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APPLICATION OF REDUCED AND ATMOSPHERIC PRESSURE DISCHARGES AS A RADIATING BODY OF A VIBRATOR ANTENNA *)

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Currently, adaptive (“smart”) wireless data transmission systems for various purposes are being actively developed, such as software-defined radio systems, 6G generation communication systems, radar, navigation and electronic warfare systems [1]. Such systems require antennas with the ability to programmable electronic control of their parameters and characteristics, for example, plasma antennas. Plasma antennas can be divided into two classes: the first, plasma is part of the radiating element of the antenna (vibrator, loop antennas) and the second, plasma serves to control the passage and shielding of radio waves (for example, a drum-type antenna) [2]. In [3], a vibrator-type plasma antenna using a low-pressure discharge as a radiating body was considered in detail. This work is devoted to determining the parameters of discharges at reduced and atmospheric pressures necessary for their effective use as a radiating body of such antenna.

The plasma antenna was a gas-discharge tube partially placed in a coaxial resonator with a screen. The screen diameter is 10 cm, the length of the protruding part of the discharge tube is 12.5 cm. The distance from the screen plane to the central core of the microwave connector, which serves to feed a microwave signal to the resonator with a discharge tube, is 3.5 cm. In the experiment a gas-discharge lamp GSh-5 (neon, 70 Torr) was used. Its maximum realizable gain, azimuthal radiation pattern and elevation pattern were determined. It is shown that the antenna has a circular azimuthal radiation pattern with one main lobe in the direction of 60° in elevation (measured from the screen plane). At an electron density of more than 10^{15} cm^{-3}, the maximum gain of the plasma antenna is more than -6 dB. The obtained characteristics were compared with the characteristics of a similar antenna in which the plasma column was replaced by a copper rod, and it was shown that the gain of the plasma antenna is close to the gain of the similar metal antenna with a radiating body of smaller diameter. The resulted difference is probably due to the phenomenon of discharge contraction. The obtained experimental data were compared with the results of simulations performed in the COMSOL Multiphysics software. The created numerical model allowed us to estimate the possibility of realization of plasma antenna with atmospheric pressure gas discharge as radiating body. It was shown that the defining characteristic of the plasma using is its conductivity. For a discharge at atmospheric pressure, the maximum gain is realized at an electron density of more than 10^{16} cm^{-3} and a conductivity of more than 1000 S/m.

The obtained results are important for the development of high-speed adaptive radio electronics systems.

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