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A DIRECT DIGITAL SYNTHESIZER OF FREQUENCY WITH PHASE QUANTIZATION IN THE SYSTEM OF RESIDUAL CLASSES

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The paper considers principles of design and functioning of a direct digital synthesizer of frequency in the system of residual classes. In order to lower the level of spurious components in the output signal, the synthesizer has a decreased number of controlled phase-shifters, which is possible due to quantization of instantaneous phase of the synthesized harmonic oscillation. The paper includes a description of phase quantization in the code of the system of residual classes. The spectra of synthesizers with and without phase quantization are compared.

One of the main requirements to frequency synthesizers used in military radio communication equipment is quick readjustment of the operation frequency within a prescribed range. In this regard the direct digital synthesizers of frequency are beyond any competition. In [1] we suggested a new technique of direst digital synthesis of frequencies, when the shaping of current (instantaneous) phase of the output harmonic oscillation, and its conversion into a flow of multilevel pulses, approximating the harmonic function, was carried out in special calculating units, which were functioning in the system of residual classes (SRC). Also, it has been shown [2] that the main reason for spurious components in the output signal spectrum (in this method of frequency synthesis) consists in phase errors in controlled phase shifters of the synthesizer, and the total power of these components is defined by expression

$$P_N = 10\lg\left(\sum_{i=1}^{N} D(\Psi_i)\right) \qquad (1)$$

where $D(\Psi_i)$ [radn^2] is the mean arithmetic of the squared centered values of phase errors in the ith ($i = \overline{1,N}$) controlled phase shifter; and N is the number of controlled phase shifters equal to the number of SRC radices.

The increment of the frequency spectrum in this type of synthesizer is directly proportional to the clock frequency (quantization frequency) and inversely proportional to the range of representation of numbers in SRC (we call it M), which in its turn is dictated by composition of the set of SRC radices m_i ($i = \overline{1,N}$) representing mutually simple positive integers:

$$M = \prod_{i=1}^{N} m_i . \qquad (2)$$

As can be seen from (2), realization of a small step in the frequency spectrum demands expansion of the range of SRC numbers' representation (and, hence, an increase in the number of controlled phase shifters in the synthesizer). Moreover, expression (1) shows that minimization of phase noise in the output signal spectrum can be attained at the expense of lowering the number of phase shifters.

One of the ways, which help overcome this contradiction, consists in discrete samplings of the synthesized harmonic oscillation for a less (than the range of representation of SRC numbers) number of discrete values (discretization quanta) of

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