Bit Error Rate Determination in LPF Rectangular PAM

ECE 4513
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February 22,2017

Abstract:
The performance of a digital system with additive white Gaussian noise (AWGN) can be studied by the measurement of the bit error rate or the BER. Simulink model Fig210,which is used for this lab, is a rectangular polar pulse amplitude modulation (PAM) system with a AWGN channel. This figure has a sample and hold receiver with a low pass filter.

Introduction:
In this lab the parameters of the Random Integer Generator block data source and the rectangular PAM transmitter is at a rate of Rb b/sec, where rb is given to use in a data sheet. For this lab we are assigned a random amplitude and a random bit time and a LPF based on our last name. The given values for this lab were as followed A = 12 V, Tb = 150uSec and a low pass filter of Bessel based on the first letter of our last name.
The first step was create a analog filter and find the plot of voltage magnitude response of LPF versus an appropriate frequency range.Next this filter is added to the block diagram replacing the previous filter in the diagram. Next an appropriate simulation step time Ts is chosen and used for the Data Rate Translation blocks,pulse generator block as the control voltage and bandwidth for the LPF.
For the pulse generator block the period,pulse width, and phase delay must be integer multiple of Ts.
Next the bandwidth of the LPF with 3-9 poles can be approximately 1.2 * Tb for baseband rectangular PAM signal.Once the entire system is configured properly the total simulation stop time will be 10^4 * Tb.
Our task was to first sample the signal at .5Tb at variation of 0,2,6, 10 and the data is recorded in a table. Next the signal is sampled at Ts,5Ts, and 10Ts repeating the variatio change of 0,2,6,10, all the data is recorded and saved.
Discussion:
In this lab the first step was to create a low pass filter with bandwidth of 1.2 * Tb. Since Tb is equal to 150uSec the bandwidth found was 5.5 kHz. The filter had 6 poles and the bode plot is shown in figure 1 below.

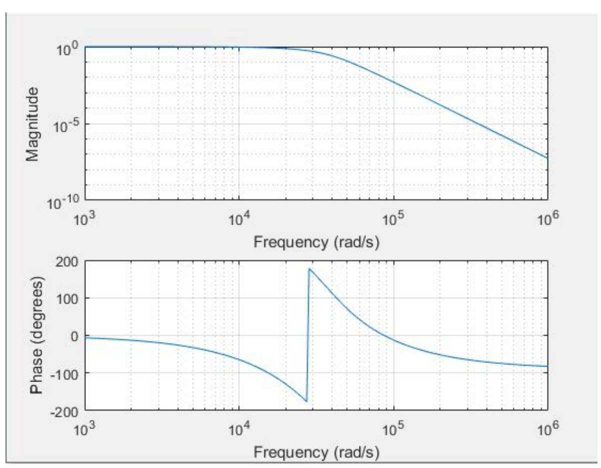

Figure 1: The figure above shows the bode plot of the filter created. The filter has 5 poles and a bandwidth of 5.5kHz

The next step is to choose a appropriate simulation step time Ts. In this case using the Ts is found using the simulink example model of 1kb/sec which used a step time of Ts. Using this ration the simulation time was chosen to be 2 uSec. The pulse period,width, and phase delay all are integer multiples of Ts if they are not the block diagram would have a error occur.

Ts	3 usec
Fs	333.333 Khz
Tb	150usec
Rb	6666
Pulse period	150 uSec
Pulse Width	22.5% =27uSec
Delay	66uSec
Bandwidth = 1.2 * (1/rb) =.000180018 = x	
1/x = 5555	

Figure 2: Table shows the values used for the pulse,LPF and step time.

The next step was to find the BER of the system based on different variances and Ts. The table below shows the list of values found for the BER and their corresponding variances and Ts.

Ts = 2uSec		BER	Variance
.5Ts		0.1187	10
		0.1188	6
		0.1195	2
		0.1196	0
Ts		0.1247	10
		0.1236	6
		0.1244	2
		0.1325	0

5*Ts		0.1297	10
		0.1284	6
		0.1282	2
		0.1194	0
10*Ts (Gave errors)		0	10
		0	6
		0	2
		0	0

Figure 3: The table above shows the BER values found when changing the variance and Ts

When finding the BER of 10*Ts an error was received that stated the value was now a integer multiple of the step time. In order to fix this problem the Tb was changed to 160 uSec and the parameters of the pulse were changed based on the new Ts.

Conclusions:

For this lab the modification of figure 210 was needed in order to create the system needed to find the BER for. When choosing the appropriate Ts the equation 22*Ts=Tb/2 was used which gave us a value of 2uSec. When trying to change the Ts to 10 * Ts the block diagram would give a error stating the the values must be integer multiples of the step time, In order to correct this the Tb was changed in order to properly find the BER. With the change in Tb the BER decreased dramatically to zero which was opposite of what was expected. Throughout the lab the BER would stay around .12 but with the change in Tb the BER decrease to almost zero.

Appendix:

```
[b,a]=besself(5,2*pi*5555);
freqs(b,a)
```

Figure 4: The code above is used to find the bode plot of our filter.