Radioelectronics and Communications Systems
Vol. 49, No. 8, pp. 47–50, 2006

Izvestiya VUZ. Radioelektronika
Vol. 49, No. 8, pp. 66–71, 2006
UDC 681.2.088

COMPENSATION OF EXPERIMENTAL ERRORS IN THE MULTIRESONANCE METHOD OF MEASUREMENT OF REFLECTION FACTOR IN A WAVEGUIDE

V. I. Ponomarenko, V. V. Popov, and D. F. Vinogorodskii

Tavrichesky National University, Simferopol, Ukraine

The paper considers main sources of experimental errors arising at measurement of the complex reflection factor in a waveguide by the multiresonance method. Several techniques are suggested for compensation of generator's instability and of non-identity of directed couplers. Also, a new method is proposed for determination of resonant frequencies and width of peaks of the waveguide quasiresonator.

The multiresonance method for measurement of complex reflection factor in waveguides [1, 2] is based on analysis of resonant characteristics of a quasiresonator formed by a waveguide segment located between an inductive diaphragm and the object under investigation. Accuracy of the method depends on accuracy of measurement, with the aid of a scalar analyzer, of the frequency function $\Psi(\omega) = (E_2/E_1)^2$, where E_1 and E_2 are amplitudes of electric field in waveguide sections S1, S2 (Fig. 1), and on accuracy of determination of resonant frequencies and width of resonant peaks in $\Psi(\omega)$. Under the assumption of quadratic behavior of current-voltage characteristics of diode detectors of directed couplers of sections S1 and S2, the sources of errors, in the measurement of this dependence, are as follows:

(a) instability of the function $U(\omega)$ of correspondence between the generator frequency and voltage U, acting as its mapping, (the instability means that the function $U(\omega)$ is slowly changing in time);

(b) non-identity of transfer characteristics of directed couplers meaning that in the event of identical intensities of the field in sections S1 and S2, the fields near the detector gauges and, consequently, the signals from detector diodes, may differ — either due to incomplete identity of couplers or because of their detuning; and

(c) the noise in the measured signals resulting in distortion of the function $\Psi(\omega)$ and in errors during analysis of resonant characteristics.

The present paper describes the techniques of compensation of these errors, which have been used in the works [1, 2].

Account of generator's instability. A short-circuited line consisting of sections S3 and S4 and connected to the generator in parallel with the main measuring line (sections S1 and S2), plays the part of a resonant frequency meter (Fig. 1). Signals S_3 and S_4, in parallel with signals S_1 and S_2, are converted into digital form in the device of mating the installation with a computer [3] simultaneously with the signal U coming from the generator. Denote by U_n, $n = 1, 2, ...$ the resonant values of U corresponding to maximums of the S_4/S_3 ratio. Denote by ω_n the respective resonant frequencies measured by the frequency meter. Having used the magnitudes of $\{\omega_n\}$ and $\{U_n\}$ as nodes for interpolation by cubic splines, for any U we can calculate the corresponding frequency value. Acting in this manner, we can recalculate the experimental dependencies (on the voltage U) of signals at the outputs of detectors of sections S1 and S2. Thus we compensate the "drift effect" of the voltage U at a fixed frequency of the generator. Note that for the generator, type GCh-61, employed in [1, 2], the time interval of a pronounced change in the function $U(\omega)$ does not exceed 5 minutes.

REFERENCES

1. V. I. Ponomarenko and V. V. Popov, Pribory i Tekhnika Eksperimenta, No. 1, pp. 94–100, 2005.
2. V. I. Ponomarenko and V. V. Popov, Pribory i Tekhnika Eksperimenta, No. 6, pp. 33–36, 2005.
3. V. V. Popov, V. I. Ponomarenko, V. V. Rudenko, and D. F. Vinogorodskii, A scalar analyzer of networks for waveguide measurements [in Russian], Scientific Notes of the V. I. Vernadskii Tavrichesky National University, Series "Physics", Vol. 17–18 (56–57), No. 1, pp. 70–78, 2005.
4. Hewlett-Packard, Applying Error Correction to Network Analyzer Measurement, Application Note No. 1287-3, 1999.
5. D. F. Williams, J. C.-M. Wang, and U. Arz, IEEE Transactions on Microwave Theory and Techniques, Vol. 51, No. 12, pp. 2391–2401, December 2003.
6. R. Inoue, K. Miwa, H. Kitano, A. Maeda, Ya. Odate, and E. Tanabe, IEEE Transactions on Microwave Theory and Techniques, Vol. 52, No. 9, pp. 2163–2168, September 2004.
7. Paul J. Petersan and Steven M. Anlage, Journal of Applied Physics, Vol. 84, No. 615, pp. 3392–3402, September 1998.
8. V. I. Ponomarenko and V. V. Popov, Izv. VUZ. Radioelektronika, Vol. 49, No. 6, pp. 70–75, 2006.

15 March 2006