# Larg Band Ridged Waveguide Polarizer as Feed for Telecommunications Satellites Antennas

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**Abstract**

For the transmission in high power in the systems of telecommunications Satellite; the systems in technology guides wave are best placed. the current progress recorded in the field of telecommunications requires an increase in the performances of these devices, more especially as average data processing and the recent software, such as for example the software of simulations and optimizations make it possible to make such studies. Thus the object of this work is registered [1].

Contemporary RHCP and LHCP wave occurs in several applications of microwave communication and measurement system. From this point of view the septum polarizer can be useful. The septum polarizer is a four-port waveguide device. The square waveguide at one end constitutes two ports because it can support two orthogonal modes. A slopping (or stepped) septum divides the square waveguide into two standard rectangular waveguides sharing a common broad-wall. The size of the septum as well as two versions of the waveguides excitation were analyzed and are described in this paper [11] and [12].

***Keywords:*** *Circular polarization, Ridged waveguide polarizer, septum feed horn, Simulation, Optimization, Ansoft HFSS.*

## 1. Introduction

The principal scopes of application of the devices ultra high frequencies are telecommunications (terrestrial and satellite), the radars and radiometry. The polarizer with guides with veins seems the best means of obtaining right circular polarizations and left in the antennas of telecommunications satellites. It is a system with three simple doors and manpower which can be used to feed from the waveguide antennas of various structures: squares, rectangular, circular, and trapezoidal.

The ridged waveguide polarizer [1], [2] is considered as the better way to get right-hand and left-hand circular polarization in the antennas of telecommunications satellites. In fact, it is a system of three ports used to feed a square waveguide antenna in order to achieve high purity in the right-hand and left-hand circular polarization. Obtaining a great purity of polarization results by the addition from screw from adaptation and blades from correction. A solution with this problem is obtained by the optimization of dimensions of the various ridges. The object of work consists in determining optimal dimensions of the ridges of the polarizer by using the "Genetic Algorithms". The structure is modeled in 3 dimensions then simulated and optimized in order to obtain a 90° phase shift between the two orthogonal components in the system output and this in the waveband [8-13] GHz. The results of simulation and optimization are outlined using the HFSS software (figures 1) and (figures 2a, 2b) [3].

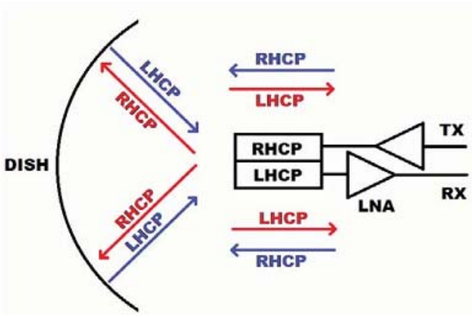


Fig. 1 CP communications systems.

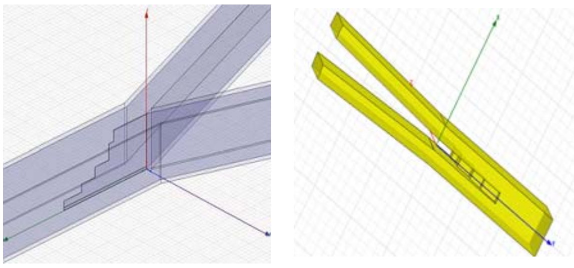

Fig. 2a Stepped septum feed.

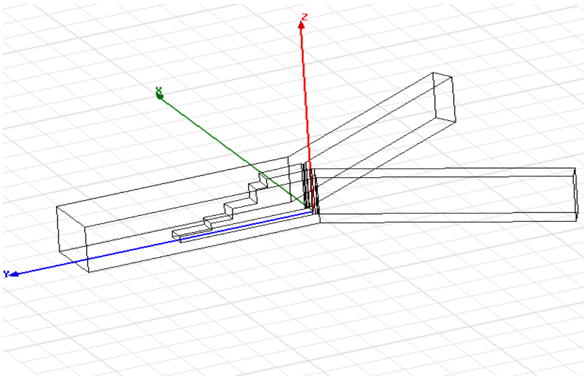

Fig. 2b Stepped septum feed.

## 2. Circular polarization

Circular polarization used in communication systems has several advantages. First of all it is very low depolarization effect during long way of propagation, low sensitivity to the multi-pass propagation and high cross-polarization isolation. Quality of CP is expressed by axial ratio A (Figure 3). Polarization efficiency is then given by PE.
The polarization efficiency is defined:

$$PE = 20 \log (1 \pm \rho_R \rho_T) \qquad (1)$$

where $\rho_R$, $\rho_T$ are voltage cross-polarization ratios:

$$\rho_I = (Ai-1)/(Ai+1) \qquad (2)$$

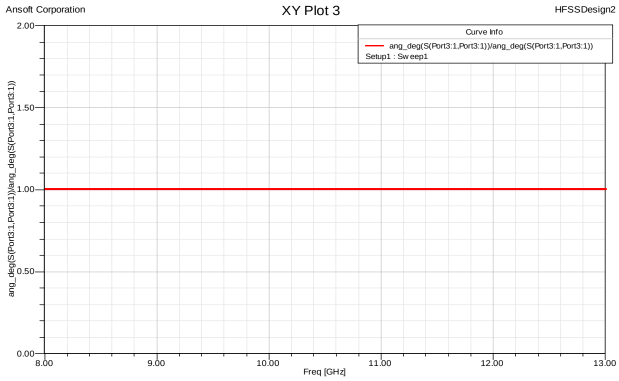


Fig .3 Axial ratio “A”.

## 3. Stepped Septum

Template for the first optimization was used from the reference [4] and [5] again. Septum plate thickness was set very thin 5mm. The first optimization analysis was focused on high of teeth from the supply end towards aperture end. Very small differences of septum size have had a big influence on axial ratio peaks. After many changes and iteration the septum plate was optimized according to the table 2. The axial ratios for both CP were very size sensitive but far to the optimum. For this reason the thin of septum was increased in millimeter steps. Then the feed parameters are quite better. Axial ratio goes down less than 1 dB and return loss stop within -10.87 dB, (Figure 4). The Figure5 shows the VSWR at the both driving ports [6], [7].

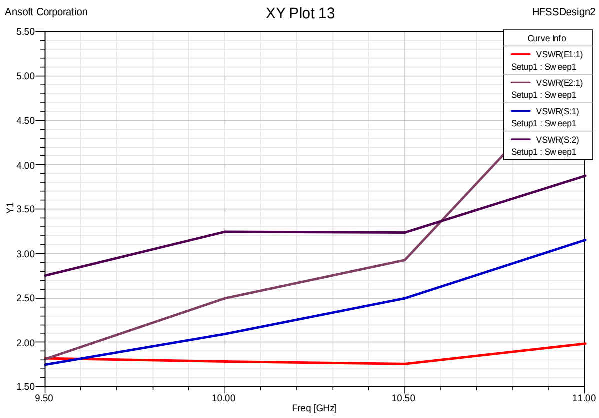


Fig. 4 VSWR of waveguide supplied feed.

## 4. Applications

The simulator of structures high frequency of Ansoft HFSS (Hight Frequency Structural Simulator [13], [14], [15]) is a software package (EM) electromagnetic double alternation allowing the electromagnetic calculation of a structure in 3D. HFSS is used in several electromagnetic fields and in particular in the field of Telecommunications for the simulation of satellites antennas.

In our application, we took the parameters of the following guide:

- *x =18.1 mm* (width of the guide).
- *z =18.1 mm* (height of the guide).
- *a = 5 mm* (thickness of the ridge).
- *Y=74,2 mm* (length of the guide)

Where,

- x(i): is the space between the rectangular waveguide and the height of i$^{th}$ ridged waveguide.
- Length (i): is length of i$^{th}$ ridged.

The dimensions of the ridge waveguide before optimization are given in Table 1.

TABLE1. Dimensions of the optimized Length and height of 5 ridges waveguide.

| RIGDES | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| **The optimized height (mm)** | 12.87 | 2.54 | 6.86 | 6.55 | 8.78 |
| **The optimized length (mm)** | 17.70 | 13.80 | 7.90 | 4.20 | 1.38 |
| **The optimized thickness (mm)** | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 |

The dimensions of the ridge waveguide after optimization are given in Table 2.

TABLE 2. Dimensions of the optimized length and height of 5 ridges waveguide.

| RIGDES | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| **The optimized height (mm)** | 14.70 | 3.40 | 7.80 | 7.40 | 9.80 |
| **The optimized length (mm)** | 18.10 | 14.70 | 9.00 | 5.10 | 2.35 |
| **The optimized thickness (mm)** | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 |

## 5. Optimization

The application of the "Genetic Algorithm" enables us to solve the problem of synthesis of the ridged waveguides polarizer. It is a question of determining the lengths and the heights of the ridged, which generate a phase shift of 90°.

In our application, we put forward the characteristics of AGs in their applications to optimization [8] lengths and heights of the ridged waveguide.

In fact, many parameters influence the solution of the problem by the genetic algorithm. After several tests, we noted that a good precision with a relatively acceptable computing time are obtained [9].

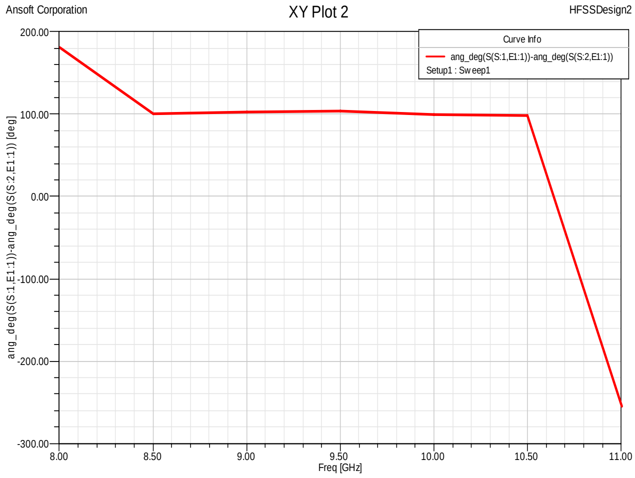


Fig .5 Variation in the phase shift versus frequency after optimization of different lengths and heights of the 5 ridges of the guide by the AGs method.

The results obtained in figure 5, one can observe the various variations of phase shift versus according to the frequency and this while varying the various parameters of the ridges (lengths Li, heights hi, thickness Ti,..) and also by modifying each time the positions of the ridges of the guide. This constitutes a practical means to grant the polarizer on the phase shift versus of 90°.

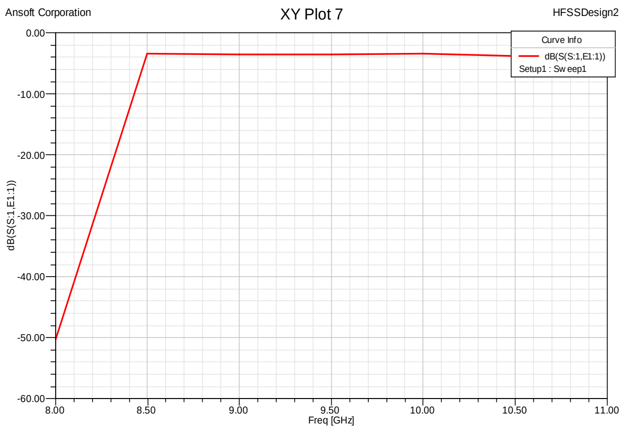


Fig .6 The coefficient of reflection of the waveguide.

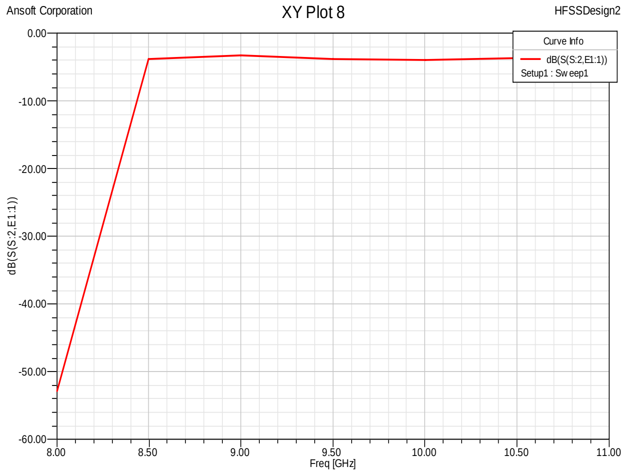

Fig. 7 The coefficient of transmission of the waveguide.

The following figures (Figures 6 and 7) show the different coefficients of transmission S11 and reflection S12, after optimization of the different dimensions of ridge waveguide polarizer.

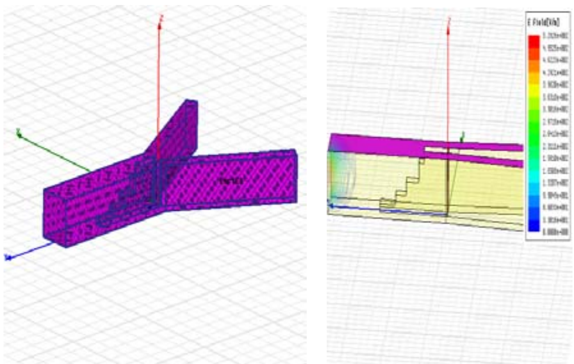

Fig .8 The perfect Electronic field “E”.

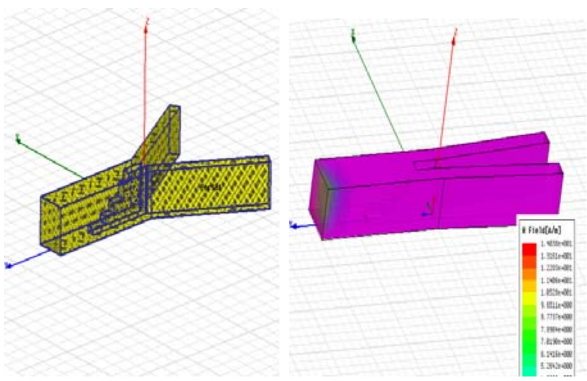

Fig .9 The perfect Magnetic field “H”.

## 6. Conclusions

We have investigated the septum feed for the X band. Though on lower frequencies the coaxial probes are often used for the septum feed supplying, this way is problematic on the X band. Much better results have been achieved by waveguide supplied septum feed. Interesting pieces of knowledge is the optimized thickness of the septum [10].

In our various applications, we have represented the variations obtained in phase according to frequency. For a prefect circular polarization; whose phase must remain constant and equal to 90°. Several optimizations have been performed using simulation software HFSS: optimization software which is robust and very professional performance for analysis, simulation and optimization of 3D ridged waveguide. The results were satisfactory [7].

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