MATHEMATICAL EXPECTATION AND CORRELATION FUNCTION OF THE PROCESS AT THE OUTPUT OF A SUM-DIFFERENCE DIRECTION FINDER HAVING INSTANTANEOUS AUTOMATIC GAIN CONTROL

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The sum-difference signal-handling method using instantaneous automatic gain control (IAGC) finds extensive application in single-pulse direction finders. The voltage at the output of such a direction finder (see [1]) may be written in the form

$$u_d(t) = k_p B^2(|Y_1^{\cdot}(t)|)\,\mathrm{Re}\,[Y_2^{\cdot}(t)/Y_1^{\cdot}(t)], \tag{1}$$

where $Y_l^{\cdot}(t)$ are the complex amplitudes of the processes at the outputs of the controlled intermediate-frequency amplifiers (IFA) of the sum ($l = 1$) and difference ($l = 2$) channels without consideration of the IAGC action; B(U) is the static amplitude response of the sum channel; k_p is the transmission factor of the phase detector which multiplies the waves of the sum and difference channels from the outputs of the IFA. Equation (1) is valid for the condition that the control characteristics of the channels are identical.

The present article finds the mathematical expectation m and the correlation function $R(t_1, t_2)$ of the process $u_d(t)$. It is assumed that $Y_l^{\cdot}(t) = U_l^{\cdot}(t) + V_l^{\cdot}(t)$, where $V_l^{\cdot}(t)$ are random normal stationary processes which describe the signal and interferences; $U_l^{\cdot}(t)$ are the deterministic components of the signal. A similar problem was considered for $U^{\cdot}(t) = 0$ in [1-3].

In analyzing angle-tracking radars, extensive use is made of discrimination and fluctuation characteristics which may be determined from m and $R(t_1, t_2)$. Case $U_l^{\cdot}(t)$ considered in [1-3] corresponds to the assumption of broadband fluctuations of the useful signal. An analysis of a direction finder in the presence of narrowband fluctuations of the signal, when the width of the fluctuation spectrum is commensurate with the passband of the angle tracker, is of no less interest. In this case, the signal is assumed to be deterministic (in particular, harmonic) when the discrimination and fluctuation characteristics are found, while in the subsequent analysis of the tracking system the signal/noise ratio incorporated in the indicated characteristics is assumed to fluctuate according to a stipulated law.

In determining m and $R(t_1, t_2)$ we make use of the results given in [4] where the mathematical expectation and correlation function were found for the process at the output of an ideal frequency detector:

$$u_p(t) = k_2 B^2(|U^{\cdot}(t)|)\,\mathrm{Im}\,[U^{\cdot\prime}(t)/U^{\cdot}(t)]. \tag{2}$$

Comparing Eqs. (2) and (1), we arrive at the conclusion that these expressions coincide if it is assumed that $k_2 = k_p$, $U^{\cdot}(t) = Y_1^{\cdot}(t)$, $U^{\cdot}(t) = jY_2^{\cdot}(t)$. The amplitude response of the channel with IAGC is approximated by the function

$$B(U) = c\sqrt{[1 - \exp(-bU^2)]}, \quad c > 0, \quad b > 0. \tag{3}$$

The mathematical expectation of the process $u_d(t)$ is determined by the expression

$$\frac{m}{k_\text{д} c^2} = [1 - \exp(-|U_1^{\cdot}|^2/2\sigma_{11}^2 h)]\,\mathrm{Re}\,(U_2^{\cdot}/U_1^{\cdot}) + (\sigma_{12}^2/\sigma_{11}^2 h)\exp(-|U_1^{\cdot}|^2/2\sigma_{11}^2 h), \tag{4}$$

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