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ANALYSIS OF CHARACTERISTICS OF COMPOSITE ULTRA-WIDEBAND SIGNALS WITH AMPLITUDE AND POSITIONAL CODE MODULATION

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The paper considers composite ultra-wideband signals with amplitude code modulation and with intrablock positional pulse modulation. Investigation of the generalized indeterminacy function for these signals is implemented. Analytical expressions for the correlation matrix of simultaneously effective estimates of delay time and period of these signals are derived. Analysis of potential accuracy of these parameters' estimates is performed for various modulation techniques. An algorithm is suggested for generation of modulating shift sequences.

The present-day systems of location, short-range navigation and communication must possess high accuracy of estimation of objects' motion parameters, and be able to transmit large volumes of information with high speed. One of promising ways to improvement of efficiency of such systems is application of coded ultra-wideband signals (UWBS) without carrier [1–2]. The amplitude-code and positional pulse modulation of UWBS sequences are most widely used. The known code sequences have to be optimized in terms of structure of the signal autocorrelation function (ACF). The availability of an additional information parameter (the period of the pulse sequence) in a composite UWB signal necessitates optimization of the generalized indeterminacy function (GIF) [1]. The problem of selection of the code, corresponding to optimal GIF structure, has not been resolved in full measure.

The GIF structure and potential characteristics of composite UWBS with amplitude code modulation are investigated in [1]. In the present work we suggest a new technique of intrablock positional pulse modulation (IPPM) based on ternary discrete codes with optimal correlative properties. The work also includes results of investigations of two classes of binary and ternary codes for the amplitude and intrablock positional modulation of UWB sequences. Analytical expressions are deduced for matrices of simultaneously efficient estimates of delay time and period of UWB signals, and the structure of GIF signals with intrablock positional pulse modulation is determined.

In order to describe the process of code modulation, some definitions will be introduced. By periodic modulation of a generating sequence, consisting of $(\nu + 1)$ pulses, by a discrete code with its number of positions M, is meant a partition of this sequence into $L = (\nu + 1)/M$ blocks, so that in each block we perform the modulation of the pulses in amplitude or time position in accordance with code elements' values. In the case of aperiodic modulation, $L = 1$.

The amplitude code modulation (ACM) is a method of periodic modulation of a composite signal by a binary code sequence $\{a_k\}$, $a_k = \{0, 1\}$, $k = \overline{0,(M-1)}$, with the number of nonzero elements $M_0 \le M$. The amplitude code modulation is performed by eliminating, from each block, $(M - M_0)$ pulses in the positions corresponding to the value $a_k = 0$ in the modulating code. The number of pulses in the generated sequence, i.e., $M_0 L < (\nu + 1)$.

IPPM is the method of periodic modulation of a signal by the ternary discrete code $\{b_k\}$, $b_k = \{-1, 0, 1\}$, $k = \overline{0,(M-1)}$, containing $(M - M_0)$ nonzero elements. Within each block of the generating sequence we perform shifting of the pulses,

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