ANALYSIS OF ENERGY CHARACTERISTICS OF A CASCADE CONNECTION OF DISSIPATIVE MICROWAVE QUADRIPOLES

V. V. Zagoruiko, V. P. Koval, V. P. Narbut (deceased), and A. I. Yushin

Izvestiya VUZ. Radioelektronika,
Vol. 35, No. 11, pp. 18-25, 1992

UDC 621.372.85

A method of determining the absorbed power in a cascade connection of dissipative quadripoles is described, expressions enabling calculation of the absorbed power in the i-th quadripole are given. The distribution of power in multicascade pin attenuators was analyzed. The factors affecting an increase of the maximum level of the operating power were determined.

As a consequence of the high degree of integration of active heat-liberating elements in microwave radio-electronics modules - the main parts of modern radio-electronics apparatus - a determination of the energy operating regimes of these elements acquires special significance, particularly in such microwave devices as electrically controlled high-power (HP) pin attenuators.

The correct selection of the regimes of pin diodes enables a rational distribution of the power being dissipated between the cascade of the attenuator, an increase of the value of the input power of the entire device as a whole, and not creating excess margins with respect to the power being dissipated. Consequently, it is possible to optimize HP pin attenuators on the basis of the criterion of minimization of cost with maximum reliability.

Problems of a theoretical and experimental determination of dissipated power in one- and two-cascade attenuators are examined in [1-3]. However, the known approaches do not enable working out recommendations for designing multicascade HP pin attenuators.

In the present work we will examine problems of analyzing the dissipated power in cascades of an n-cascade connection of wave dissipative microwave quadripoles (QPs), for example, multicascade microwave pin attenuators, and describe the algorithm for calculating the power being dissipated in the cascades by means of the method of recursion relations.

Let us examine a circuit consisting of a generator, n-cascade connection of the QPs, and load (Fig. 1, a) in the form of a cascade connection of two QPs described by scattering matrices S′ and S″ (Fig. 1,b). Here S″ is the scattering matrix of the n-th QP and S′ is the scattering matrix of the cascade connection of the remaining QPs.

The power entering the dissipative QP (P_{inc}) is divided into three parts: reflected (P_{ref}), transmitted farther (P_{tra}), and absorbed in the QP (P_{absr}). The equation of conservation of energy for an n-cascade connection (Fig. 1, b) has the form:

$$\begin{gathered} P_{inc} = P_{ref} + P_{absr} + P_{tra}\ ; \\ |a_1|^2 + |a_2|^2 = |b_1|^2 + P_{absr} + |b_2|^2; \end{gathered} \qquad (1)$$

where $P_{inc} = |a_1|^2 + |a_2|^2$ is the power entering the set of QPs being transported by the incoming waves from the side of the generator (a_1) and from the side of the load (a_2); $P_{ref} = |b_1|^2$ is the power being transported by the wave b_1 reflected from the set of QPs toward the generator; $P_{tra} = |b_2|^2$ is the power transported by the wave reflected from the set of QPs toward the load; P_{absr} is the power absorbed (dissipated) in the entire set of QPs.

We write Eq. (1) in the form:

$$|a_1'|^2 + |a_2''|^2 - |b_1'|^2 - |b_2''|^2 = P'_{absr} + P''_{absr}\ ,$$

where P'_{absr} and P''_{absr} are the powers absorbed respectively in the first and second QPs, respectively.

From Eq. (1) we determine the total absorbed power normalized to the input (incoming) power:

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REFERENCES

1. J. Lepoff, "PIN power calculation simplified," Microwave J., no. 7, pp. 38-41, 1972.

2. I. V. Lebedev, A. S. Shnitnikov, and E. I. Kuptsov, "Solid-state microwave limiters - problems and solutions," Izv. VUZ. Radioelektronika, no. 10, pp. 34-41, 1985.

3. V. S. Stepanov, "Calculation of the power absorbed in individual parts of microwave devices," Izv. VUZ. Radioelektronika, no. 3, pp. 85-87, 1988.

4. A. L. Fel'dshtein and L. R. Yavich, Synthesis of Microwave Four- and Eight-Terminal Networks [in Russian], Svyaz, Moscow, 1971.

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