ISSN 0735-2727, Radioelectronics and Communications Systems, 2008, Vol. 51, No. 5, pp. 247–255. © Allerton Press, Inc., 2008.
Original Russian Text © A.A. Karpenko, Ya.I. Lepikh, 2008, published in Izv. Vyssh. Uchebn. Zaved., Radioelektron., 2008, Vol. 51, No. 5, pp. 22–33.

# Calculation Method for Microwave Pyramidal Horn Radiators with Curvilinear Generatrix

**A. A. Karpenko and Ya. I. Lepikh**
*Odessa National University, Odessa, Ukraine*
Received in final form January 29, 2007

**Abstract**—Calculation method for pyramidal horn radiators (PHR) with curvilinear generatrix has been developed on the basis of the theory of waveguide tapers. This method makes it possible to reduce the value of spurious reflection coefficients and transformation of the principal wave into waves of higher order modes by forming generatrixes of walls with specific curvilinearity.

**DOI:** 10.3103/S0735272708050038

Horn radiators (HR) of electromagnetic waves are widely applied in radars and systems of satellite communications as feeds of parabolic antennas operating in the microwave (MW) band. Increasing volumes of data transmitted via the channels of satellite communications necessitate the need to increase the capacity of receiving and transmitting devices than include horn radiators. This situation implies the need of raising the requirements to HR in respect of the increased bandwidth of microwave electromagnetic radiation, enhanced directive gain (DG), reduced microwave back reflection coefficient (RC), and reduced conversion ratio (CR) of the energy of principal wave into the energy of waves of higher order modes, enhanced efficiency coefficient, the reduced level of lateral radiation, reduced overall dimensions and mass of the radiator.

The existent horn radiators with rectilinear form of generatrixes do not adequately satisfy the above specified requirements. In particular, for enhancing DG it is often necessary to enlarge the area of HR aperture that results in a growing difference between the dimensions of the feeding waveguide mouth and HR aperture. This leads to the rise of RC and an increase of the phase error in the radiator aperture caused by sphericity of the phase front of waves. In this case, losses increase, the efficiency coefficient drops, and the HR bandwidth is reduced. The reflection coefficient (RC) and the phase error can be reduced by increasing the HR length that results in the rise of the overall dimensions and mass of HR. At the same time, as the walls flare, waves of higher order modes are generated in HR resulting in distortion of the directivity pattern (DP) and rise of the level of side lobes.

In paper [1] the DP narrowing is achieved by introducing an impedance slowing down comb into the HR design. However, in this case, the number of side lobes slightly increases in the DP vertical plane. In paper [2] the DP narrowing problem was solved by aligning the phase front in the HR aperture, but only for *H*-sectorial HR. The methods of optimizing HR parameters by using curvilinear generatrixes are deemed to be the most effective for eliminating the specified disadvantages.

It is necessary to find such curvilinear form of generatrixes of pyramidal HR that will ensure minimum values of RC and CR at the minimal overall dimensions of HR.

Let us present a pyramidal horn radiator (PHR) in the form of a length of rectangular waveguide with flaring walls and geometrically similar sections of the mouth and aperture. Let us divide it into two regions. The part of PHR limited by the mouth, generatrix, and the critical section shall be designated as the first region. The part of PHR limited by the critical section, generatrix, and the PHR aperture shall be designated as the second region. Under the critical section we understand such PHR section where waves of higher modes originate. We shall be solving the problem in the following order:

1. Finding the critical section of PHR.

2. Determination of the form of generatrixes and the length of the first region of PHR which ensure that RC does not exceed the admissible value (optimization of the PHR design in terms of RC).

3. Determination of the form of generatrixes and the length of the second region of PHR which ensure that CR does not exceed the admissible value (optimization of the PHR design in terms of CR).

4. Structural connection of the first and second regions of PHR into one unit.