Dispersion Comparison Between Ring-Bar Helix and a New Sloped-Ring Helix

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Abstract: *In this paper we present recent progress on the investigation of a new slow-wave structure named sloped-ring helix which, like the ring-bar helix, is a spatial distortion of the cross-wound twin helix. A preliminary measure of the dispersion characteristic is present.*

Keywords: ring-bar helix; slow-wave structure; dispersion measurement.

Introduction

Since its introduction by Birdsall & Everhart [1], the ring-bar helix has been broadly applied in high-power traveling-wave tubes (TWT) slow-wave structures (SWS) due to its interesting properties in the backward-wave mode attenuation. Even though looking different, ring-bar helix is a practical form for the contra-wound helix introduced by Chodorow & Chu [2] and its mathematical model are the same. In fact, the ring-bar helix preserve the backward mode attenuation characteristic from the contra-wound helix, but its dispersion characteristics may differ appreciably due to its greater dispersivity.

Looking for construct a helix SWS closer to the contra-wound helix, we propose a new practical form for it, named, the sloped-ring helix, showed in Fig. 1 as well its conception.

With this new helix we expect to obtain a less dispersive slow-wave structure.

Measurement Setup

For the realization of the dispersion and impedance measures we are finishing a set-up [4] which able to test practically any slow-wave structure in *cold* conditions. The SWS used in the initial measures is shown in Fig. 2 below, where we can see the two kind of helices.

The measurement of the dispersion characteristic is based in to obtain the half guided-wavelength $\lambda_g / 2$ for a given frequency.

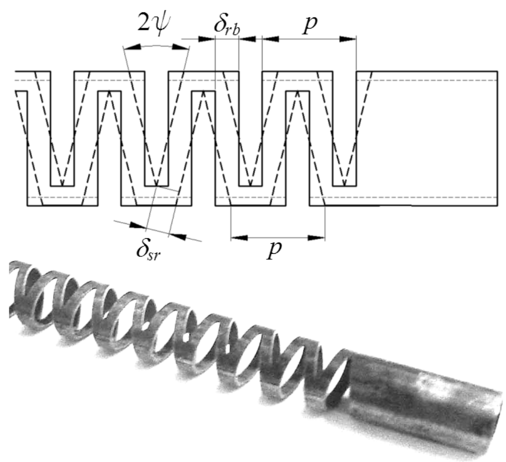

Figure 1. Conception and picture of the sloped-ring helix made by electromachining.

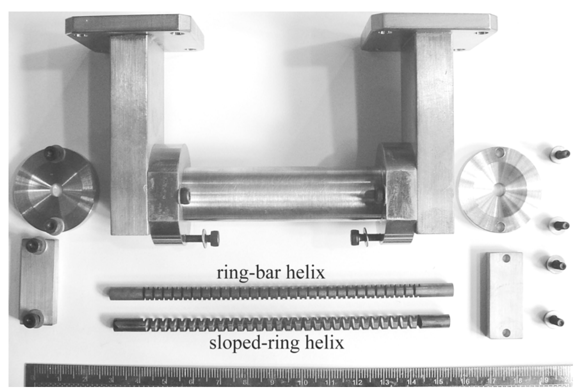

Figure 2. Picture of the SWS used in the initial measurement.

The relation between the axial phase propagation constant β and λ_g is given by the well known formula

$$\beta = 2\pi / \lambda_g = \pi / (\lambda_g / 2) . \qquad (1)$$

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The quantity $\lambda_g / 2$ is found measuring the displacement of a short along the SWS axis between two consecutive points of same phase.

A picture of the current set-up stage is shown in Fig. 3.

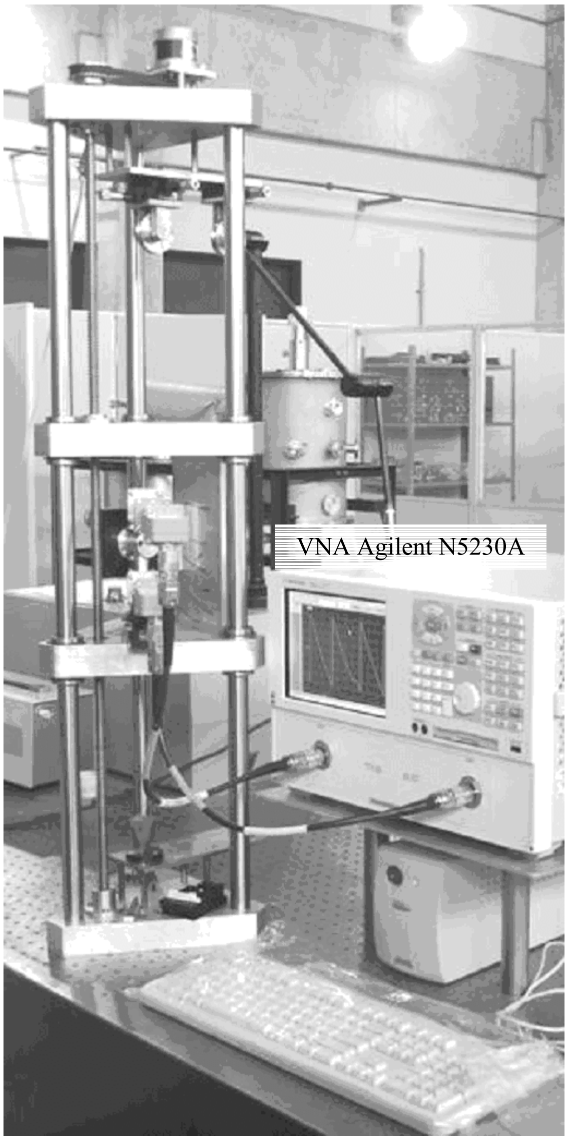

Figure 3. Picture of our home-made setup for measuring dispersion and interaction impedance characteristics of SWS.

Results

We present in Fig. 4 the results for the phase velocity characteristics for the theoretical model, the ring-bar and the sloped-ring helices. Due to some matching problems, this measure (for while) ranges about 8.4 – 8.8 GHz operation frequency. However, there are some indications that the new helix behaviour can be closer to the theoretical model.

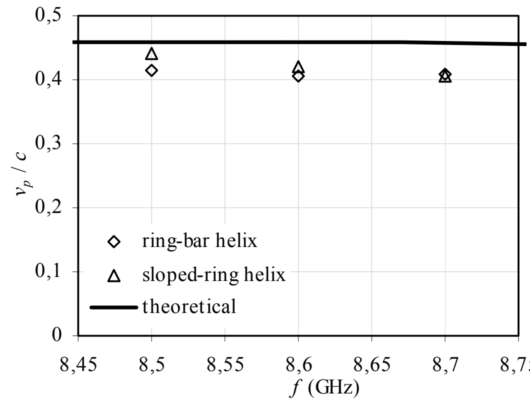

Figure 4. Results of the dispersion measures of a sloped-helix and its equivalent ring-bar helix used in radar application.

Conclusion

We presented our recent progress on the development of the dispersion and the impedance measurement setup and a new practical form for the counter-wound helix which appear to be closer to the theoretical model.

References

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