EC 415 Software Radios
3/2/21
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Lab 3

1) Noise is usually an additive signal, therefore it is more likely that sufficient noise will be present to push a ‘0’ signal up to a ‘1’ signal than the opposite. Since our input signal is ‘11010’ we suspect the highest BER would be 40%, the two ‘0’s flipping to ‘1’ out of the 5 total bits.

2) Here is our table:

Noise Voltage	Bit Error Rate (BER) %
0.0	0
0.15	4.8
0.3	9.3
0.6	25.3
1.0	37.1
1.5	40
2.0	40

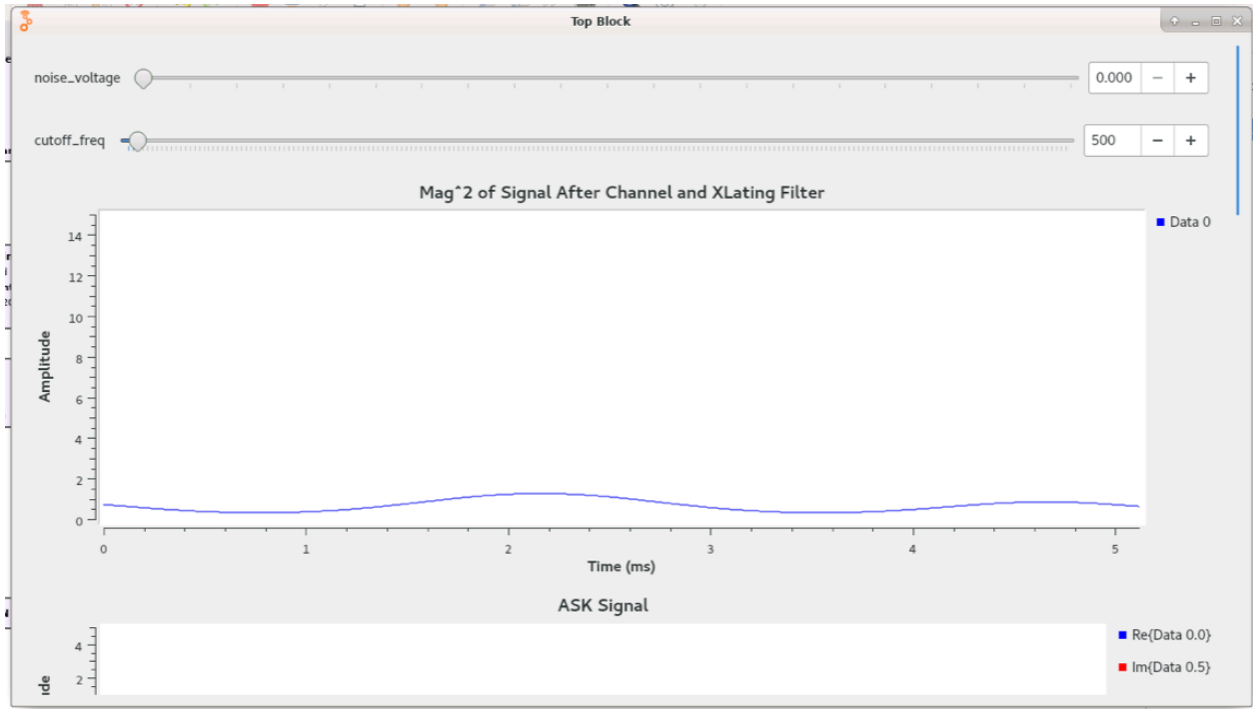
3) Converting SNR from voltage to dB is done using 20 ∗ log10(Vsignal/Vnoise)

From our results, it seems like a noise voltage of 0.3 (probably closer to 0.33) would result in about 10% BER, so using Vsignal = 0.5 and Vnoise = 0.33 we get the equation:

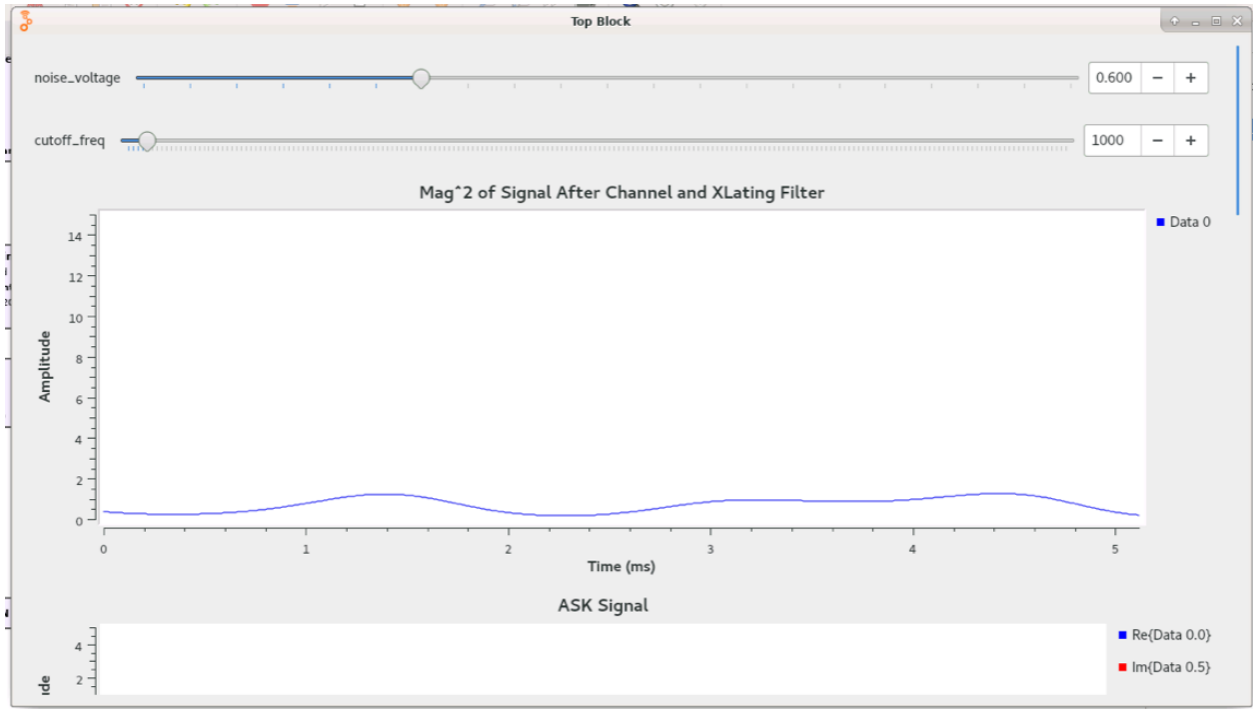
$$20 * log_{10}(0.5/0.33) = 3.6$$

So an SNR of 3.6 would result in 10% BER

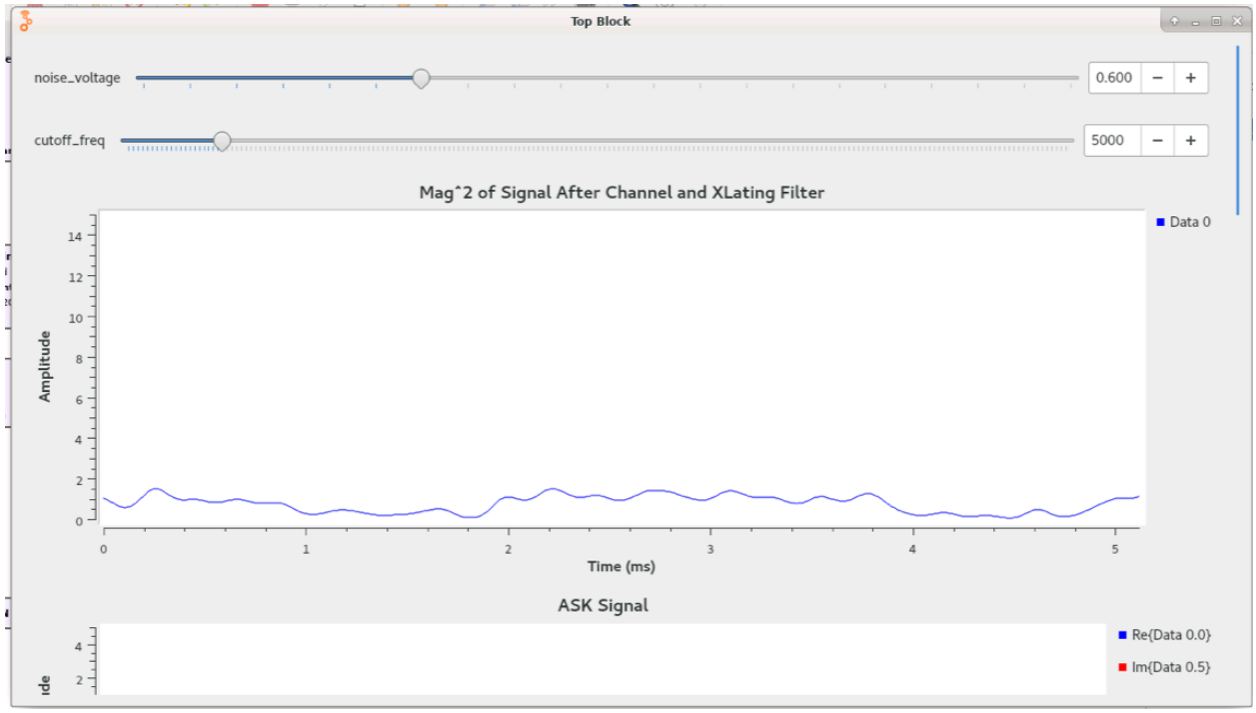
4) When the cutoff frequency for the low pass filter is set too low, the square wave is flattened into a sine wave.



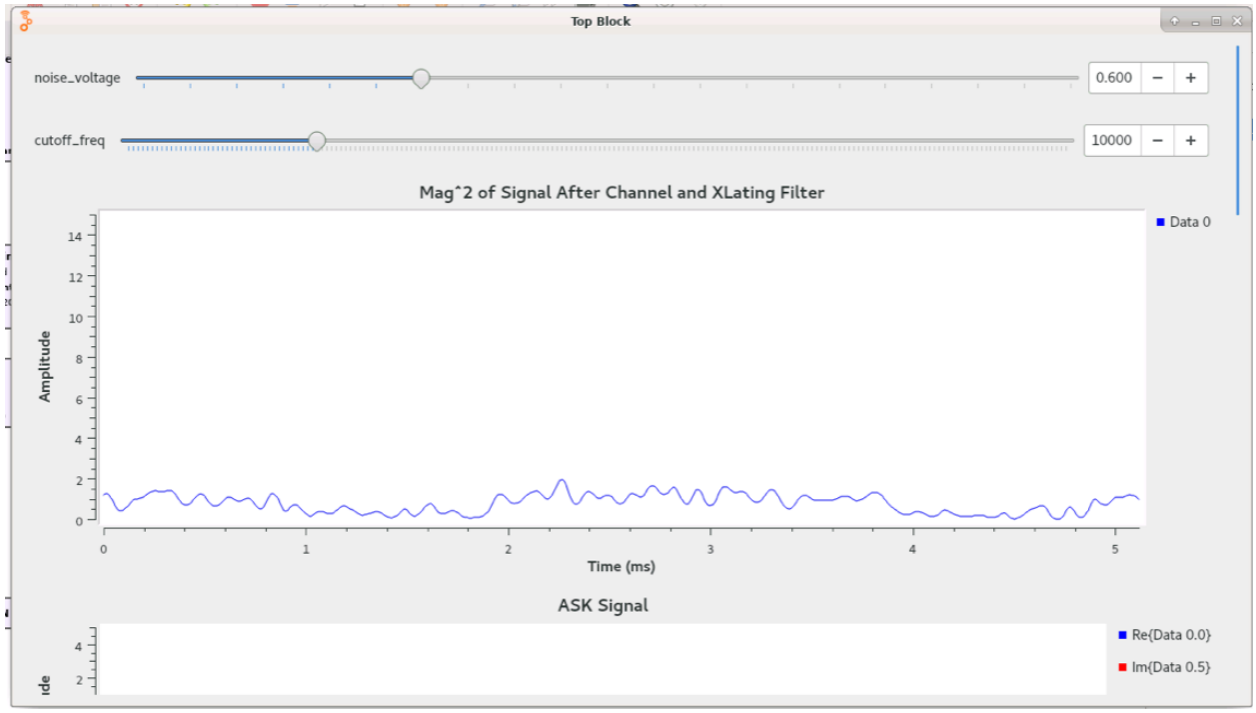
5) When the cuttoff frequency is 1kHz, the BER is 60%



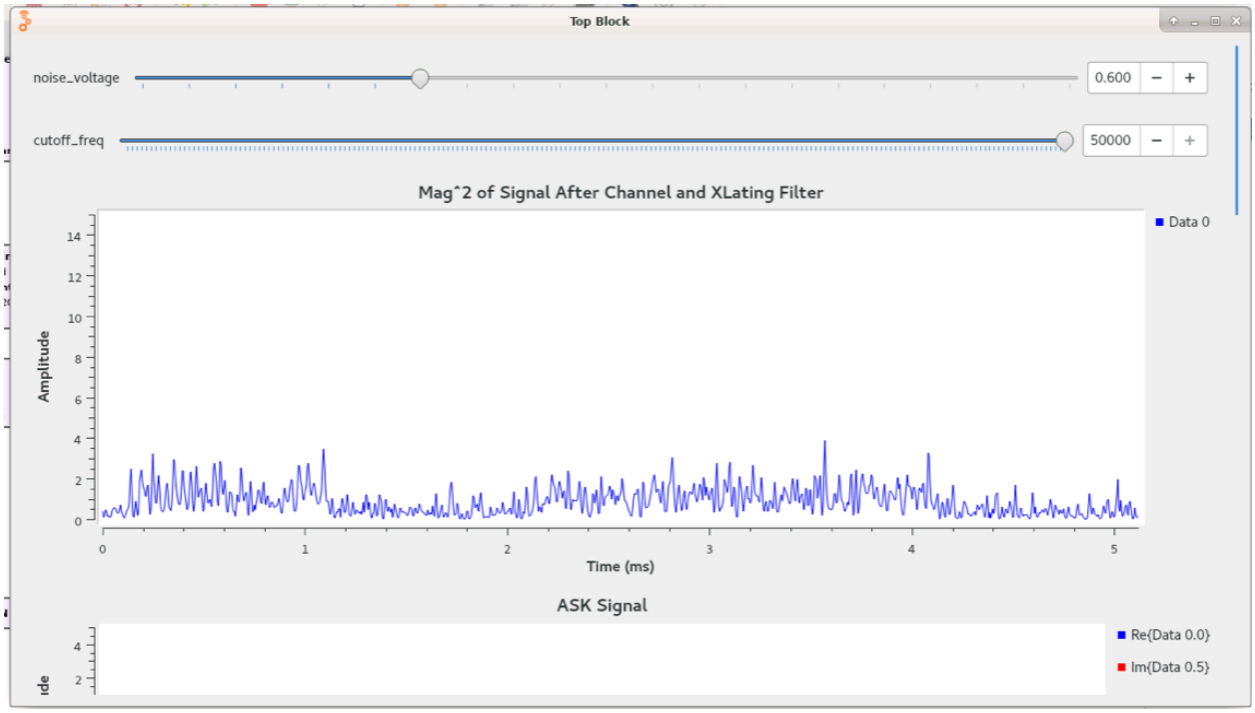
When the cutoff frequency is 5kHz, the BER is 5%



When the cutoff frequency is 10kHz, the BER is 0.7%

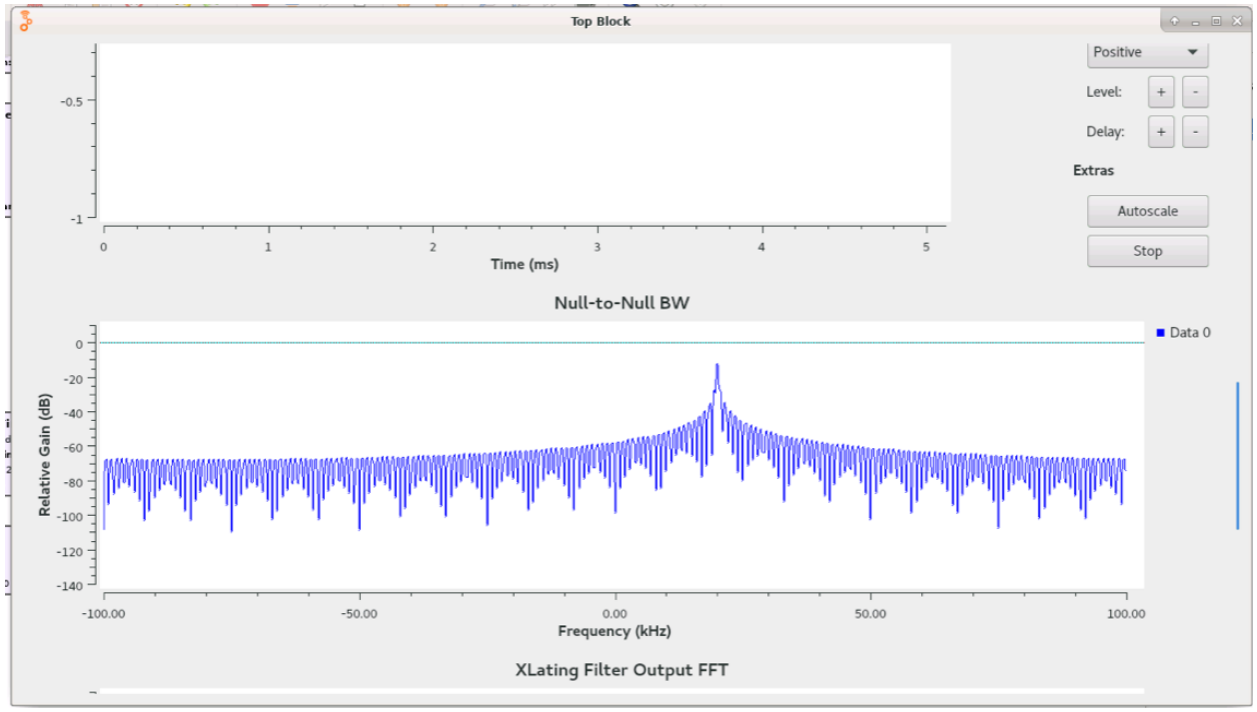


When the cutoff frequency is 50kHz, the BER is 12.7%



The pattern we're seeing in the BER is due to the fact that the baseband frequency is 20kHz. When the high pass filter is set to anything below 20kHz (first 3 plots) the BER gets increasingly better as we approach 20k since more and more low frequency noise is removed. When the cutoff frequency is set to above 20k though, the BER starts increasing since some of the useful frequencies/signal is filtered out, resulting in error.

6) The null-to-null bandwidth of this signal is about 20kHz (below). This also happens to be the ideal cutoff frequency for the lowpass filter to optimize the output signal BER.



This is because the modulated signal has a frequency of 20kHz. This can be confirmed by looking at the signal period of the zoomed in image of the modulated signal below.