UDC 621

Igor Zinenko
assistant NU “Zaporizhzhia Polytechnic”

MATHEMATICAL MODEL OF A FLANGED H-PLANE HORN WITH DIELECTRIC SLAB IN APERTURE

An H-plane sectoral horn with the rectangular waveguide feed is studied using the generalized scattering matrix (S-matrix) method and domain-product technique (DPT). The structure incorporates dielectric slab flush with the flanged aperture. The excitation mechanism involves the dominant mode. Calculated radiation characteristics have been presented for several configurations. A flanged radiator is efficient means for radiation of microwave energy used in phased arrays and flush-mounted antennas. Dielectric loading is usually applied to protect such a structure from the environment and to improve impedance matching. Radiators of this type have been investigated in the past by many authors using different techniques. Typical configurations considered are open-ended waveguides covered with dielectric slabs [1,2] or regular semi-infinite waveguides loaded by plugs with a rectangular outline [3,4].

The radiator is shown in Fig.1. The relative permittivity of the slab is ε. The modeled structure is uniform along the z-axis. It is excited by TE_{10} mode with the electric field component $U=E_z$. The problem is to find U satisfying the Helmholtz equation and appropriate boundary conditions.

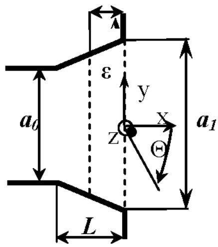

Figure 1 – Radiator

Using the method of the work [5], let us disjoin the structure into the autonomous multiangular blocks with homogeneous fillings. The decomposition scheme is presented in Fig.2. The blocks are shown separated by a finite distance d. The calculation formulas are obtained for $d\to0$. It is assumed that the apertures of the blocks and open-ended waveguide have infinite planar flanges superposing for d=0.

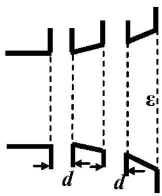

Figure 2 – Decomposition scheme

The block is formed by an interior region, bounded by a polygon, and attached half-planes. The total field in the half-plane consists of a possible incident wave, caused by the opposite building block, and waves propagating from the flanged aperture and obeying the radiation condition.

The scattering matrix of a separate block is determined as follows. Following the DPT, we represent U in the interior region as $U=\sum u_j$, with $u_j=\sum_{n=0}^{\infty} D_n^{(j)} \frac{Me_n^{(2)}(\xi_j,q_j)}{Me_n^{(2)}(0,q_j)} ce_n(\eta_j,q_j)$. Here, ($\xi_j$, η_j) are local elliptic coordinates related to the j-th boundary segment, $ce_n(\eta_j , q_j)$ are even angular Mathieu functions and $Me_n^{(2)}(\xi_j,q_j)$ are relevant radial Mathieu functions. The known quantity q_j is expressed through the electrical length of the segment and parameters of the medium [5]. $\{D_n^{(j)}\}$ is a sequence of expansion coefficients. Half-planes, attached to the apertures, have separable geometry in elliptic coordinates and the sought-for function U_i, defined within the i-th half-plane, can be written in the form

$$U_i = \sum_{n=0}^{\infty} S_{np}^{ik} \frac{Me_n^{(2)}(\xi_i, q_i)}{Me_n^{(2)}(0, q_i)} ce_n(\eta_i, q_i) + \delta_{ik}(-1)^p \frac{Me_p^{(2)}(\xi_k, q_k)}{Me_p^{(2)}(0, q_k)} ce_p(\eta_k, q_k).$$ Here, S_{np}^{ik} are elements of the scattering matrix, subject to definition. The second term represents an incident wave propagating from the opposite block. Next, using boundary conditions and orthogonal properties of the angular Mathieu functions, we get an infinite linear system with respect to $\{D_n^{(j)}\}$ and $\{S_{np}^{ik}\}$. It is solved by means of a truncation procedure.

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