Communication Basics
Lap Report 2
Receiver Simulink Study

Performed by:
Aidyn Ardabek
a.ardabek@jacobs-university.de

Instructor:
Mathias Bode
m.bode@jacobs-university.de

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Lab Write Up:

- *Explain briefly how the receiver works. Also, please highlight anything that was new that you didn't know before*

Usually first, antenna captures the radio waves. RF amplifier amplifies the very weak signal from the antenna so that the signal can be processed. In our case, we don't need these steps. In our simulation received signal is multiplied by sinusoidal function and proceeded through the low-pass filter to get the pulse shape of the initial message. After, sampler gets values of the signal every period. Finally, decision block returns digital signal.
Also, in our simulation, we used PLL to synchronize the signals. Answer to the question 3 says how it is done in our simulation.

Explain how we can get a RC response by using root filters at the transmit and receive. Explain why this is preferable to using just a single (non root) RC filter somewhere.

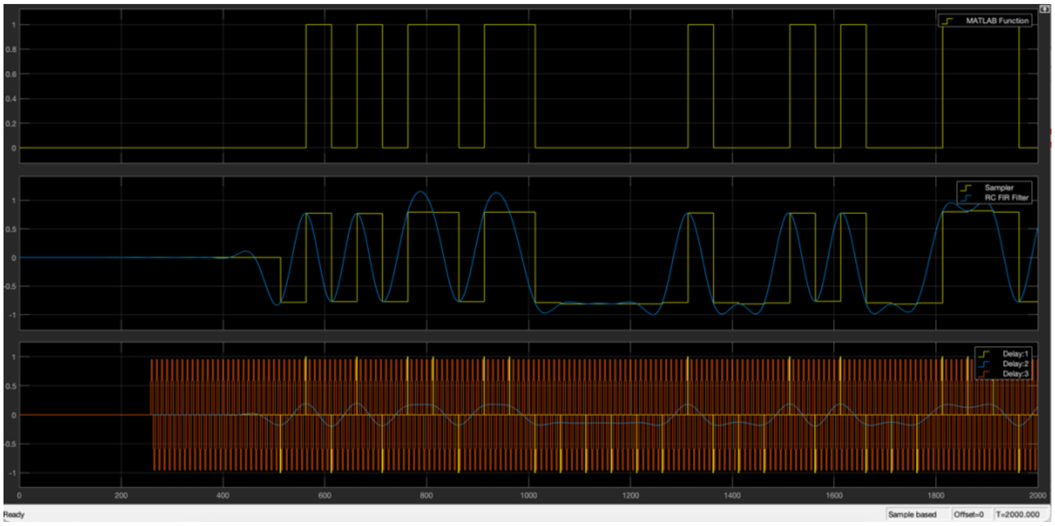
To get the raised cosine response and zero ISI property, we use a root raised cosine filter at the transmitter and receiver. "Root" means that we take the square root of the RC response in the frequency domain. So, cascading two Root RC filters results in an RC shape. The problem with RRC filters is that the time response is much longer than the RC filters. However, a real system would compensate it by using 1/10 of the rate for the baseband processing.

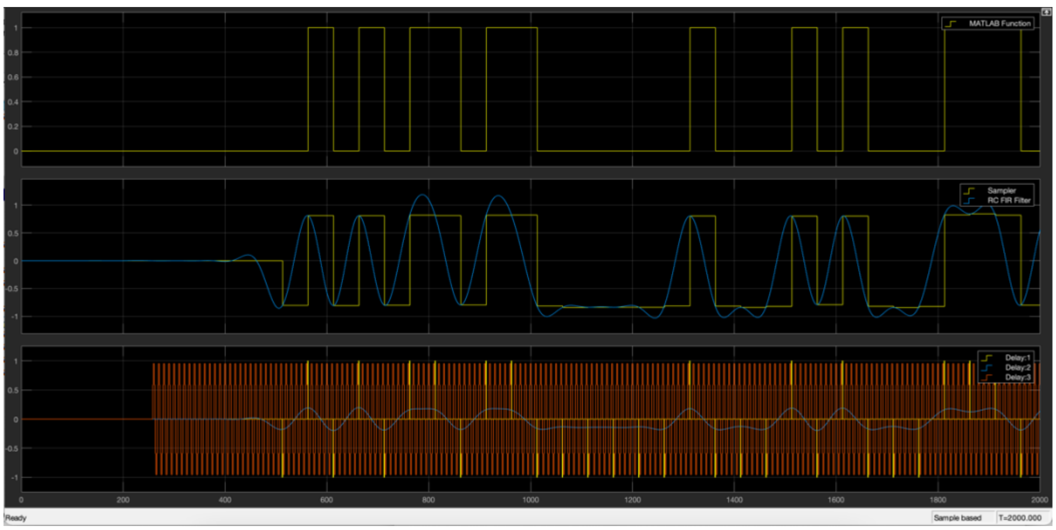
- *Explain the need for synchronization in communications systems, and how this was accomplished in this lab. Also describe what a PLL is and what it can do. What are carrier and symbol timing recovery for?*

The receiver must figure out when to sample the channel in order to recover the symbols correctly. The delay from the transmitter to the receiver is an unknown amount of time. Therefore, the receiver must be able to synchronize itself based on information found only in the signal. In other words, the synchronization is the process by which a receiver node determines the correct instants of time at which to sample the incoming signal.
In our lab, it is achieved by using PLL – a phase locked loop. It is a control system that generates an output whose phase is related to the phase of an input signal.
In real life, two carriers at transmit and receive will not be identical. Usually, the offset can be 10s to 100s of KHz, which leads to a significant error. Therefore, we use carrier recovery circuits. It is a circuit used to estimate and compensate for frequency and phase differences between a received signal's carrier wave and receiver's local oscillator for the purpose of coherent demodulation. In our lab, it is achieved by using phase-locked loop (PLL).
Also, in real life situation, we do not know how much delay in our system, so we can not sample at exactly the right times. Therefore, we use symbol timing recovery. In our lab, optimal sample points are obtained by locking a PLL to the rising and falling edges of the waveforms.

- *Give plots showing the output of your communications system for two cases: (i) with perfect ideal synchronization, and (ii) with the synchronization blocks. Circle and label points in the printout to "prove" to the TA that it is working.*

The first picture below is output with perfect ideal synchronization and the second one is with PLL, which serves as a synchronization block.
As we can see, the output is almost identical, meaning that out synchronization blocks worked as we wanted.





- Describe any difficulties you experienced in getting your design to work and how you fixed these problems.

My MATLAB 2020 does not have a “decision” block. I had to use “function” block and write the code on my own. Luckily, the code is given in the lab manual.