Additive Manufactured Waveguide Polarizer in 7.2 – 8.6 GHz

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Abstract-A novel two-stage cascaded waveguide polarizer that operates over the full 7.2 - 8.6 GHz SATCOM X band is described. The polarizer comprises a half-wave polarizer and a quarter-wave polarizer. Following optical achromatic theory, the cascaded rotated polarizers achieve broadband operation. Pancharatnam [1] showed that cascading half-wave and quarter-wave plates made from birefringent crystal can be used to design wideband achromatic circular polarizers. The half-wave and quarter-wave plates are implement using elliptical waveguides, with circular waveguide transitions. For ease of manufacturing, the entire polarizer is produced using Masked Stereolithography (MSLA) 3D printing technology, followed by a conductive layer of in-house electroplating [2]. The simulated and physical model is shown in Fig.1. Fig.2 shows the results from an initial measurement of phase difference, axial ratio (AR) and S_{11}. The measurement results are consistent with the simulation. The half-wave and quarter-wave polarizers achieve phase differences of 180 degrees and 90 degrees near 7.7 GHz. The measured S_{11} is below -15 dB over the frequency range. The measured AR is less than 1.7 dB. This is approximately 1 dB higher than the simulation. However, an AR of 1.7 dB corresponds to a cross-polarization level of approximately -20 dB, which is close to the accuracy limit of the measurement set-up in the general laboratory. Both simulation and measurement demonstrate good results with an AR of less than 1.7 dB within the operating frequency band and 17% bandwidth. The proposed polarizer provides an excellent solution for X-band satellite communications and the design can be easily extended to multi-stage structures for wider bandwidth.

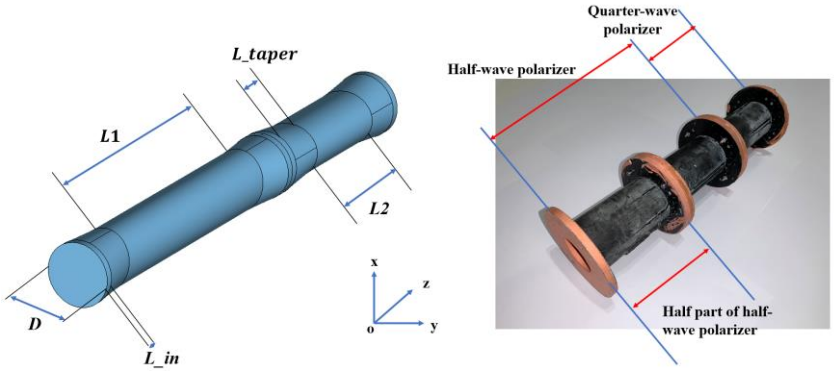
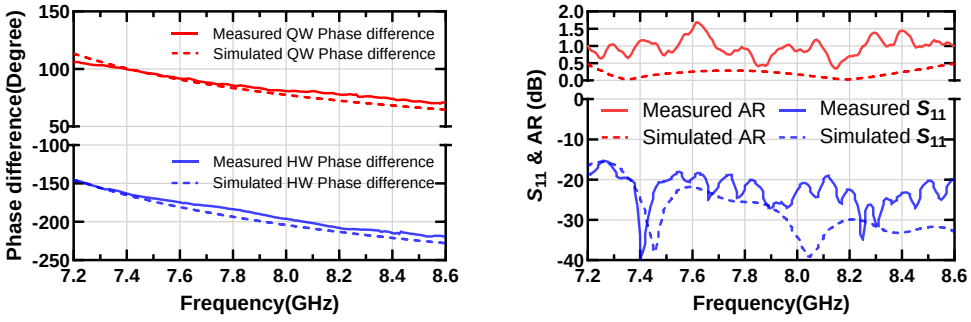


Fig. 1(a): Simulated model and (b)Fabricated model



(a) (b)

Fig. 2(a): Measured phase difference and (b) Measured S_{11} and AR

[1] S. Pancharatnam, "Achromatic combinations of birefringent plates," Proc. Indian Acad. Sci. 41, 130–136, 1955.
[2] A. Tamayo-Dominguez, P. Sanchez-Olivares, A. Camacho-Hernandez and J. -M. Fernandez-Gonzalez, "Guidelines for accurate in-house electroplating and 3-D-Printing processes applied to mm-wave devices," IEEE Microw. Wirel. Compon. Lett., vol. 32, no. 11, pp. 1267-1270, Nov. 2022