Radioelectronics and Communications Systems
Vol. 48, No. 9, pp. 28–31, 2005

Izvestiya VUZ. Radioelektronika
Vol. 48, No. 9, pp. 40–45, 2005
UDC 621.396.6

SIMULATION OF A SMALL-SIZE ULTRA-WIDEBAND ANTENNA IN THE SHAPE OF BICONICAL VIBRATOR WITH RING GROOVES

V. B. Avdeyev, A. V. Asikhmin, A. V. Berdyshev,
S. V. Korochin, V. M. Nekrylov, and Yu. G. Pasternak

Military Institute of Radioelectronics, Voronezh, Russia

The paper is devoted to investigation of a version of solid biconical vibrator having several ring-shaped grooves on its side surface. With the same overall dimensions of such antenna, its lower operation frequency can be decreased by 20% and, if using the grooves with dielectric — even by a larger value.

The design of small-size antennas with uprated values of effective height (gain factor, efficiency, etc.) in the low-frequency domain of operation range, when the antenna linear dimensions are considerably less than the wavelength λ in the free space, is a rather complex task. However, designers of modern equipment for various complexes of radio direction finding, control, communication, suppression etc., constantly come up against this problem, especially in the case when the complex is arranged aboard some mobile carrier.

There are a number of successful implementations of antenna devices, including those of transmission type, in which, along with small dimensions, for example, $0.0326\lambda\times0.014\lambda$ [1], a high efficiency close to 0.5 is obtained. An increase in radiation resistance in such antennas is attained due to imparting complex shape to the radiating elements (vibrators), i.e., by making them spiral, meander, etc. However, these devices are rather narrow-band: relative width of their working frequency ranges makes up to several percent. Examples of wide-band antennas, and ultra-wideband in particular, are presented in [2–3]. They include a solid biconical vibrator, which, at vertical orientation of its axis, in a number of practical applications allows for circular radiation pattern in the azimuth plane.

The purpose of this work is to investigate the opportunities for expanding the band of operation frequencies of a biconical vibrator towards the low-frequency side, where the expansion is attained by arrangement of ring-shaped grooves on the vibrator side surface (Fig. 1). The grooves extend the path of the current flowing in the vibrator and, consequently, increase the radiation resistance, particularly, at the required low frequencies. In addition, the capacitance component of the input impedance of an electrically short vibrator will be partly compensated by the introduced inductive impedance of the grooves, and the phase velocity of the quasi-spherical wave in the structure will slow down, resulting to the growth of the antenna effective length.

In numerical simulation of the electrodynamic structures, similar to the vibrator under consideration and having a relatively large surface area, we have to diminish the grid step considerably (compared to "smooth" structures), which, naturally, increases the order of the system of linear algebraic equations (SLAE). Moreover, it leads to additional computational errors, accumulated when using iterative procedures of SLAE treatment, whose dimension may reach several tens of thousands. To get around this difficulty, a mathematical model of the biconical vibrator, supplied with a number of annular grooves of rectangular cross-section, was drawn up, permitting to pass, if necessary, from the antenna device under consideration to the electrodynamic structure representing a bi-cone with anisotropic impedance [4].

REFERENCES

1. V. V. Dolzhikov and B. G. Tsybayev (editors), Active Transmitting Antennas [in Russian], Radio i Svyaz', Moscow, 1984.

2. Ultra-Wideband Antennas — a collection of works [Russian translation, ed. by L. S. Benenson], Mir, Moscow, 1964.

3. V. V. Krymskii, Antennas for Non-Sinusoidal Waves [in Russian], Izd-vo TsNTI, Chelyabinsk, 2004.

4. Ye. N. Vasil'yev Excitation of Bodies of Revolution [in Russian], Radio i Svyaz', Moscow, 1987.

5. G. T. Markov, B. M. Petrov, and G. P. Grudinskaya, Electrodynamics and Propagation of Radio Waves [in Russian], Sov. Radio, Moscow, 1979.

6. A. F. Verlan' and V. S. Sizikov, Methods for Resolving Integral Equations with Computer Programs — A Textbook [in Russian], Naukova Dumka, Kiev, 1978.

17 February 2005