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ESTIMATION OF PULSE REPETITION PERIOD WITH THE USE OF A RECIRCULATOR*

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A new structure of a quasiprobable measurer of repetition period of pulses against the white noise background is suggested. The loss in accuracy of quasiprobable estimation, in compared with the accuracy of maximum likelihood estimation, is determined for regular and discontinuous pulses.

Sequences of various kinds of pulses have found wide application in radioelectronics, radar and communication systems, etc. [1–6]. Moreover, in a number of practical tasks there arises a necessity in estimating the pulse repetition period. The optimal measurer, realizing the maximum probable estimation (MPE) of a repetition period, is multichannel-type for the parameter to be estimated [1]. Every channel of the meter includes a matched filter for a single pulse, and an ideal comb filter [2, 3]. However, the hardware implementation of a comb filter, in the case of a large number of pulses in the sequence, presents some difficulties because of severe requirements to stability of delay line parameters, and to the accuracy of arrangement of DL taps — to ensure the synchronism in accumulation of the pulses. These difficulties can be partially overcome by using a recirculator, which contains only two delay elements [2, 3]. Since the recirculator also contains a section of positive feedback, an attenuator is introduced in the FB loop to make the operation stable. As a result, the repetition period estimate, obtained in the measurer with a recirculator, will differ from MPE. This estimate will be called the quasiprobable estimate (QPE) — being identical to MPE in the absence of attenuator in the feedback loop when the transfer functions of the comb filter and of the recirculator are coincident [2, 3]. The use of a recirculator to estimate the pulse repetition period helps approach the QPE accuracy to the MPE accuracy. In this connection, consider a structure of a quasiprobable measurer with a recirculator involved, and assess the loss in QPE accuracy as compared to that of the MPE.

Assume that in the presence of the Gaussian white noise $n(t)$ with one-sided spectral density N_0 we observe a sequence of N pulses, each described by the function $s(t)$. This sequence may be written in the form

$$s_N(t,\theta_0)=\sum_{k=0}^{N-1}s(t-k\theta_0)=a\sum_{k=0}^{N-1}f\left[(t-k\theta_0)/\tau\right]. \qquad (1)$$

Here $a = \max s(t)$ is the pulse amplitude; θ is the repetition period, $\tau=\int_{-\infty}^{+\infty}s^2(t)\,\mathrm{d}t/\max s^2(t)$ is the equivalent duration of the pulse; and the function $f(\cdot)$ describes the shape of a single pulse and is normalized so that

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