Radioelectronics and Communications Systems
Vol. 49, No. 5, pp. 52–58, 2006

Izvestiya VUZ. Radioelektronika
Vol. 49, No. 5, pp. 72–80, 2006
UDC 621.372.8.049.75

ANALYSIS OF A WAVEGUIDE-SLOT TRANSMISSION LINE WITH A METAL-DIELECTRIC INSERT IN THE SLOT

V. G. Kryzhanovskii and Yu. V. Rassokhina

Donetsk National University, Ukraine

The paper gives in strict formulation the solution to the problem of proper waves in a waveguide-slot transmission line (WSL) with a rectangular metal-dielectric inclusion in the slot imitating the behavior of a cutoff diode in this line. An algorithm is deduced for calculation of the generalized matrix of wave scattering by a usual WSL on the WSL segment with a "diode". Based on the calculated data about the reflection loss, a matching network for a microwave attenuator in two *p–i–n*diodes, composed of two WSL segments, is built and optimized.

Realization of networks, whose main part is a slotted transmission line, is often performed with the aid of *E*-technology, which makes these networks compatible with standard waveguide structures and establishes junctions between them [1–4]. Particularly, the structures based on "unilateral finline" — one-sided slotted transmission line arranged in the *E*-plane of a rectangular waveguide (waveguide-slot line — WSL) have found wide application in the design of active devices.

Active elements (diodes, transistors etc.), located in WSL, in the cutoff conditions introduce the substantial loss at high frequencies. As a rule, requirements imposed on active devices include certain filtering properties of the whole network under conditions when the active element is cut off. Because of this, designing of microwave devices has not only to foresee the transition from the feeding waveguide to the major transmission line, but to match the cutoff active element (or several elements) to the whole network [5]. The purpose of this work is development of a dynamic model of a cutoff active element (*p–i–n*-diode) placed in WSL, calculation of the reflection loss in this element, and optimization of the circuit used for matching the active element to the main WSL.

The step transition to WSL. An in [5], we designed a transmission line for a microwave attenuator in *p–i–n*-diodes. The main part of the structure represented a WSL with parameters $A = 8$ mm, $b = 4$ mm, $t = 0.5$ mm, $s = 0.8$ mm, and $\varepsilon_r = 2.6$ (Fig. 1). The boundary problem is resolvable under the condition that the dimension of the electric wall in the *y*-plane equals *b*. The problem of determination of proper waves in an ordinary WSL was treated by a standard method [6, 7], with regard for the field behavior on an infinitely thin fin at $x = t/2$ and $g \le y \le b$. The cross section and the calculated spectrum of WSL proper waves are shown in Fig. 1. After that, based on the method of generalized scattering matrices (GSM) [6, 7], we set up an algorithm to determine the integrals of relation between different types of waves at a stepwise change of slot's width in WSL. Knowledge of these integrals permits to calculate the scattering matrices at the joints of different WSL and at cascade connections of these lines.

With the use of these algorithms and of the quarter-wave Chebyshev filter-prototype, we designed and optimized a 5-step transition from a hollow rectangular waveguide to the major WSL with $s = 0.8$ mm. The calculation has been implemented with regard for the first four waves of higher type. The obtained characteristic of the transition is presented in Fig. 2. The measurement of characteristics of the breadboard transition shows that its VSWR does not exceed 1.2 in the band of working frequencies from 12 to 15 GHz. The parameters of the 5-step transition, obtained after optimization, are as

REFERENCES

1. K. Solbach, IEEE Trans. MTT, Vol. 31, No. 2, pp. 107–121, 1983.

2. D. Mirshekar-Syahkal and J. B. Davies, IEEE Trans. MTT, Vol. 30, No. 11, pp. 1854–1861, 1982.

3. J. Mingo, A. Moliner, and A. Comeron, Waveguide–to–coupled fin-line transition in Ka band, IEEE Microwave and Guided Wave Letters, Vol. 6, No. 10, pp. 363–365, 1996.

4. R. Vahldieck, IEEE Trans. MTT, Vol. 32, No. 11, pp. 1454–1460, 1984.

5. A. A. Buzlov, V. I. Parlikov, and Yu. A. Soskov, A *p–i–n*-attenuator based on a waveguide-slot line, Materials of the 12th Int. Crimean conference “Microwave Equipment and Telecommunication Technologies”, 9 September 2002 (CriMiko–2002), Sevastopol: “Veber”, pp. 387–388, Ukraine, 2002.

6. V. G. Kryzhanovskii and Yu. V. Rassokhina, Radiotekhnika i Elektronika, Vol. 46, No. 10, pp. 1206–1211, 2001.

7. V. G. Kryzhanovskii and Yu. V. Rassokhina, Izv. VUZ. Radioelektronika, Vol. 46, No. 12, pp. 12–15, 2003.

7 September 2005