WPAN 용 송신기의 SSR 을 만족시키기 위한 에러 성분들의 requirements

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The Requirements of the error components for the SSR in WPAN

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Abstract : The modulation quality of the I/Q modulator in a wireless transmitter usually affects system performance and it mostly depends on both a nonlinearity and a distortion, from the third order intermodulation(IM_3) signal and the error components such as an input amplitude error and a local phase error, respectively. This paper focused on how much the *Single Sideband Ratio(SSR)*, which indicates the signal distortion, changes according to the variation of the error components. Consequently, since a desired signal, side band signal at the I/Q modulator output are also represented with those power series coefficients and the error components, the effects of the error components on *SSR* to meet the EVM specification of the WPAN can be clearly analyzed
Keywords: *SSR*(Single Sideband Ratio), Imperfection features, I/Q modulator

1. Introduction

Recently, the importance of a modulation quality at the I/Q modulator has been emphasized more than before [1] because the increased demand for a broadband requires the system to adopt a higher modulation over M-PSK. Since the modulation signal is usually degraded by IM_3 signal and the error components, it is very important to reduce IM_3 signal and error components. There are numerous analyses on signals and the *SSR* at the I/Q modulator [2]-[4], but they are not practical because none of them include both the system parameters and the error components, and it can increase the difference between the simulated data and the measured data. In this reason, we propose a new expressions including both of them through the power series, they can make it clear to analyze the *SSR* according to the variation of the imperfection features error In this paper, the nonlinear models for a mixer and the I/Q modulator are expressed in Section 2. And the simulation results on the relations between error components features and the *SSR* are presented in Section 3. Finally, the conclusion is represented in Section 4.

2. The Nonlinear Model for the I/Q modulator

2.1 A Nonlinear Mixer Model

The nonlinear mixer model to estimate the powers of a variety of output signals is as follows. For simplicity, input signal *x(t)* and output signal *y(t)* are assumed to be

$$x(t) = A\cos\omega_1 t + A\cos\omega_2 t \quad (1)$$

$$y(t) \approx \alpha_1 x(t) + \alpha_2 x(t)^2 + \alpha_3 x(t)^3 \quad (2)$$

In (2), the higher order terms are excluded because they are not a matter of concern in this analysis. From (1) and (2), the fundamental and intermodulation products are obtained as follows.

$$\omega_1, \omega_2 : \left(\alpha_1 A + \frac{9}{4}\alpha_3 A^3\right) \cos\omega_{1,2} t \quad (3)$$

$$\omega_1 \pm \omega_2 : (\alpha_2 A^2) \cos\left((\omega_1 \pm \omega_2)t\right) \quad (4)$$

$$2\omega_1 \pm \omega_2 : \left(\frac{3}{4}\alpha_3 A^3\right) \cos\left((2\omega_1 \pm \omega_2)t\right) \quad (5)$$

From a basic definition on IIP_3 [5].

$$\alpha_1 A + \frac{9}{4}\alpha_3 A^3 = \frac{3}{4}\alpha_3 A^3 \quad (6)$$

Solving the equation for variable *A*, and A_{IIP3} becomes

$$A_{IIP3} = \sqrt{-\frac{2\alpha_1}{3\alpha_3}} \quad (7)$$

Since OIP_3 is equal to be IIP_3 plus *Gain,* using (7), the relation between α_1 and α_3 is obtained as follows.

$$\alpha_3 = -\frac{\alpha_1}{150 \times 10^{\frac{OIP3-Gain-30}{10}}} \quad (8)$$

From a basic definition on IIP_2 [5],

$$\alpha_1 A + \frac{9}{4}\alpha_3 A^3 = \alpha_2 A^2 \quad (9)$$

Since OIP_2 is equal to be IIP_2 plus *Gain,* inserting (8) into (9), the relation between α_1 and α_2 is obtained as well.

$$\alpha_1 = \frac{8c}{16-9mc^2}\alpha_2 \quad (10)$$

$$\left(m = \frac{1}{150 \times 10^{\frac{OIP3-Gain-30}{10}}}, c = \sqrt{400 \times 10^{\frac{OIP2-Gain-30}{10}}} \right)$$

From the basic function of a mixer on conversion gain and (4), the equation about α_2 leads to.

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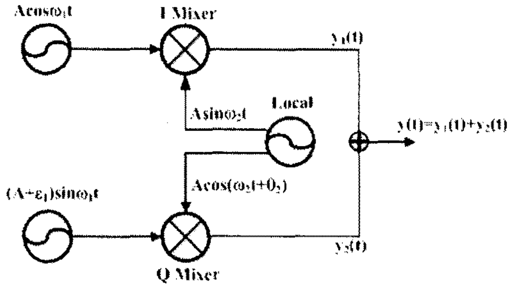

Fig.1 I/Q modulator with the error components

$$\alpha_2 = \frac{1}{10^{\log_{10}A}} \times \sqrt{10^{\frac{Gain}{10}}} \quad (11)$$

As listed from (3) to (11), the coefficient of the power series are represented with the system parameters of OIP_2, OIP_3 and conversion gain, respectively.

2.2 A Nonlinear Model for the I/Q modulator

Since the practical I/Q modulator as shown in Fig.1 always has error components such as the input amplitude error, and local phase error, a side band signal is also present at the I/Q modulator output [4]. From a similarity to the nonlinear mixer model, a desired signal and side band products on different arms of the I/Q modulator are easily obtained. The products on an upper arm are as follows

And the products on a lower arm become.

$$\omega_1 \pm \omega_2 \ : \pm\alpha_2 A^2 sin\left((\omega_1 \pm \omega_2)t\right) \quad (12)$$

$$\omega_1 \pm \omega_2 \ : \ \alpha_2(A+\varepsilon_1)Asin\left((\omega_1 \pm \omega_2)t \pm \theta_2\right) \quad (13)$$

Given $\lambda=\alpha_2(A+\varepsilon_1)$, a desired signal and side band signals at the I/Q modulator output can be expressed using (12) to (13) and become, respectively.

$$\omega_2 + \omega_1 : \{\alpha_2 A^2 + \lambda\cos\theta_2\} sin\left((\omega_2+\omega_1)t\right) + \lambda \sin\theta_2 \cos\left((\omega_2+\omega_1)t\right) \quad (14)$$

$$\omega_2 - \omega_1 : \{\alpha_2 A^2 - \lambda\cos\theta_2\} sin\left((\omega_2-\omega_1)t\right) - \lambda \sin\theta_2 \cos\left((\omega_2-\omega_1)t\right) \quad (15)$$

3. Simulation Results

The simulations were performed using derived equations. The simulations for the effects of the error components on *SSR* are performed under assumptions that input signals to the I/Q modulator have the peak values of ±0.5v, OIP_2 of 60dBm, OIP_3 of 30dBm and conversion gain of 10 dB. the *SSR* is shown to have relation with error components such as the input amplitude error and local phase error. Assuming a maximum 10% error of an input amplitude and 3° error of a local phase, the curves relating those error components to the *SSR* in Fig.1 and 2 represent that the *SSR* decreases as either an input amplitude or a local phase error increase, meaning the degradation of signal modulation.

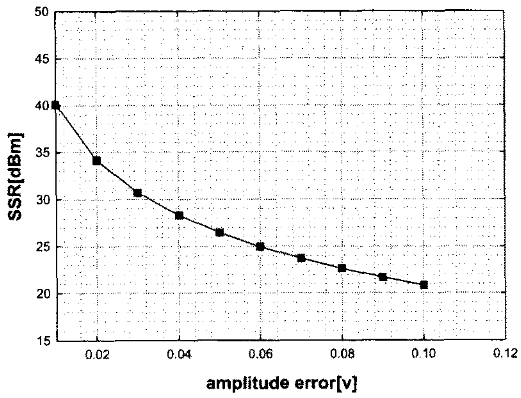

Fig.2 *SSR* vs input amplitude error

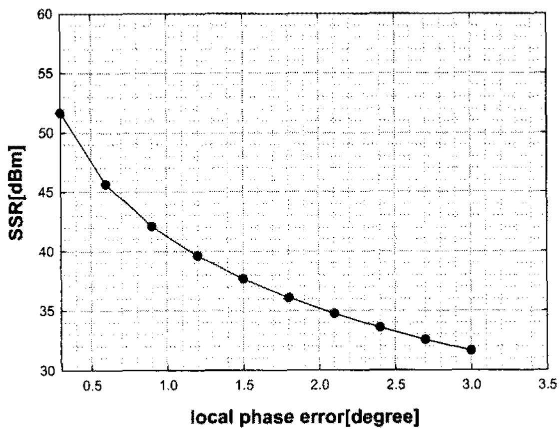

Fig.3 *SSR* vs local phase error

4. Conclusion

In summary, it was key point to obtain the power series coefficients represented with the system parameters of OIP_2, OIP_3 and conversion gain for the nonlinear analysis of the I/Q modulator. As a result of that, the analytical expressions for a desired signal and side band signal were derived. Moreover, it was definitely found that the *SSR* decreases according to the increase of the input amplitude error and local phase error. And the error components values where the *SSR* value is under required specification to meet the WPAN modulation quality of QPSK can be analyzed and induced.

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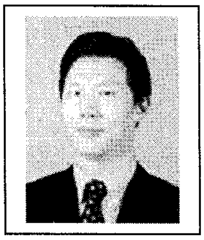

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