Radioelectronics and Communications Systems
Vol. 46, No. 2, pp. 36–42, 2003

Izvestiya VUZ. Radioelektronika
Vol. 46, No. 2, pp. 51–60, 2003
UDC 621.396.67

ELECTRICALLY LONG WAVEGUIDE-SLOT ANTENNAS WITH OPTIMAL RADIATION AND DIRECTIVITY CHARACTERISTICS

V. A. Katritch, V. A. Lyashchenko, and S. L. Berdnik

V. N. Karazin National University, Kharkov, Ukraine

The paper is devoted to theoretical and experimental investigation of radiation pattern, directivity and gain factors, and frequency responses of electrically long longitudinal slots cut in a broad wall of finite thickness in a rectangular waveguide. The authors have analyzed the dependence of slot antennas' directivity characteristics on physical dimensions of slot radiators, their location in the waveguide wall, and physical dimensions of the waveguide itself. The calculations are performed in the single- and multimode conditions.

The antennas made as protracted longitudinal slots in the walls of waveguides of rectangular or circular cross-section are the most simple and easy-to-fabricate leaky wave antennas [1–4]. The planar configuration, possibility for creating narrow radiation patterns (RP), and control of their width, side-lobe level and orientation, open wide opportunities for using these antennas in radio-engineering systems of various purpose.

Theoretical investigation of this type of antenna, as well as any other type, can be broken in two stages. At the first stage we determine the amplitude-phase distribution (APD) in the antenna opening, i.e., solve the internal problem of the antenna theory. At the second stage we solve the external problem — define the radiation pattern and directivity factor (DF) of the antenna based on the APD just determined. The accurate solution to the radiation problem can be obtained only by sewing together the solutions to the internal and external problems on the antenna opening surface. There are no strict theoretical methods of investigation of electrically long longitudinal slots of finite dimensions. As a rule, both problems are treated separately. Usually, in our efforts to find the radiation pattern, we assume that the field variation in antenna openings obeys a certain law, but we never know whether some APD corresponds to our antenna. Particularly, in [1, 2] the method of lateral equivalent circuits was applied to infinitely long longitudinal slots in broad and narrow walls of waveguides with rectangular and circular cross-section. Moreover, in [2] one can find a description of an antenna made in the form of a long longitudinal slot loaded with a pair of parallel plates of a certain height, which serve as a stub for the main waveguide. The plates can be bent at a right angle and, therefore, form flanges of finite or infinite size. The methods employed in [1, 2] permit us to determine the propagation constant β and attenuation constant α of the wave in a slotted waveguide, to analyze the dependence of the β and α values on the slot width and on its location on the waveguide wall. Naturally, the field APD is not determined, since we assume that the slot is infinitely long. In seeking the radiation pattern of a slot having a finite length, the amplitude distribution is assumed to decrease exponentially while the phase distribution is considered linear.

In [3] the method of integral equations is applied to investigation of longitudinal, inclined, and curvilinear slots cut in a wide, infinitely thin wall of a rectangular waveguide. There we can find the results of calculation of the electric field in the slot, and the radiation pattern for prescribed antenna dimensions at a fixed frequency. The optimization of directivity in [3] has not been performed — probably, because of complexity of the mathematical model proposed. In the authors' opinion [3], the best antenna is a curvilinear asymmetric slot, since the straight longitudinal slot gives a RP with high level of side

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3 December 2002