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THEORY AND PRACTICE OF MEASUREMENTS OF ANTENNA RADIATION CHARACTERISTICS IN THE NEAR ZONE BY THE COLLIMATOR METHOD

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The radiation characteristics of apertures in the near and far zones are considered. The range of optimal distances between the antenna under test, collimator mirror, and radiator of the collimator mirror in the echoless compartment is determined. Characteristics of the collimator mirror and of the echoless compartment are included.

The ground experimental try-out and tests of antenna systems represent an important problem in the process of equipping the space-rocket and aircraft technology with radioelectronic aids [1]. This problem arises due to a pressing need in accurate microwave measurements under conditions similar to those existing in the free space and with a minimum of expenditure of time and material resources.

The near and far radiation zones. To make it more convenient and effective, it is expedient to precede the experimental works by determination of antenna radiation characteristics in the near zone, at relatively small distances R (Fig. 1) between collimator *3* and antenna *2* under test — at a compact antenna test ground (CATG) with relatively small dimensions [1–3]. At small distances R, the antenna *2* under test is irradiated by a limited in space (collimated) beam of electromagnetic energy from collimator *3*. All the hardware, including irradiator *1*, antenna *2* under test, and collimator *3*, is placed in an echoless compartment (ELC) having a relatively small volume.

One of the main issues in designing ELC is determination of the maximum permissible distance ($R_{\max}$) from the aperture of collimator *3* to antenna *2* under test, such that the oscillation of the field amplitude in the beam is insignificant and may be neglected.

Having introduced the far zone parameter $\Delta = \dfrac{R}{(2D^2)/\lambda}$, with regard for Fresnel's diffraction theory [2], let us write the expression for the component of the electromagnetic field in the vicinity of the beam axis:

$$E_\theta = -\frac{iZ_0 \cos\theta \cos\varphi}{\pi/4\Delta} e^{-\frac{i\pi}{4\Delta}} \left[L_1(\pi/8\Delta, U) + iL_2(\pi/8\Delta, U) \right] \tag{1}$$

where $Z_0 = \sqrt{\mu_0/\varepsilon_0}$ is the wave resistance of free space; L_1 and L_2 are Lommel's functions; $U = 0.5kD \cdot \sin\theta$; $k = 2\pi/\lambda$ is the wave number; and $\Delta < 1$.

Let us find out how expression (1) can be transformed at $\Delta \to 1$, i.e., when going to the far zone of radiation and taking into account that the Lommel functions can be expressed by a series in Bessel functions:

REFERENCES

1. V. V. Ovsyanikov, V. M. Popel', and A. L. Ol'shevskii, A compact antenna test ground for experimental adjustment of space-vehicle antennas, "Kosmicheskaya Nauka i Tekhnologiya" Scientific-Technical Journal, ISSN 1561-8889, Vol. 10, No. 1, pp. 85–91, 2004.

2. R. C. Hansen (editor), Microwave Scanning Antennas, Vol. 1 — Apertures, Academic Press, N. Y., London, 1964.

3. L. N. Zakhar'yev, A. A. Lemanskii, V. I. Turchin et al., Methods of Measurement of UHF Antenna Characteristics [in Russian, ed. by. N. M. Tseitlin], Radio i Svyaz', Moscow, 1985.

4. Ya. S. Shifrin, Introduction into Statistical Theory of Antennas [in Russian], Sov. Radio, Moscow, 1970.

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