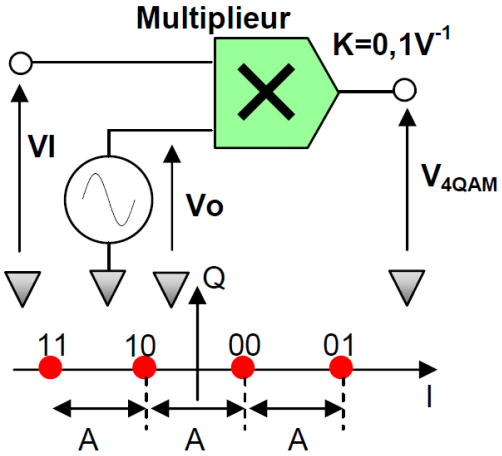
Tutorial n°4
Bandpass modulation and demodulation

Exercise 1: 4-QAM modulator

We consider the 4-QAM modulator where the IQ constellation diagram is shown below.

We give A=0,5V. Moreover, the carrier frequency is f_o=125kHz and the symbol duration is T_s=400µs.



To generate the modulated signal V4QAM we use the modulator scheme of the figure above.

We give $Vo=E_o.\cos(2\pi.f_o.t)$ and E_o=2V.

1- What should we do to make the output independent from Eo and K?

2- In this case, represent the signal VI when the binary sequence to be transmitted is: {01 10 00 11 01 00}. You will give the expressions of the signal levels as functions of Eo, A and K.

3- Assuming that all symbols are equiprobable, what is the RMS value of the V4QAM modulated signal?

Exercise 2: Examples of amplitude demodulators

1. What is the influence of a phase shift (phase error) during synchronous demodulation of the analogue signal $x_{MA}(t) = \cos(w_m t).\cos(w_p t)$?

2. Show that a synchronous demodulator can demodulate an amplitude modulated signal of the form $x_{MA}(t) = [A + m(t)].\cos(w_p t)$, taking into account the value of A and without necessarily knowing the expression of m(t).

3. show that the following phase-delay system can be used to demodulate a single-sideband amplitude-modulated signal $x_{MA}(t) = \cos([w_p + w_m] t)$