ADJUSTABLE POLARIZATION CONVERSION DEVICE FOR FSS-RANGE

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Every year the need for the use of polarizing devices in modern telecommunications systems increases. Polarization signal processing used in satellite [1, 2], telecommunication information processing systems 5G [3-5] and OFDM systems [6-8] is also becoming widespread. Such devices are polarizers that have different designs, but they have one common function - the transformation of the types of polarization [9]. The simplest and most popular are rectangular waveguides containing diaphragms and pins as reactive inhomogeneities [10-13], which are widely used in the Ku range, ie for satellite communication. In general, the Ku band can be divided into three subbands: 10.7-11.7 GHz; 11.7-12.5 GHz; 12.5-12.8 GHz, but in this paper the results for the whole band will be presented, without division into subbands. The polarizer contains reactive elements - diaphragms, which act as a reflective element for further coordination [14-16]. However, if the disadvantage of a polarizer with diaphragms only is that there is no further adjustment of the characteristics depending on the needs before use, the characteristics are static after manufacture, this is why we should still use the pins that help us with this dilemma. Reactive elements are also used in various waveguide filters [17-19].

The aim of the work is to study the main characteristics of the device for converting the polarization of the FSS range with the possibility of adjustment.

Three-dimensional model and internal design of a polarization conversion waveguide device with four diaphragms and two pins in total, 2 diaphragms and 1 pin, arranged symmetrically. Fig. 1 shows the three-dimensional model. Fig. 2 shows the internal structure. The height of two diaphragms is h, and the thickness is w, two pins are of height hp and diameter d, the distance between the diaphragm and the pin is *l*.

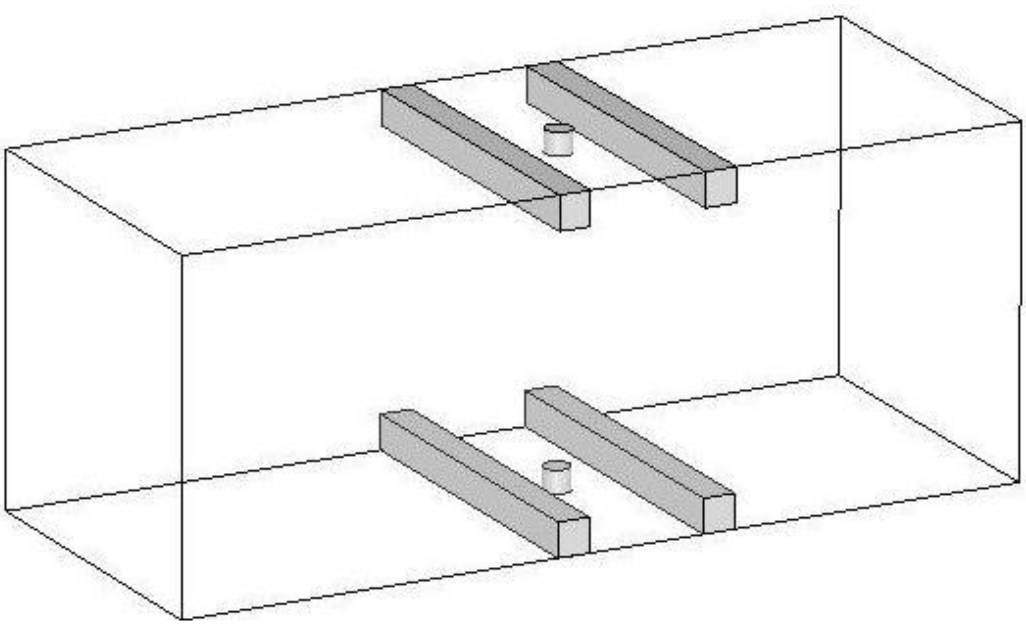

Fig. 1. Three-dimensional model and design of the polarizer

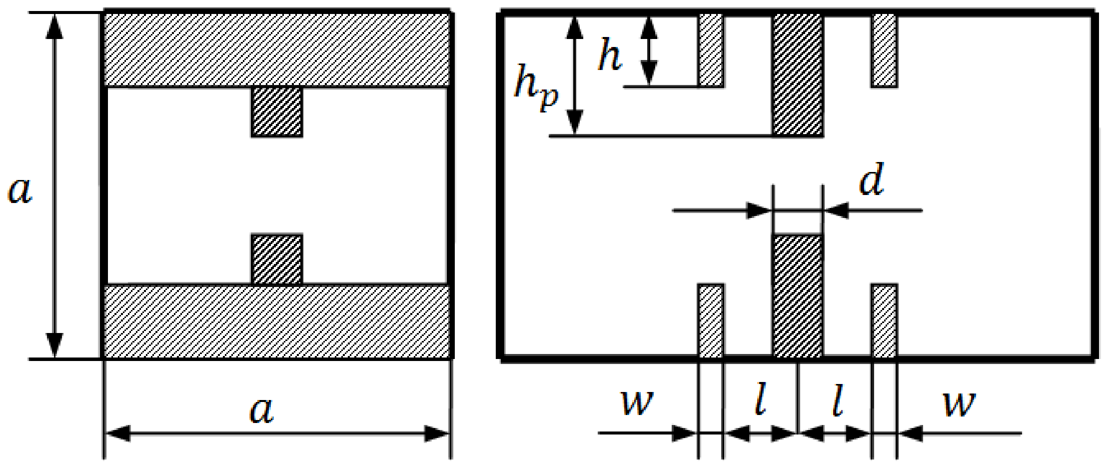

Fig. 2. The internal design of the polarizer

This design provides the basic polarization characteristics. The cylindrical pin provides adjustment of characteristics due to change of height hp

Before proceeding to the matching characteristics, it should be noted that we used the method of wave matrices [20] to obtain the basic parameters of the wave matrix scattering:

$$[S_\Sigma] = \begin{bmatrix} S_{11.\Sigma} & S_{12.\Sigma} \\ S_{21.\Sigma} & S_{22.\Sigma} \end{bmatrix}.$$

So it is worth moving on to defining the characteristics. Let's start with the differential phase shift [21]:

$$\Delta\varphi = \varphi_{21.\Sigma L} - \varphi_{21.\Sigma C}$$

VSWR horizontal and vertical polarization is determined by the formula [21]:

$$VSWR = \left[1+|S_{11}|\right] / \left[1-|S_{11}|\right].$$

The coefficient of ellipticity r, which should be prematurely transferred to a linear scale [22]:

$$r = 10lg\ \frac{A^2 + B^2 + \sqrt{A^4 + B^4 + 2A^2B^2\cos(2\Delta\varphi)}}{A^2 + B^2 - \sqrt{A^4 + B^4 + 2A^2B^2\cos(2\Delta\varphi)}}.$$

The cross-polarization isolation (CPI) is determined by the formula [23]:

$$CPI(dB) = 20lg\left(\frac{r+1}{r-1}\right).$$

Below are the results of the study, namely the dependence of the characteristics on the frequency for our frequency range 10.7 GHz - 11.5 GHz, which were obtained in a specialized program using computer simulation.

Fig. 3 presents the graphical dependence of the VSWR of the developed polarizer for horizontal and vertical polarization. As can be seen, the maximum level of VSWR for both linear polarizations is 2.0 and is reached at a frequency of 11.5 GHz.

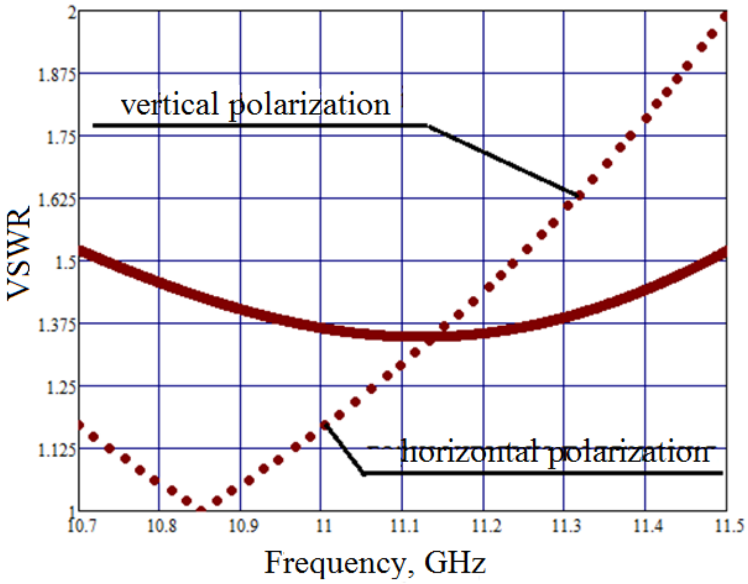

Fig. 3. Dependence of VSWR on frequency for both polarizations

Fig. 4 shows the dependence of the differential phase shift of the polarizer in the frequency range 10.7-11.5 GHz. As can be seen, the differential phase shift is equal to 90 ° at a frequency of 11.02 GHz. In the operating range, the differential phase shift of the polarizer varies from 87.1 ° to 93.9 °. The maximum deviation from 90 ° is 3.9 ° and is observed at 11.5 GHz.

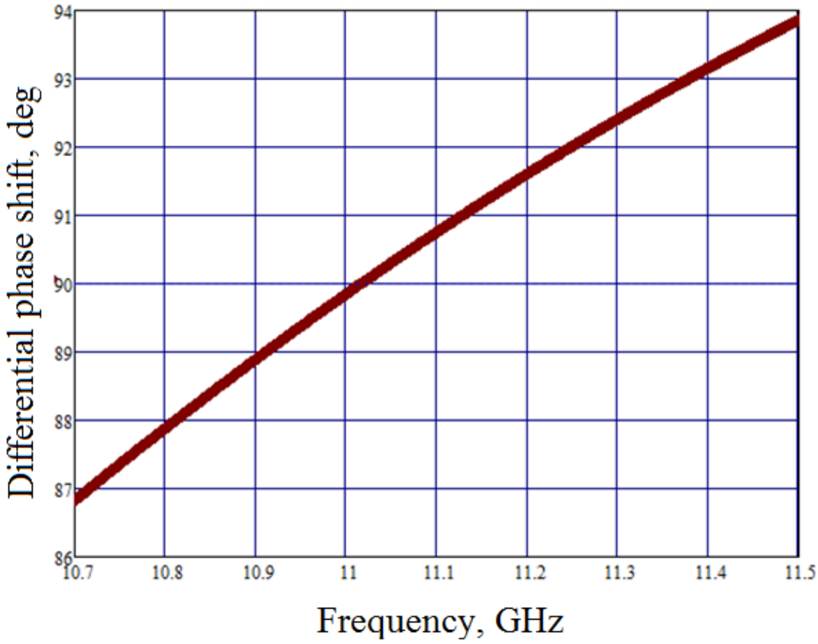

Fig. 4. Dependence of differential phase shift on frequency

The dependence of the ellipticity coefficient and CPI of the polarizer on the frequency in the operating frequency range can be seen in Fig. 5 and fig. 6 respectively. In fig. 5 you can see that the maximum value is 1.10 dB.

From fig. 6 we see that the maximum value of CPI is 31 dB. It should be noted that in the range of 10.7-11.5 GHz CPI takes values of 29.6 dB and 24 dB, respectively.

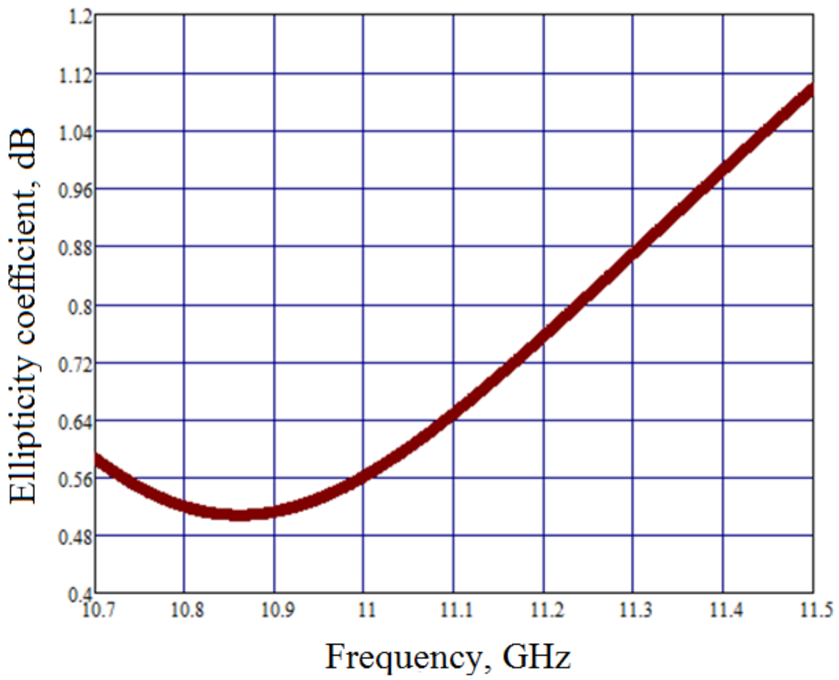

Fig. 5. Dependence of the ellipticity coefficient on frequency

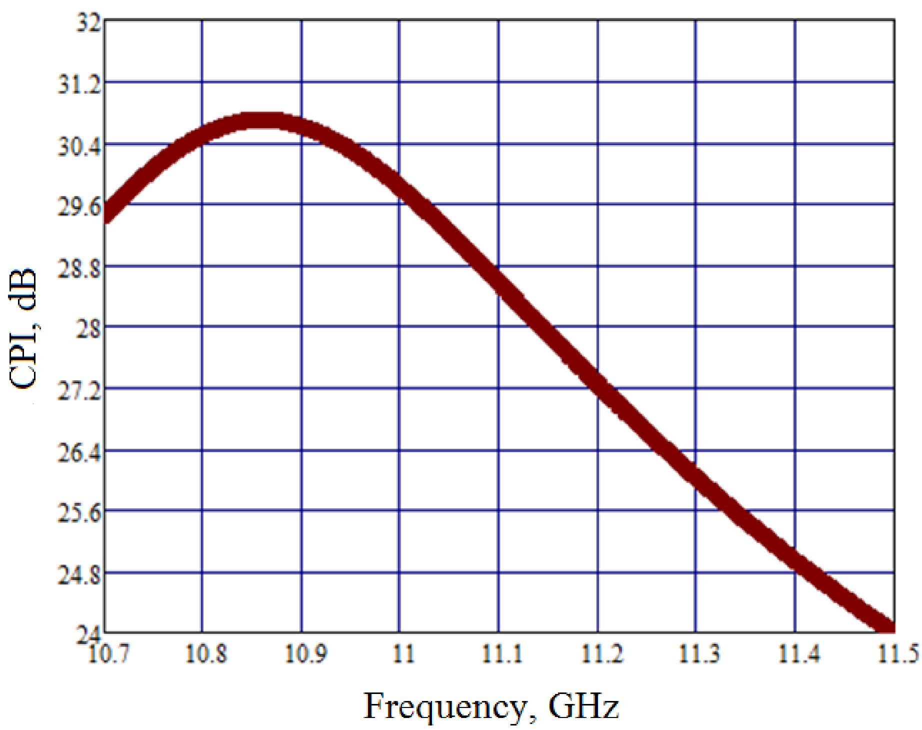

Fig. 6. Dependence of CPI on frequency

Therefore, the study designed a polarization conversion device with diaphragms and pins for satellite systems in the range of 10.7-11.5 GHz, which showed the performance characteristics: VSWR, differential phase shift, elipticity coefficient and CPI, which actually meet the requirements of modern satellite systems.

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