A METHOD FOR CORRECTION OF QUADRATURE DISBALANCE OF RECEPTION CHANNELS IN A DIGITAL ANTENNA ARRAY

V. I. Slyusar, O. N. Soloshchev, and I. V. Titov

Kiev, Ukraine

The paper describes a new method for correction of quadrature nonidentities of reception channels in a digital antenna array. The method is distinguished by minimal computation.

Realization of potentialities of the digital RP-shaping in radiolocation, cellular communication systems of the third and four generation, and in other radio-engineering applications requires, as a necessary condition, minimization of hardware errors which are inevitable at signal processing. One of the ways to resolving this problem is application of special procedures for correcting the receiver channels' characteristics, since their different transfer factors inevitably lead to distortion of signal arrays and, consequently, to loss of information. During the last few years this issue has been investigated extensively [1]. However, regardless of what structure of the receivers coupled with the antenna elements may be (non-quadrature or quadrature-type with orthogonal subchannels), development of correction procedures for reception channel characteristics in digital antenna arrays (DAA) was mainly related to compensation of their inter-channel discrepancies in the amplitude- and phase-frequency responses. At the same time, in the case of analog orthogonalization of signals (one of its implementations is presented in Fig. 1), the procedures of correction of inter-channel nonidentities cannot eliminate completely the impact of different gain factors of the quadrature subchannels, or neutralize their non-orthogonality. It is possible only if using special procedures for correction of quadrature disbalance [2]. Meanwhile, the known procedures of this type are distinguished with large amount of computations, which complicates realization in real time at high-frequency quantization of signals.

With regard for the fact that the potentialities of the quadrature algorithm of processing (Fig. 1) outperform considerably the non-quadratic reception scheme [2] when working with broad-band signals, the purpose of this paper is development of a method of correction of quadrature subchannels' nonidentities in the case of analog orthogonalization of signals in the reception path of digital antenna arrays. The new method must be distinguished with moderate hardware expenditures at its implementation.

It is known that in receivers with orthogonal subchannels the main contributors of errors are nonidentities of gain factors of quadrature channels, and deviation from $\pi/2$ of the phase shift introduced into one of the subchannels. The phase error may also include a spread in the group delay of signals.

Prior to derivation of the correction algorithm, assume that the check signal (CS) represents a continuous harmonic oscillation, whose period T_0 is related to the ADC clock period:

$$T_{\text{ADC}} = T_0 (2n+1)/4, \ n = 0, 1, 2, \ldots . \tag{1}$$

If one of the subchannels is taken as a reference one, with its output voltage

$$a_k(i) = a_{\text{s}} \sin(2\pi f_{\text{s}} i T_{\text{ADC}} + \varphi_{\text{s}}), \tag{2}$$

REFERENCES

1. V. I. Slyusar, Izv. VUZ Radioelektronika, Vol. 46, No. 1, pp. 44–52, 2003.
2. D. Yu. Bobrov, A. P. Dobrozhanskii, G. V. Zaitsev, et al., Tsifrovaya Obrabotka Signalov [Digital Processing of Signals], No. 4, pp. 2–11, 2001.
3. V. I. Slyusar, Izv. VUZ Radioelektronika, Vol. 39, No. 5, pp. 55–62, 1996.

17 June 2003