COMMUNICATIONS LAB. Experiment #9: Symbol Detector

OBJECTIVES

Experiment on symbol detection logic on binary signals using correlator circuitry.

INFORMATION

A binary antipodal symbol detector that gives the correlation result can be implemented with the model shown in the Figure 1. The $\psi(t)$ signal is a periodically repeating version of the waveform that represents one of the binary symbols. It must be synchronized with the waveform train at the input. The multiplier followed by integrator calculates the correlation between incoming waveform and locally generated one for each symbol period T_b. At the end of the period, the correlation result is sent to the decision circuit so that the binary symbol represented by the received waveform can be determined. Correlator must either start from zero at every T_b period beginning or continuously output the correlation of the two waveforms for the last T_b interval. For antipodal rectangular pulses repesenting binary symbols 0 and 1, the multiplier is not necessary since multiplication with a constant does not affect the decision as the decision threshold is 0 (zero).

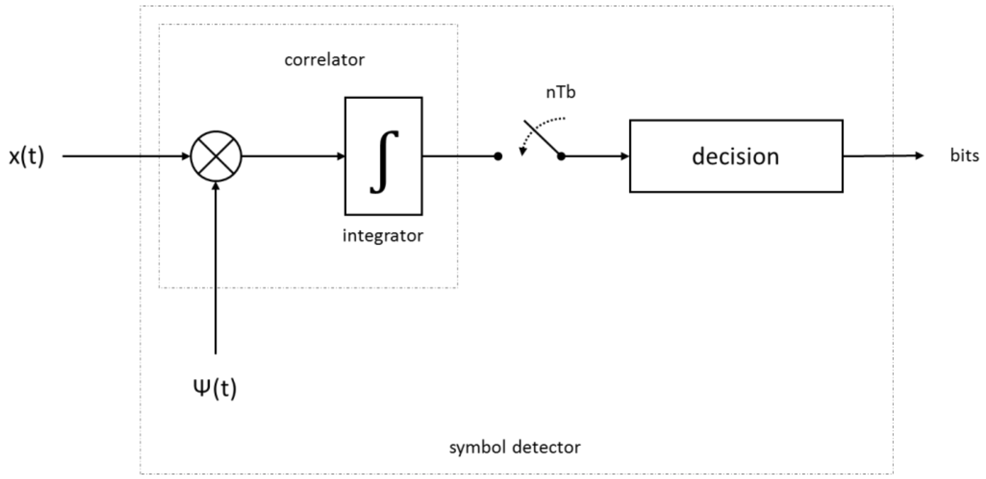

Figure 1 : Symbol detector that uses a correlator

Example input for rectangular pulses case and the resulting correlator outputs for noisy and noiseless cases are shown in Figure 2.

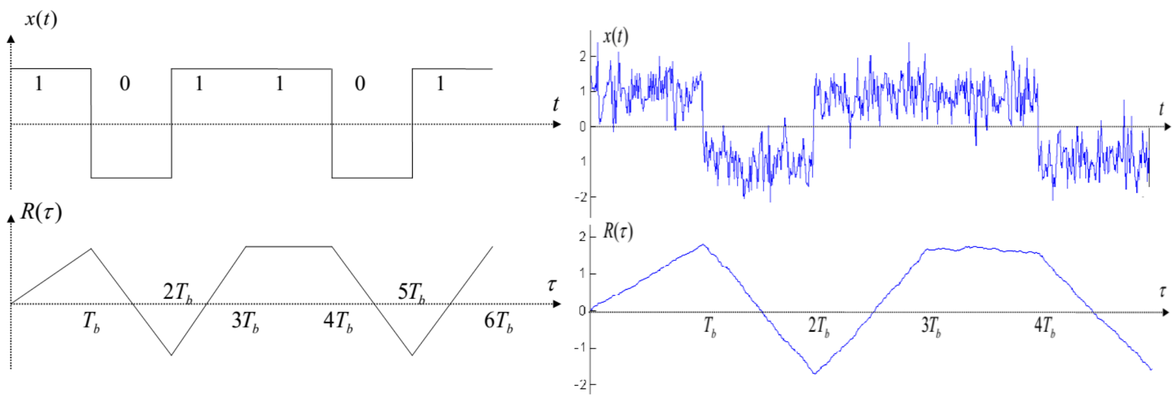

Figure 2 : Output of $[0,T_b]$ *correlator for example noisless and noisy inputs*

EXPERIMENT

a) Consider the bitstream $r(n)$=[0 1 1 0 0 1 1 1 0 1 1 0 0 0 0 1 0 1 1 1]. Assume that the system uses rectangular antipodal (+1, -1) waveforms for each bit where -for digitization purposes- each waveform consists of 100 samples. Find the waveform stream $x(t)$ corresponding to the bitstream (total of 20x100=2000 samples) and plot the result.

b) Write an Octave(MATLAB) code that calculate $R(t) = \sum_{\tau=t}^{t+T_b-1} x(\tau + t)\psi(\tau)$ where T_b=100. Plot your -numerically calculated- integration results. You may need to append zeros to vectors in order to complete the calculation. $\psi(t)$ is one of the representative rectangular pulses and constant for this example. Note that this is a sliding-window summation.

c) Show decision points on the graphic that you've obtained in part **b**.

d) Generate normal distributed random numbers with μ=0(mean), σ^2=0.25(variance) to represent noise {be cautious to make your noise data same length with your waveform data} then add this noise to your signal generated at part **a**, then repeat the part **b.** Change parameters of the noise and observe the results.

e) Compare the results of part **b** and **d**, comment on your findings.

f) Try to retrieve your bitstream $\hat{r}(n)$ on decision points that you obtained in **c** (noiseless) and **d** (noisy).

g) Adjust (increase) the noise variance in **d** so that at least 2 of the detected bits are erroneous. At this point calculate E_b/N_0. Does this conform to the waterfall graph for binary antipodal case that you will find from the Internet? Explain the discrepancies, if there are any.

h) How would inaccurate decision points affect the detection results? Explain in your report.