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SYNTHESIS OF DIGITAL GENERATORS FOR MONITORING THE TECHNICAL CONDITION OF USERS' RADIO NAVIGATION SYSTEMS

Today, radio navigation systems of various users (vehicles, water, air transport, gas transport network, cellular communication equipment, etc.) ensure not only the safety of movement, but also provide accurate coordinates in the event of emergency events (accidents). Failure of the elements of this system can lead to significant material losses: disasters, loss of cargo, increase in the duration of the route, untimely detection of damage, etc. [1 – 7]. The need for the synthesis of a digital generator of sinusoidal signals for monitoring the technical condition of users' radio navigation systems is associated with increased requirements for the means of generating sinusoidal voltage of such systems and their ability to meet the specified characteristics with high accuracy [1, 3].

Today, the main means of generating sinusoidal signals for monitoring the technical condition of users' radio navigation systems are analog generators or generators, the principle of operation of which is to convert an analog signal into a digital form. However, the digital synthesis of a signal of the required form implies a significant complexity of technical implementation compared to analog generators. Therefore, generators of sinusoidal signals based on digital methods are much more expensive than analog ones and require certain qualifications of service personnel. This shortcoming can be overcome by the use of stepwise approximation of the synthesized sinusoidal signal [2, 6].

According to the methodical error of approximation, which characterizes the degree of approximation of the generated signal to the desired one, the piecewise-staircase approximation is inferior to other types of approximation (with the same number of approximation sections), but due to simpler hardware implementation and a much smaller instrumental error, it turns out to be the most effective in general, and therefore proposed for use in digital generators [4, 5].

The paper examines the method of stepwise approximation of a sinusoidal signal and substantiates the main characteristics of such a signal. Such a signal provides the minimum value of the harmonic coefficient and the best approximation of the generated signal to a sinusoid with a given number of approximation levels per signal period. But the simplest for hardware implementation is the piecewise stepwise approximation with a uniform location of the approximation nodes in time.

We especially emphasize that this signal does not contain harmonics close to the main one, and the initial phase of the first harmonic is not always zero.

The results of the analysis of two other variants of the piecewise step signal approximating a sinusoidal signal are presented. Their main results are presented.

All three versions of the piecewise stepwise quasi-sinusoidal signal contain, in addition to the main, higher order harmonics, which depends on the number of approximation sections (steps) per signal period. For example, if the number of steps is 100, the signal will contain 99, 101, 199, 201, 299, 301, etc. higher harmonics. The amplitudes of the harmonics decrease sharply with increasing harmonic number (approximately inversely proportional to the harmonic number).

Thus, an increase in the number of approximation sections leads to an increase in the numbers and a decrease in the amplitudes of the higher harmonics in the stepwise signal. If necessary, the higher harmonics of the piece-step signal can be filtered and thus the quality of the signal is improved.

At large values of the number of steps of the piecewise step signal, the optimal approximation reduces the harmonics coefficient by 5% compared to the uniform approximation by level, and by 15% compared to the uniform approximation by time. With small values of the number of steps, this difference reaches (30 ... 50)%. Uniform approximation in level compared to uniform approximation in time gives a gain of 10%.

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