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A SMALL-SIZE SPIRAL CONICAL ANTENNA FOR SATELLITE TELECOMMUNICATION SYSTEMS

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A new method for calculation of spiral antennas with directed radiation pattern and small overall dimensions is developed. A technique of optimization of the absorbing load in the antenna base is investigated, permitting to vary the level of antenna backward radiation and simultaneously to assess the active loss in this load.

The changes in mutual orientation of telecommunication low- and medium-orbit space vehicles and their subscribers must not affect the quality of communication between them. The best way to meet this requirement is usage of weakly directed antennas of circular (elliptical) polarization, such as spiral antennas [1]. In the meter and decimeter ranges of wavelengths, the problem of reduction of overall dimensions and mass of spaceborne satellite antennas, with the required characteristics being the same or even improved, is of particular importance. Treatment of this problem is considered in this paper, devoted to calculation of spiral antennas of a reduced size.

The spiral antennas have been considered, for example, in [2–4]. In [2, 3] one can find the strict formulation and solution to the problem of the ordinary equiangular spiral conical radiator — with determination of complex distribution of the current along radiator's branches, and of the radiation patterns (RP). As follows from [3], reduction of branches of the spiral radiator, i.e., a decrease in its dimensions, results in a growth of backward radiation (because of increased amplitudes of reflected waves from the ends of the spiral branches), which is intolerable in some cases.

One of the ways to diminishing the spiral antenna size consists in connection of distributed absorbing impedance loads to their radiating branches [5, 6]. An Archimedean planar spiral antenna was suggested in [5]. The last loops of the spiral are made with a pitch much less than the pitch of the main radiating part of the spiral and, therefore, represent a weakly radiating load, suppressing the current flow wave reflected from the antenna ends. Thus we can lower the level of backward radiation of the antenna. In [6] the ends of a spiral antenna are connected to external loads, which almost make no impact on the radiation, but suppress signals reflected from the antenna ends. Two loads represent identical spiral lines laid on substrates with loss. It makes possible to diminish the antenna dimensions and to lower the backward radiation level. However, the designs presented in patents [5, 6] require additional theoretic substantiation and research. Moreover, the asymmetric arrangement of loads in the azimuth plane, proposed in [6], distorts the radiation pattern in this plane, which is unacceptable in some cases.

Below are presented the results of investigation of such small-size radiators, which have a better arrangement of the absorbing load — axially symmetric about the radiator axis in the azimuth plane. This implementation makes it possible to eliminate the above drawback and to provide a uniform radiation pattern of the antenna.

Figure 1 shows the circuit of a small-size spiral antenna with absorbing loads Z in its base. The main segments of the antenna are the transitional segment S_1–S_2, and the segment of intensive radiation S_2–S_3. In addition, introduce in our consideration the antenna segment S_3–S_k, where the radiator current decreases smoothly because of Joule's losses in the loads Z. The axially symmetric loads Z are connected to the ends S_3 and S'_3 of the radiating spirals with smooth transition

REFERENCES

1. A. V. Runov, O. A. Yurtsev, and A. N. Kazarin, Spiral Antennas [in Russian], Sov. Radio, Moscow, 1974.
2. Y. S. Yeh and K. K. Mei, IEEE Trans., Vol. AP-15, No. 5, pp. 634–639, 1967.
3. Y. S. Yeh and K. K. Mei, IEEE Trans., Vol. AP-16, No. 1, pp. 14–21, 1968.
4. N. P. Timerev and V. S. Zadvornov, Calculation of directivity characteristics of two-wire conical spiral antennas [in Russian], Antenny, Issue 11, pp. 60–73, Svyaz', Moscow, 1971.
5. Reese Jee, Spiral Antenna Load, Patent No. 3787871 (the U.S.A.), published 22 January 1974.
6. T. Debski and J. Gaudio, The strip load for spiral antenna, Patent No. 3825933 (the U.S.A.), published 23 July 1974.
7. A. M. Chernushenko (editor), Design of Screens and Microwave Devices — a Textbook for Higher School [in Russian], Radio i Svyaz', Moscow, 1990.
8. D. I. Batishchev, Optimal Design Methods [in Russian], Radio i Svyaz', Moscow, 1984.

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