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LINEAR ANTENNA EXCITATION BY THE SPECTRAL COMPONENT OF A FILAMENTARY ELECTRON BEAM

ЗБУДЖЕННЯ ЛІНІЙНОЇ АНТЕНИ СПЕКТРАЛЬНОЮ СКЛАДОВОЮ НИТКОПОДІБНОГО ЕЛЕКТРОННОГО ПУЧКА

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Анотація. *Conductive and inductive modes of excitation of a linear antenna by a filamentary electron beam are considered. Attention is paid to the change of monopole moments of the beam and the antenna. (на яз. тексту).*

Ключові слова: *Монопольні моменти електронного пучка та лінійної антени, спектральна складова струму, інтегральне рівняння Галена*

Key words: *Monopole moments of electron beam and linear antenna, spectral component of current, integral Gallen equation.*

A linear antenna represents a rectilinear segment of an ideal conductor, and a filamentary electron beam is a straight-line length of a free charge located in vacuum. At longitudinal orientation of the linear antenna, the filamentary electron beam moves uniformly in the longitudinal direction.

Until the beam comes in contact with the antenna, an inductive or dipole excitation mode takes place, which is formed by the free charges of the beam through the induction of current on the antenna surface.

When the beam collides with the antenna, the free charges of the beam turn into free surface charges of the antenna. The monopole moment or the total charge of the antenna varies from zero to the total charge of the beam. At that, the conductive or monopole of excitation mode is realized.

At the far end of the antenna away from the electron beam, the antenna current is zero, this being the classical boundary condition for a linear uncoupled antenna. At the near end of antenna, the antenna current is equal to the filamentary electron beam current.

Regarding the antenna current, use is made of the integral Gallen equation, which can be solved by the asymptotic method.

Until the beam collision with the antenna, the current at both ends of the antenna is zero. Negative and positive charges are accumulated at the far and near ends of the antenna, respectively.

At collision of the beam with the near end of the antenna, the positive charge at the near end reduces to zero, where as the current increases from zero up to the beam current value. The electron beam scattering at the end of the antenna gives rise to a time-varying surface charge density at its end, which is equal to the electron beam current density. At the vacuum - ideal conductor boundary, close to the near end of the antenna, the free charge density of the beam has a discontinuity that creates a generalized derivative in the longitudinal direction. As a result there occurs the free charge flow from vacuum into the medium of the ideal conductor along the antenna axis. This flow is due to the charge concentration and is described by the gradient of the free charge density. The density gradient forms the potential component of the longitudinally oriented electric field strength, which is inversely proportional to the first degree of the distance. This component is obtained in analytical form as a divergent ball wave. In the mode of conductive excitation, the potential electric field at far distances is simultaneously generated by decreasing and increasing the monopole moments of the beam and antenna, respectively, in the form of volume and surface free charges.

During electron beam scattering at the vacuum-ideal conductor boundary at far distances, there appears the potential component of the electric field strength, directed along the normal to the ideal conductor surface.

The source of the long-range potential electric field strength is the potential energy of the electron beam, or its internal energy, which is released by the beam as the charge density decreases or the distance between charges increases.

It appear possible to use the potential electric field strength for acceleration not only in the near and intermediate zones, but in the far zone too.

Due to the high penetrating ability of the longitudinal electromagnetic wave there are prerequisites for the development of promising means of underwater and underground communications.

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