Increasing the QAM Spectral Efficiency

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Abstract – **In this paper the method of increasing the spectral efficiency of quadrature amplitude modulation by using the instantaneous phase of the carrier as an additional parameter information is substantiated.**

Keywords – **QAM, spectral efficiency.**

I. Introduction

Spectral efficiency is one of the most important characteristics of any narrowband signal. Using quadrature amplitude modulation (QAM) allows to provide a high value of the spectral efficiency by increasing the number of signal levels. But the increasing the number of signal levels leads to decrease signal noise immunity, so there is a need in developing of other ways of increasing the spectral efficiency, that would cause smaller losses of signal noise immunity.

II. Main Part

In [1, 2] was proposed a method of increasing the speed of QAM information transmission by using the instantaneous signal phase information as an additional parameter (QAMPh). Its practical implementation involved the use of controlled carrier generator [1] or carrier components overcommutation [2]. The essence of this method is as follows: if during the existence of a separate pulse of modulating signal the phase of carrier frequency will be changed, the transmission of additional bits of information in this pulse could be provided. The simplest example of using the method QAMPh shown in Fig. 1: the solid line shows the sequence of 8 modulating pulses of QAM-16 in-phase component, and the dashed line shows the sequence of corresponding demodulated pulses [3].

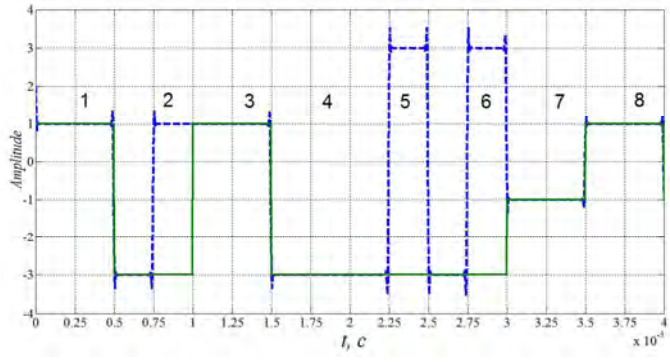

Fig. 1

At the same time phase of carrier changed on 180° in a moment of time equal to half the duration of the current modulating pulse when the additional bit equal to 1 is transmitted, and not changed when the additional bit equal to 0 is transmitted.

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As shown in Fig. 1, owing to manipulation of the phase of carrier during the existence of modulating pulses number 2, 5, 6 there is a change of demodulated pulses amplitude in its 2nd half [1-3]. The procedure of assigning the additional bits in the receiver is described in [1, 2] and it essence is comparing the value of each demodulated pulse before and after the moment of possible change in phase of carrier.

Spectral efficiency D associated with the speed of information transfer V as $D = \frac{V}{\Delta f}$ and method QAMPh [1, 2] can be considered as a method of increasing the QAM spectral efficiency if the next condition is performed:

$$(\Delta f_2 - \Delta f_1) < (V_2 - V_1), \quad (1)$$

where Δf_1, V_1 and Δf_2, V_2 - bandwidth and transmission speed of the signal before and after the increase of spectral efficiency, respectively.

In [1, 3] was shown the results of computer simulation by ways of QAMPh method practical implementation. It demonstrates that there is no expansion of the resulting signal spectrum, i.e. $\Delta f_2 = \Delta f_1$. It was achieved by using output channel filter in the model of the transmitter which ensured removing of unwanted spectrum components (arose from the use of controlled carrier generator [1] or carrier components overcommutation [2]). Thus, the developed method QAMPh can be considered as a method of increasing the QAM spectral efficiency. The results of previous simulations [1, 3] also showed that the signals created by the proposed method QAMPh have higher noise immunity than the signals created by the traditional method of increasing the QAM spectral efficiency.

III. Conclusion

In this paper the method of increasing the spectral efficiency of quadrature amplitude modulation by using the instantaneous phase of the carrier as an additional information parameter is presented. The advantage of this method is expected lower value of bit error rate than using the traditional method of increasing the QAM spectral efficiency.

References

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