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RECEPTION OF RADIO SIGNALS IN CHANNELS WITH FADING OF THE NAKAGAMI TYPE*

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The paper is devoted to statistical synthesis and efficiency analysis of a new algorithm for estimating of distribution parameters of the envelope of a radio signal with fading.

In the synthesis of radioelectronic systems of various purposes (particularly, for detection and discrimination of signals, estimation of their parameters, etc.), selection of the model for description of signals and noise is an extremely important issue. Very often [1, 2, etc.], especially when dealing with channels with fading, the signals are represented by the model of quasideterminate signal with random amplitude and initial phase. If the noise is Gaussian and white, and the initial phase of the signal has uniform distribution, then, regardless of amplitude distribution, the structure of the receiver (detector in particular) is known [1, 2] and based on calculation of quadrature components.

In practice we usually deal with the Rayleigh model of amplitude fluctuations. Then the characteristics of detection (in other words — probability of the first and second kind errors) have the form [1]

$$\alpha_0 = \exp(-h^2/2), \quad \beta_0 = 1 - \exp\left[-h^2/2(1+q^2/2)\right],$$

where h is threshold of detection; $q = \sqrt{2E/N_0}$ is the signal-to-noise ratio; E is the energy of a radio signal with the unit amplitude; and N_0 is the one-sided spectral density of the white Gaussian noise.

The dashed line in Fig. 1 shows the dependence $\beta_0(q)$ provided the detection threshold h is selected by the prescribed level of probability of the first kind error $\alpha_0 = 10^{-3}$. At the same time, as shown in a number of works (for example, in [2, 3]), during radio wave propagation in the ionosphere we may face signal fading, whose probability exceeds considerably the expected Rayleigh distribution of amplitude. This situation is described rather well by the Nakagami distribution with its parameters m and Ω:

$$W(\mu) = \frac{2m^m \mu^m}{\Omega^m \Gamma(m)} \exp\left(-\frac{m\mu^2}{\Omega}\right), \quad \mu \ge 0, \quad m \ge 1/2, \quad \Omega > 0, \tag{1}$$

where $\Gamma(\cdot)$ is the gamma-function [4].

If the structure of the detection algorithm remains unchanged, the detection characteristics will change considerably compared to the Rayleigh fading case. Indeed, the probability of the first kind error will be the same as in the case of

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REFERENCES

1. Yu. P. Grishin, P. P. Ipatov, Yu. M. Kazarinov et al., Radio-Engineering Systems [in Russian, ed. by Yu. M. Kazarinov], Vysshaya Shkola, Moscow, 1990.

2. L. M. Fink, The Theory of Discrete Message Transmission [in Russian], Sov. Radio, Moscow, 1970.

3. V. G. Somov, V. A. Leusenko, V. N. Tyapkin, and G. Ya. Shaidurov, Radiotekhnika i Elektronika, Vol. 48, No. 8, pp. 932–941, 2003.

4. M. Abramovits and I. Stigan (editors), Handbook of Special Functions [Russian translation], Nauka, Moscow, 1979.

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