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Single Sideband Hartley Amplitude Modulation

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Abstract—It is developed a method of information transmission with application of amplitude Single Sideband Hartley modulation (SSBH) allowing to increase of radio channel length for optical and fiber optic signal transmission systems where single sideband amplitude modulation (SSB) is used. Increase of communication range is provided due to application a sum of two orthogonal oscillations of the same frequency as a carrier (Hartley wave). It provides energy gain in 6 dB and 1.41 times increase of the amplitude of output signal of synchronous detector comparing to SSB in case of the same radiation power of transmitter and the same sensitivities of SSBH and SSB signals receivers. Application of SSBH and SSB modulation allows to provide the energy gain in transmitting channel approximately 15–20 times comparing to amplitude modulation (AM) application. It also provides increased security of SSBH transmission since in case of absence of modulation signal the transmitter does not radiate, that allows to provide energy saving in case of transmitter power supply with battery. Depending on the need we can use both upper and lower side bands.

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1. INTRODUCTION

Single band amplitude modulation with signal side band (SSB) is proposed first by John Renshaw Carson in 1915 and it is widely applied in radio communication and telecommunication systems and also in fiber optic signals transmission systems [1]–[3] due to efficient application of the spectrum and power of a transmitter in communication channel. We can use both lower spectrum sideband (LSB) and upper sideband (USB) [4]–[12].

Form energy viewpoint the SSB transmitter is efficient, since it does not radiate where modulating signal is absent. It allows to reduce power consumption and radio visibility (demasking) of the transmitter. It results in 15–20 times energy gain comparing amplitude modulation.

We should note the SSB signal is related to particular case of amplitude–phase modulation that is shown by analytical expressions for the SSB signal which can be written in the following form [7], [8], [13]:

$$S_{\text{LSB}}(t)=[a_n\sin(\Omega t)]\cos(\omega_0 t)-[a_n\cos(\Omega t)]\sin(\omega_0 t)$$

$$=A_n\cos(\omega_0 t)+gA_n\sin(\omega_0 t)=\sqrt{A_n^2+gA_n^2}\,\sin(\omega_0 t+\varphi_1), \tag{1}$$

$$S_{\text{USB}}(t)=[a_n\sin(\Omega t)]\cos(\omega_0 t)+[a_n\cos(\Omega t)]\sin(\omega_0 t)$$

$$=A_n\cos(\omega_0 t)-gA_n\sin(\omega_0 t)=\sqrt{A_n^2+gA_n^2}\,\sin(\omega_0 t+\varphi_2), \tag{2}$$

where ω_0 is a circular frequency of carrier (subcarrier) frequency, a_n is amplitude of cophase and quadrature or digital m-level signal, where $m=2^n, n=1,2,3,\ \ldots,\ \Omega$ is the frequency of modulating signal, t is time, $A_n=a_n\sin(\Omega t)$ is the modulating signal, $gA_n=-a_n\cos(\Omega t)$ is a conjugate signal of a Hilbert transform of modulating signal A_n,

ADDITIONAL INFORMATION

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