AN ANALYSIS OF A METHOD OF INFORMATION TRANSMISSION

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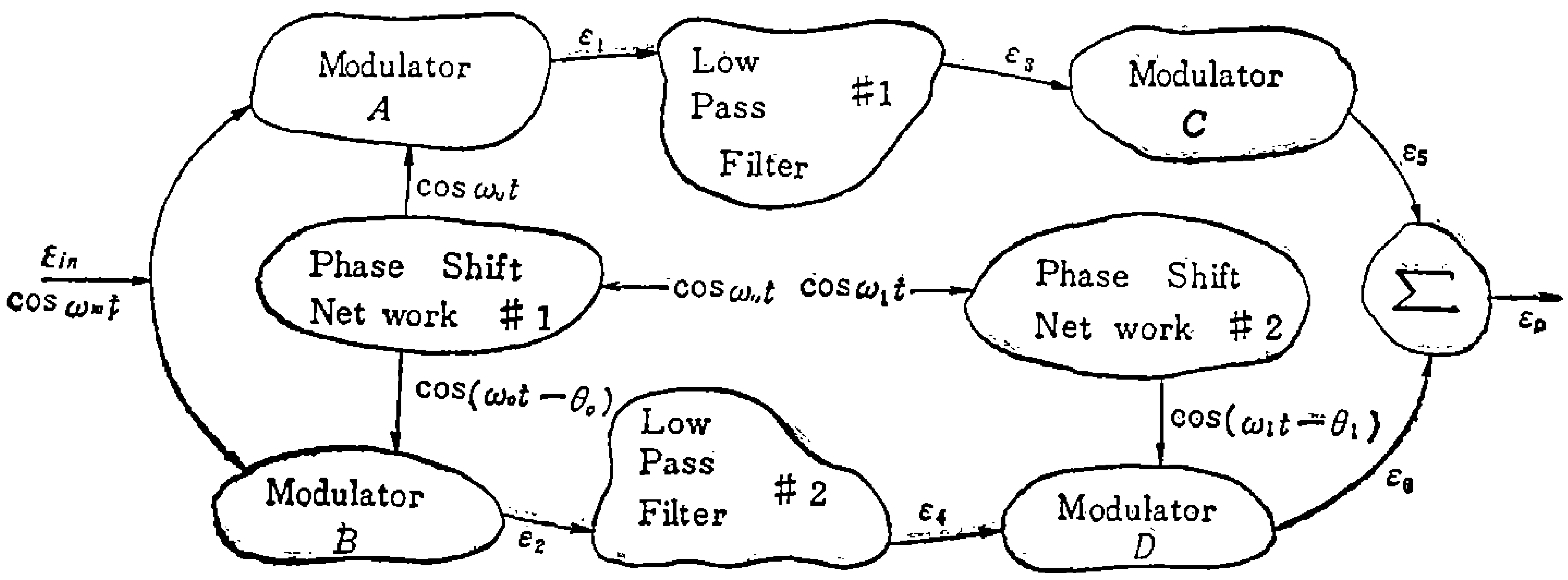
In the usual analysis of the so called third method of single sideband information transmission the assumption is tacitly made that the balanced modulators and the low pass filters have ideal transfer functions. In my analysis the assumption is made that the transfer functions for the balanced modulators and for the low pass filters only approximate those of the ideal in a piecewise linear manner. On the basis of my analysis the valid statement can be made that if the transfer functions for the balanced modulators and for the low pass filters differ appreciably from those of the ideal, then the measure of the essential spectrum of the output information as predicted by the usual analysis will be only one third that of the measure of the actual essential spectrum of the output information.



ASSUMPTIONS

1. Modulators $A, B, C,$ and D are essentially balanced modulators, but for the purpose of analysis these modulators are assumed to be *imperfect*; that is, carrier frequency voltage appears in the output in addition with the product of the input and carrier signals.

2. The two low pass filters are assumed to be identical and for the purpose of analysis have the transfer function:

$$\frac{E_0}{E_{in}} = A(\omega)e^{j\phi(\omega)}, \qquad \text{where } \phi(\omega)=0 \text{ and } A(\omega)=\begin{cases} K_L, & \omega \leqslant \omega_0 \\ K_H, & \omega_0 \leq \omega \end{cases}$$

$$\epsilon_1 = K'_A \cos\omega_0 t + K_A \cos\omega_0 t \cdot \epsilon_{in} = K'_A \cos\omega_0 t + K_A \cos\omega_0 t \cos\omega_m t$$

$$=K'_A \cos\omega_0 t+K_A/2\cos(\omega_0+\omega_m)t+K_A/2\cos(\omega_0-\omega_m)t$$

$$\epsilon_2=K'_B \cos(\omega_0 t-\theta_0)+K_B \cos(\omega_0 t-\theta_0)\cdot\epsilon_{in}$$

$$=K'_B\cos(\omega_0 t-\theta_0)+K_B \cos(\omega_0 t-\theta_0) \cos \omega_m t$$

$$=K'_B\cos(\omega_0 t-\theta_0)+K_B/2\cos\{(\omega_0+\omega_m)t-\theta_0\}+K_B/2\cos\{(\omega_0-\omega_m)t-\theta_0\}$$

$$\epsilon_3=\mathrm{Re}\{A(\omega)\cdot e^{j\phi(\omega)} \quad \bar{E}_1\}$$

$$=K_H K'_A\cos\omega_0 t+K_H K_A/2\cos(\omega_0+\omega_m)t+K_L K_A/2\cos(\omega_0-\omega_m)t$$

$$\epsilon_4=\mathrm{Re}\{A(\omega)\cdot e^{j\phi(\omega)}\cdot \bar{E}_2\}$$

$$=K_H K'_B \cos(\omega_0 t-\theta_0)+K_H K_B/2\cos\{\omega_0+\omega_m)t-\theta_0\}+K_L K_B/2\cos\{(\omega_o\text{-}\omega m)t-\theta_0\}$$

$$\epsilon_5=K'_C \cos\omega_1 t+K_C\cos\omega_1 t\cdot\epsilon_3$$

$$=K^1_C \cos\omega_1 t+K_C K_H K'_A\cos\omega_1 t \cos\omega_0 t+K_C K_H K_A/2\cos\omega_1 t\cos(\omega_0+\omega_m)t$$
$$+K_C K_L K_A/2\cos\omega_1 t\cos(\omega_0-\omega_m)t$$

$$\epsilon_6=K'_D\cos(\omega_1 t-\theta_1)+K_D \cos(\omega_1 t-\theta_1)\cdot\epsilon_4$$

$$=K'_D \cos(\omega_1 t-\theta_1)+K_D K'_H K'_B\cos(\omega_1 t-\theta_1) \cos(\omega_0 t-\theta_0)$$
$$+K_D K_H K_B/2\cos(\omega_1 t-\theta_1) \cos\{(\omega_0+\omega_m)t-\theta_0\}$$
$$+K_D K_L K_B/2\cos(\omega_1 t-\theta_1) \cos\{(\omega_0-\omega_m)t-\theta_0\}$$

$$\epsilon_5=K^1_C\cos\omega_1 t+K_C K_H K^1_A/2\cos(\omega_0+\omega_1)t+K_C K_H K^1_A/2\cos(\omega_0-\omega_1)t$$
$$+K_C K_H K_A/4\cos(\omega_1+\omega_0+\omega_m)t+K_C K_H K_A/4\cos(\omega_1-\omega_0-\omega_m)t$$
$$+K_C K_L K_A/4\cos(\omega_1+\omega_0-\omega_m)t+K_C K_L K_A/4\cos(\omega_1-\omega_0+\omega_m)t$$

$$\epsilon_6=K'_D \cos(\omega_1 t-\theta_1)+K_D K_H K'_B/2\cos\{\omega_1+\omega_0)t-\theta_1-\theta_0\}$$
$$+K_D K_H K'_B/2\cos\{(\omega_1-\omega_0)t-\theta_1+\theta_0\}+K_D K_H K_B/4\cos\{(\omega_1+\omega_0+\omega_m)t-\theta_1-\theta_0\}$$
$$+K_D K_H K_B/4\cos\{(\omega_1-\omega_0-\omega_m)t-\theta_1+\theta_0\}+K_D K_L K_B/4$$
$$\cos\{(\omega_1+\omega_0-\omega_m)t-\theta_1-\theta_0\}+K_D K_L K_B/4\cos\{(\omega_1-\omega_0+\omega_m)t-\theta_1+\theta_0\}$$

$$\epsilon_0=\epsilon_5+\epsilon_6=K'_C\cos\omega_1 t+K'_D\cos(\omega_1 t-\theta_0)+K_C K_H K'_A/2\cos(\omega_1+\omega_0)t$$
$$+K_D K_H K'_B/2\cos\{(\omega_1+\omega_0)t-\theta_1-\theta_0\}+K_C K_H K'_A/2\cos(\omega_1-\omega_0)t$$

$$+K_DK_HK'_B/2\cos\{(\omega_1-\omega_0)t-\theta_1+\theta_0\}+K_CK_HK_A/4\cos(\omega_1+\omega_0+\omega_m)t$$
$$+K_DK_HK_B/4\cos\{(\omega_1+\omega_0+\omega_m)t-\theta_1-\theta_0\}+K_CK_HK_A/4\cos(\omega_1-\omega_0-\omega_m)t$$
$$+K_DK_HK_B/4\cos\{\omega_1-\omega_0-\omega_m)t-\theta_1+\theta_0\}+K_CK_LK_A/4\cos(\omega_1+\omega_0-\omega_m)t$$
$$+K_DK_LK_B/4\cos\{(\omega_1+\omega_0-\omega_m)t-\theta_1-\theta_0\}+K_CK_LK_A/4\cos(\omega_1-\omega_0+\omega_m)t$$
$$+K_DK_LK_B/4\cos\{(\omega_1-\omega_0+\omega_m)t-\theta_1+\theta_0\}$$

Suppose the phase shift networks are adjusted in such a way that we have

$$\theta_0=\theta_1=\pi/2$$

Then:

$$\epsilon_0=\Big((K'_C)^2+(K'_D)\Big)^{\frac{1}{2}}\cos\{(\omega_1t-\tan^{-1}K'_D/K'_C)\}$$
$$+K_H/2\{K'AK_C-K'_BK_D\}\cos(\omega_1+\omega_0)t$$
$$+K_H/2\{K'_AK_C+K'_BK_D\}\cos(\omega_1-\omega_0)t$$
$$+K_H/4\{K_AK_C-K_BK_D\}\cos(\omega_1+\omega_0+\omega_m)t$$
$$+K_H/4\{K_AK_C+K_BK_D\}\cos(\omega_1-\omega_0-\omega_m)t$$
$$+K_L/4\{K_AK_C-K_BK_D\}\cos(\omega_1+\omega_0-\omega_m)t$$
$$+K_L/4\{K_AK_C+K_BK_D\}\cos(\omega_1-\omega_0+\omega_m)t$$

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