FSK

I. Compute the frequencies f_2 and f_1, allocated to the two logical levels of a 2-FSK transmission that has $f_b = 3600$ Hz and $f_c = 1800$ Hz, and the bandwidth of modulated signal. The modulated signal is assumed to have an optimum spectrum.

II. Consider a 2-FSK transmission (1 bit/symbol) within the frequency band (36, 41) kHz having $f_c = 38$ kHz.

a. Compute the maximum standard bit rate (k·600 bps) that could be transmitted with an optimum spectrum and the frequencies allocated to the two logical levels.

b. Draw the block diagram and write the operational equations of the 2-FSK modulator for the transmission established at a) if the sine carrier signal is synthetized with 4 Walsh functions. Compute the frequency of the pilot oscillator required by this modulator.

c. Compute the values of the pasive components so that the carrier's amplitude should be A≈ 1V, if the level of bipolar Walsh functions is U=5 V and $R_r = 10k\Omega$.

II'. 1) Explain the operation principle and draw the block diagram of the "zero-crossings" FSK demodulator. Supposing that the FSK transmission has the bit rate D, the central frequency f_c and a modulation index that ensures an optimum spectrum, compute the optimum value of the monostable time constant and the cut-off frequency of BB-LP filter.

2) Considering a D = 1200 bps FSK transmission over a vocal telephone channel, compute the maximum frequency deviation that could be inserted by the channel, so that the d.c. component at the output of the BB-LP filter should change with less than 4% of the ideal amplitude of the variable component from the output of the BB-LP filter.

III. a) Establish the maximum standard bit rate that could be transmitted using an 2-FSK modulation over a channel with a frequency band FB = [85; 115] kHz, for an optimum spectrum of a modulated signal. Choose f_c and compute f_0 and f_1 and the useful frequency band of the modulated signal.

b) Draw the block diagram of the ZC-demodulator used to demodulate the signal defined at a) and compute the values of the monostable's time constant and of the minimum cut-off frequency of the LP-BB filter.

c) How would the demodulated signal be modified if te modulated signal suffers a frequency offset of + 2 kHz across the channel? Compute and draw for the 1:1 modulating sequence, for the parameters computed at a). and assume that the monostable's amplitude is U.

IV. Consider a 2-FSK transmission (1 bit/symbol) within the frequency band [225, 375] kHz.

a. Compute the maximum bit rate k·16kbit/s that could be transmitted assuming an optimum spectrum of the modulated signal, and the frequencies allocated to the two logical levels.

b. Compute the passing bands of the filters employed and the time constant of the monostable included in the ZC demodulator contained in the receiver of the transmission defined at a.

c. What is the maximam frequency offset that could be inserted by the channel so that the d.c. component at the otput of the LP-BB filter would be modified with maximum 1% of the ideal value of the amplitude of the variable componet of the signal at the output of the LP-BB filter?

V. Consider a 2-FSK transmision with D = 4800bps, $f_c = 10$ kHz and optimum spectrum.

a) Compute the frequencies f_1 and f_2 associated to the logical levels, the frequency band of the modulated signal and the amplitude of the variable component at the output of the LP-BB filter of the ZC demodulator. Assume that the bipolar monostable's amplitude is U = 10V and the ZC demodulator has optimum settings.

b) The fast synchro circuit of the local clock $f_{local} = f_{bit}$ of the transmission defined at a) acts upon the first threee stages of the controlled divider. Compute the maximum value of the atack frequency so that the local clock would be synchronized in 1,7 ms at most.

c) Draw thew block diagram of the synchronization circuit defined at b) (fast + dynamic).

VI. Assume an 2-FSK transmission with bit rate D = 72 kbps, $f_c = 200$ kHz and optimum spectrum.

a) Write the mathematical expressions that define the generation of the sine carrier signal with Walsh functions and drw the block diagram of the 2-FSK modulator for the transmission with the paparameters given above.

b) Compute the values of the minimum frequency of the Walsh modulator's pilot oscillator, the division factors of its controlled divider and the parameters of the output filter.

c) Compute the maximum frequency offset df_M for which the signal at the output of the ZC demodulator still has a rectangular shape, knowing that the demodulator is optimally tuned and the amplitude of the bipolar monostable is U = 5V. The transmitted data sequence is „1010...".

VII. A bit rate D = 4800 bps, should be transmitted with 2-FSK, $f_c = 2{,}75$ MHz, which has an optimum spectrum.

a) Compute the the required frequency band and the SNR values in [dB] for which $BER \leq 10^{-5}$, knowing that $BER_{2FSK-ZC} \approx 0{,}5 \cdot \exp(-\rho/2)$.

b) Compute the SNR values for which this transmission ensures $BLER \leq 1 \cdot 10^{-2}$ for data blocks of L=1000 bits if the bit-errors are assumed to be distributed according to binomila law withn the blocks.

c) Compute the parameters of the ZC demodulator (f_c, BW, τ, f_{cut}) and the amplitude of signal at the LP-BB output (U = 10 V).

VIII. An FSK signal with optimum spectrum has the frequencies f_1 and f_2 equal to 4,8 kHz and 11,2 kHz, respectively..
a) Compute the bit rate and the parameters of the BP filter at the receiver's input.
b) If the optimally tuned ZC demodulator changes the the value of the bipolar monostable's time constant from $\tau_{optim\ to}$ $\tau' = \tau_{optim}/2$, compute how would the signal at the LP-BB filter be modified compared to signal provided for ideal tuning. How could these changes be compensated? The transmitted data sequence is "101010..".

IX Consider an optimum spectrum FSK transmission whose modulator uses the Walsh synthesis of the sinusoidal carrier signal.
a) Knowing that the ratio of the division factors of the controlled divider is $n_1/n_2=11/9$ and that f_c =320 kHz, compute the transmission's bit rate and establish the parameters of the Walsh modulator. The dimensioning of the elements of the weighted adder is not required.
b) The whole synchronization of the local clock $f_{local}= f_{bit}$, required to deliver the synchronous data of the transmission defined at a), should be accomplished in $t_s \leq 1.9$ ms. Knowing that the fast synchro operates upon the first m = 5 flip-flops of the controlled divider and that the synchronization data sequence is "11001100..", compute the maximum value of f_{atack}, and prove that it is maximum.

X. Assume a 2-FSK transmission with D=1200 bps and f_c=1800 Hz, which has an optimum spectrum ($h \approx n/(n+1)$, $n<5$)
a) Write the equation that define the recursive generation of the modulated signal with the parameters specified above, if $f_e = 64 \cdot f_s$.The modulating data are bipolar (=/-1). How is the phase continuity ensured at the modification of the bit's logical value?
b) What is the drawback of this method and how could it be partially compensated?