Suboptimal Demodulation of Binary Frequency Shift Keying

In this exercise the performance of suboptimal coherent demodulation of binary frequency shift keying (BFSK) is to be assessed by simulation. The coherent BFSK digital communication system is given in Figure 3.8 and described on pages 154-162 of the *SystemVue* text.

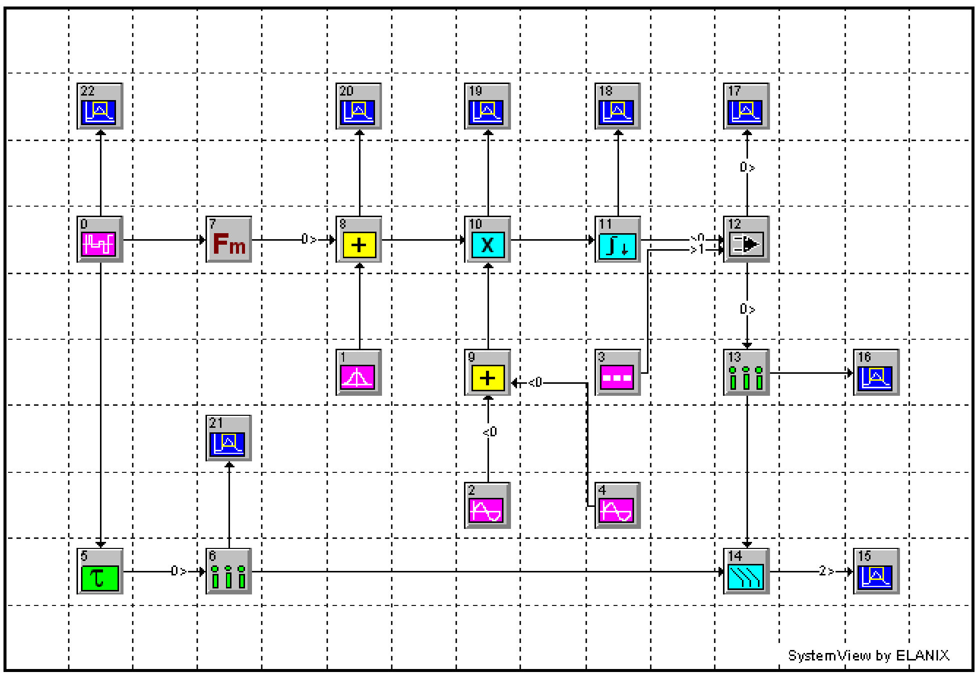

Figure 3.8

The *Analog Comparator* (Token 12) comparison input is set to the optimum threshold τ_{opt} given by Equation 3.3 in the *SystemVue* text, since the binary FSK signals, although asymmetrical, are assumed equally probable. The optimum threshold τ_{opt} is 0 V here, as given by Equation 3.2. The *Custom* token from the *Source Library* provides the constant comparator input, with parameters of one output whose the algebraic simulation equation is p(0) = 0, but this is to be modified in one task of this Laboratory.

In this Laboratory you are to investigate three *parametric changes* which may contribute to suboptimal detection and their resulting possible effect upon the observed BER: misadjustment of the threshold; variation of the coherent receiver reference frequencies $f_C \pm \Delta f$; and variable frequency deviation Δf. You are to chose a *random carrier amplitude* from the values A_C = 2.5, 5, 10 or 15 V, a single *random bit rate* from r_b = 2 to 20 kb/sec in steps of 2 kb/sec and a *random* *carrier frequency* from the values f_C = 50, 60, 80, 90 or 100 kHz for the coherent BFSK digital communication system. Initially, the frequency deviation should be $\Delta f = r_b/2$ the minimum possible and the coherent receiver reference frequencies set properly at $f_C \pm \Delta f$. The BFSK signal is sent with the carrier amplitude A_C and frequencies $f_C \pm \Delta f$.

The data rate is higher than the *SystemVue* examples (1 kb/sec), so the *System Sampling Time* $T_S = 1/ f_S$, the parameters of the *delay* and the parameters of the *down-samplers* must all be carefully chosen for the simulation to be correct.

First, you can verify the expected BER performance of the coherent BFSK digital communication system using the optimal threshold, proper reference frequencies $f_C \pm \Delta f$ and $\Delta f = r_b/2$ the minimum possible against the theoretical P_b using the standard methodology that you have used in the Laboratory. Determine *first-nulls* spectral bandwidth of the BFSK signal and verify that it is correct.

Second, you can misadjust the comparison threshold by positive steps from 0 to 0.25 $a_1(iT_b)$ in steps of 0.05 $a_1(iT_b)$ and quantify and describe in detail the possible degradation in BER performance using the standard methodology that you have used in the Laboratory. The coherent receiver reference frequencies remain at $f_C \pm \Delta f$ and the BFSK signal is sent with the carrier amplitude A_C and frequencies $f_C \pm \Delta f$ where $\Delta f = r_b/2$ the minimum possible.

Third, you can vary the coherent receiver reference frequencies from $f_C \pm \Delta f$ to $f_C \pm \Delta f + 0.1\ \Delta f$ then $f_C \pm \Delta f + 0.2\ \Delta f$. The optimal threshold (0) is to be used and the BFSK is sent with the carrier amplitude A_C and frequencies $f_C \pm \Delta f$ where $\Delta f = r_b/2$ the minimum possible. Describe in detail the possible degradation in BER performance using the standard methodology that you have used in the Laboratory.

Fourth, you can vary the frequency deviation of *both* the BFSK transmitted signal and the coherent receiver reference frequencies ($f_C \pm \Delta f$) from $\Delta f = r_b/2$ to $\Delta f = 2r_b/3$, $\Delta f = 2r_b$ and $\Delta f = 5r_b/3$. The optimal threshold (0) is to be used. Describe in detail the possible degradation in BER performance using the standard methodology that you have used in the Laboratory. Determine *first-nulls* spectral bandwidth of the BFSK signal and describe the spectral appearance for each of these frequency deviations Δf.