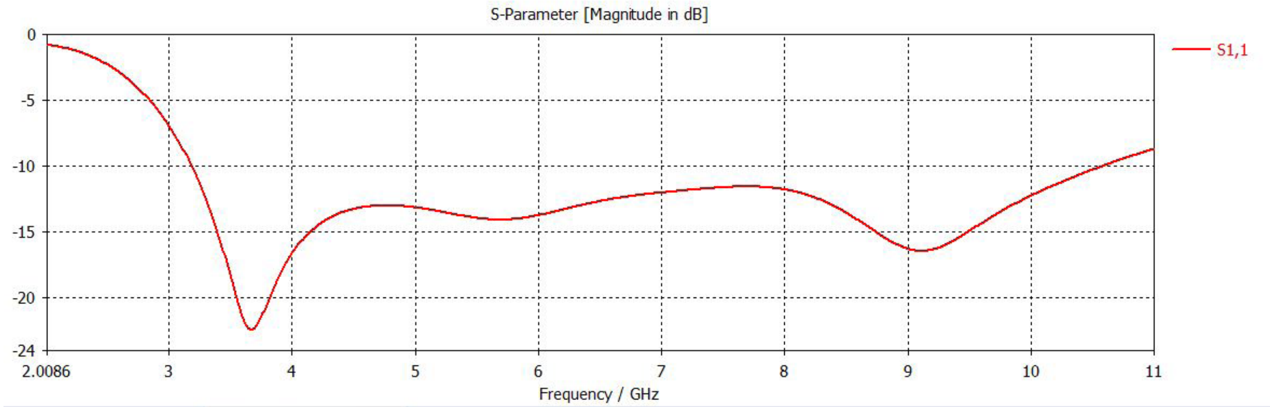

Figure 5: Return loss parameter of case 1

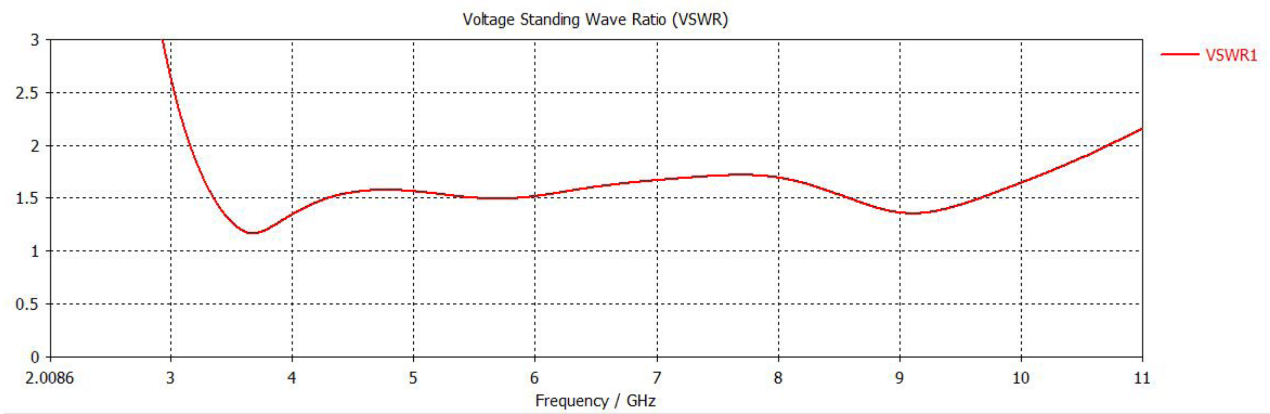

Figure 6: VSWR parameter of case 1

3.2. Case-2

The geometry in case 2 also exhibited similar response as that of case 1 inspite of enhanced area of the T-stud with a flat triangular elevation on top of it. This is evident from S11 plot and VSWR plot in Figure 7 and Figure. 8 respectively. However, with the enhanced area of the radiating stub, the corresponding gain and directivity are effected, which can be learned from the absence of another dip in S11 plot in the region around 7 GHz to the end of resonance.

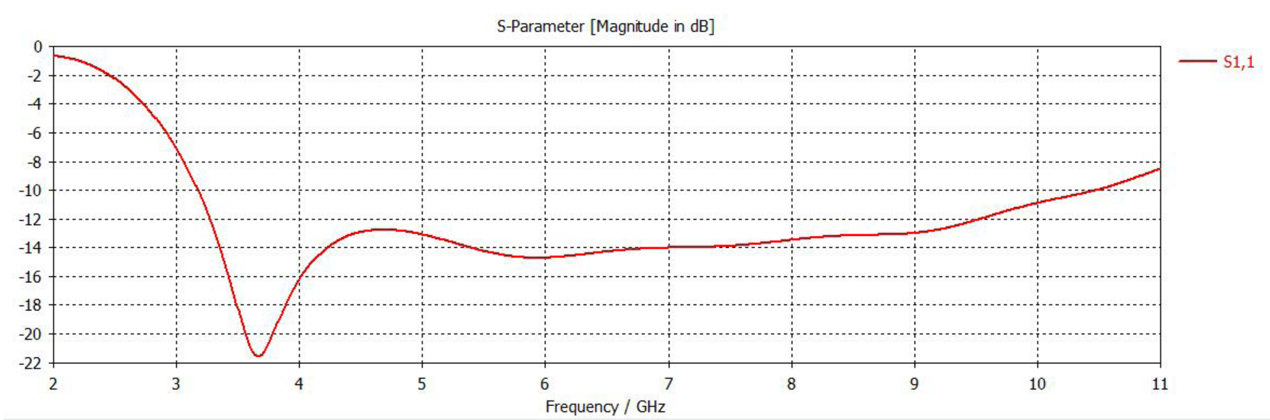

Figure 7: Return loss parameter of case 2

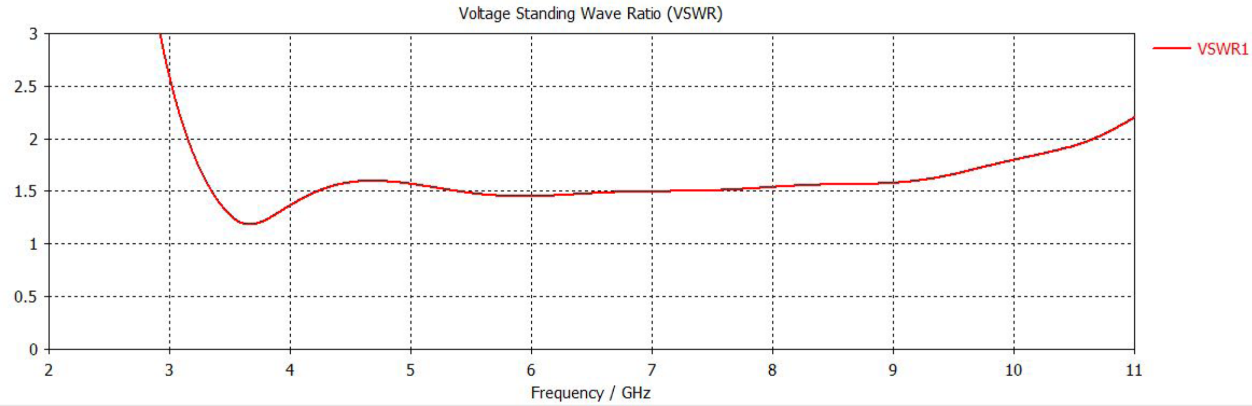

Figure 8: VSWR parameter of case 2

3.3. Case 3

The geometry presented as case 3 expressed similar radiation characteristics as that of the previous two cases. However, it expressed the several current distribution as well as the gain variations. The frequency response corresponding to the return loss parameter and the VSWR are as shown in Figure 9 and Figure 10 respectively. Through the bandwidth remains unaltered. However, the corresponding directive characteristics are enhanced which is evident from the depth of the dip at 3.8 GHz.

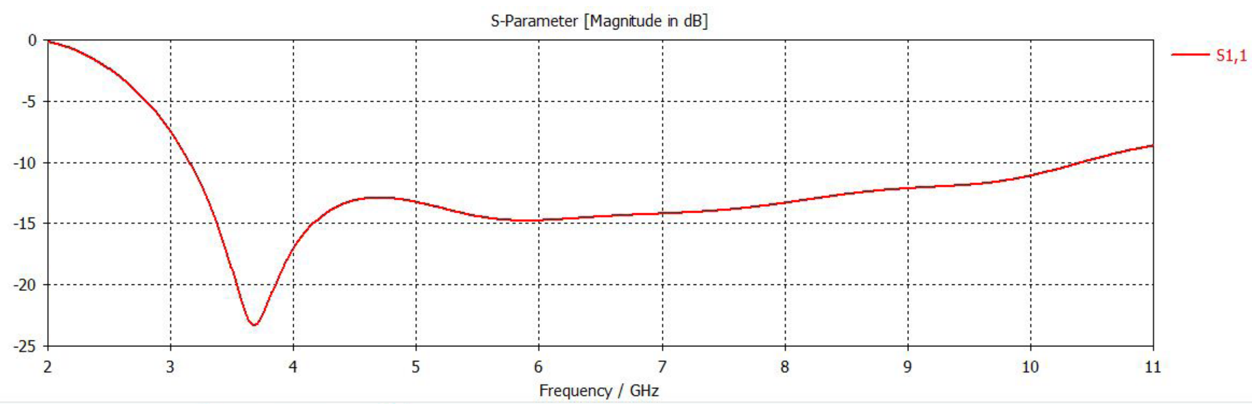

Figure 9: Return loss parameter of case 3

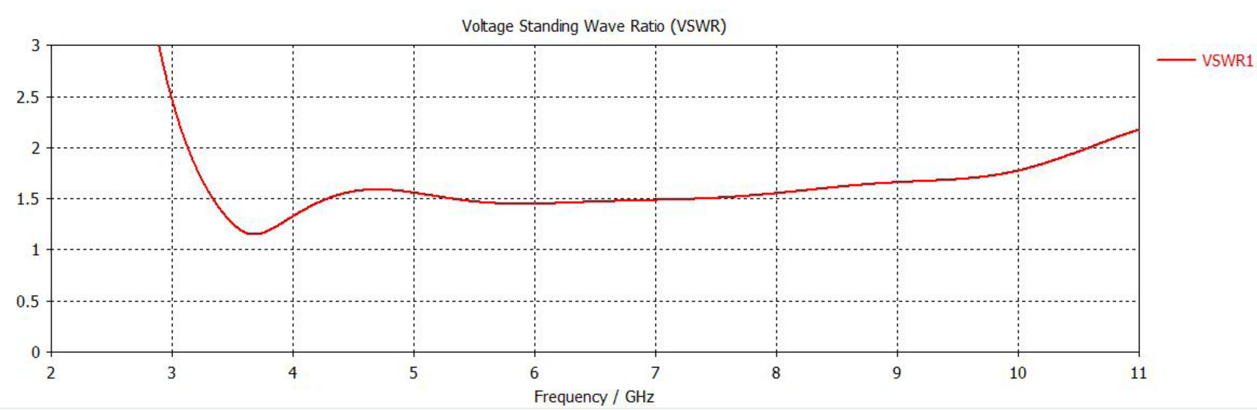

Figure 10: VSWR parameter of case 3

3.4. Case 4

The radiation characteristics interms of S11 and VSWR of case 4 geometry are as shown in Figure 11 and Figure 12 respectively. Similar to the earlier cases, the corresponding bandwidth is increased and expressing UWB characteristics.

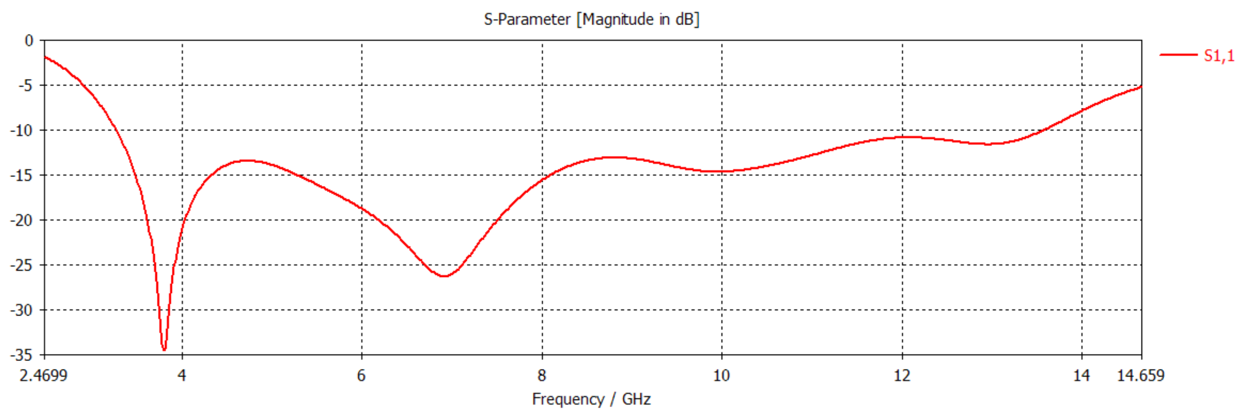

Figure 11: Return loss parameter of case 4

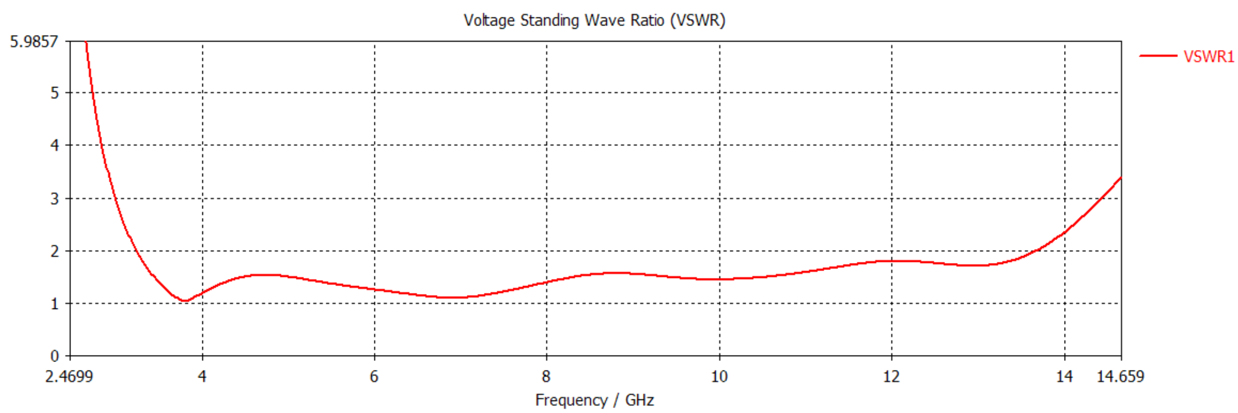

Figure 12: VSWR parameter of case 4

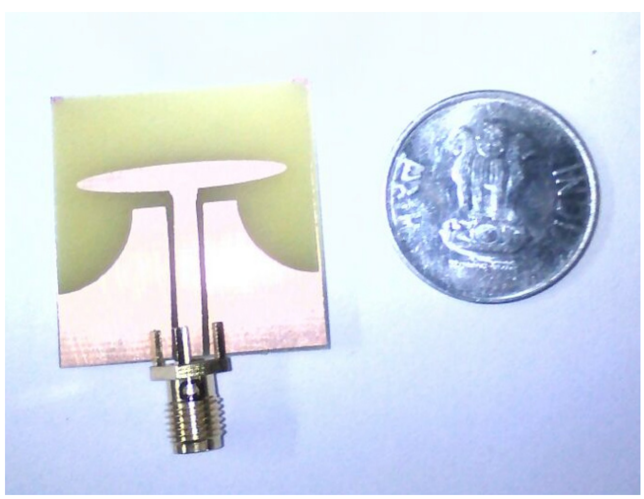

Figure 13: Fabrication Prototype of the proposed Elliptical antenna

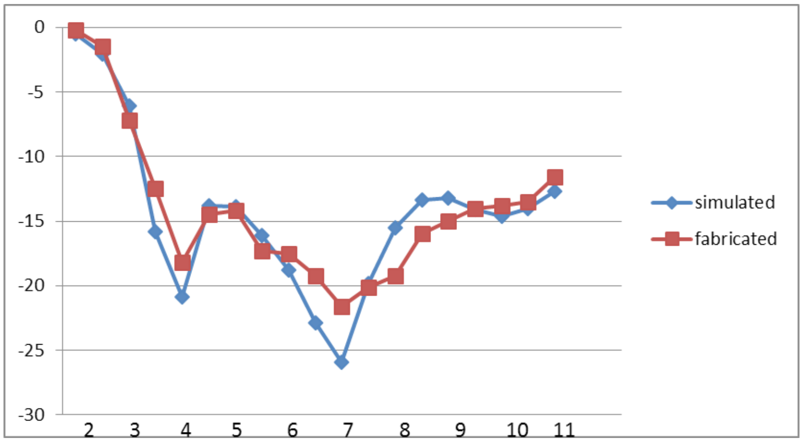

Figure 14: Validation of Return loss parameter

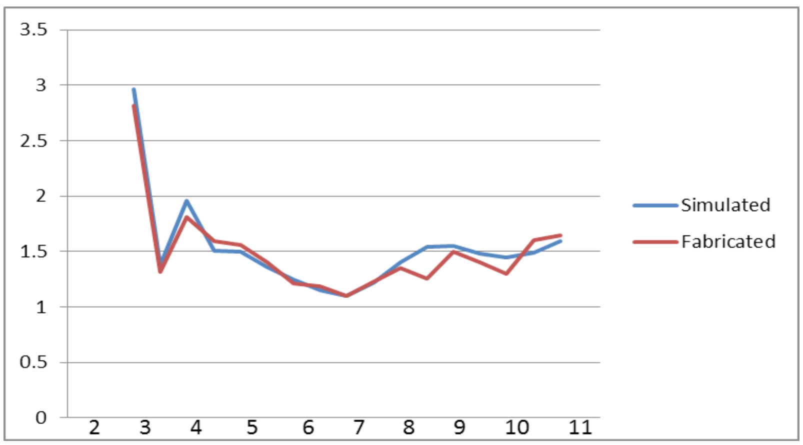

Figure 15: Validation of VSWR Parameter

4. CONCLUSION

A CPW fed patch antenna with T-Stud for UWB applications is designed, simulated with a wide variety of modified radiating stud geometry. Though, the radiating part is often referred to as T-shaped, it is obvious due to the cross shape in which the horizontal part is modified as rectangle, sector, triangle and elliptical shape. These geometrical variations could successfully provide area wise variation. However, the corresponding bandwidth remained unaltered. This is due to the fact that the largest dimension in the cross shape is the vertical bar while the horizontal part remains as load.

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