564 Digital Signal Processing

Computing Assignment

Module 2

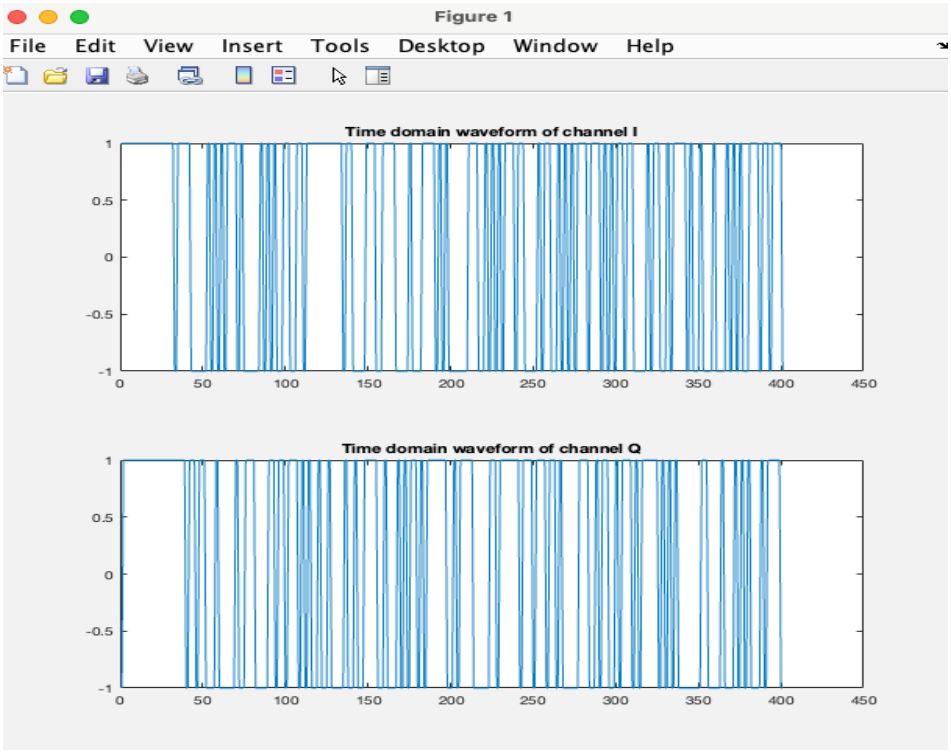
Hao Che Tsai

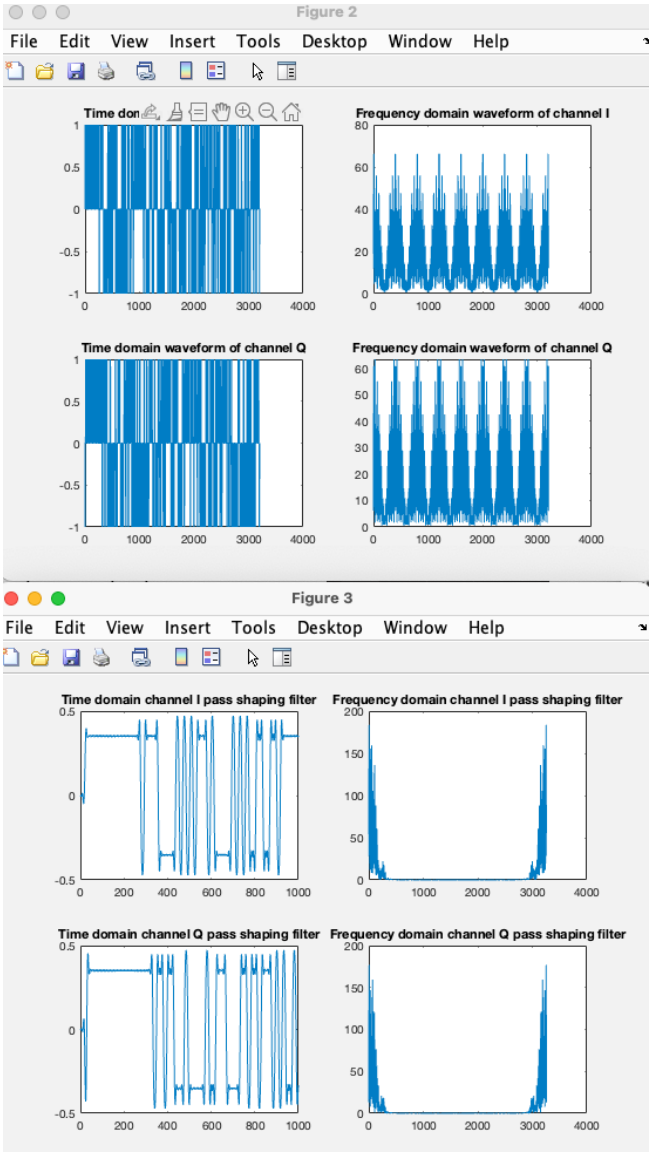
934412754

Introduction & Goal:

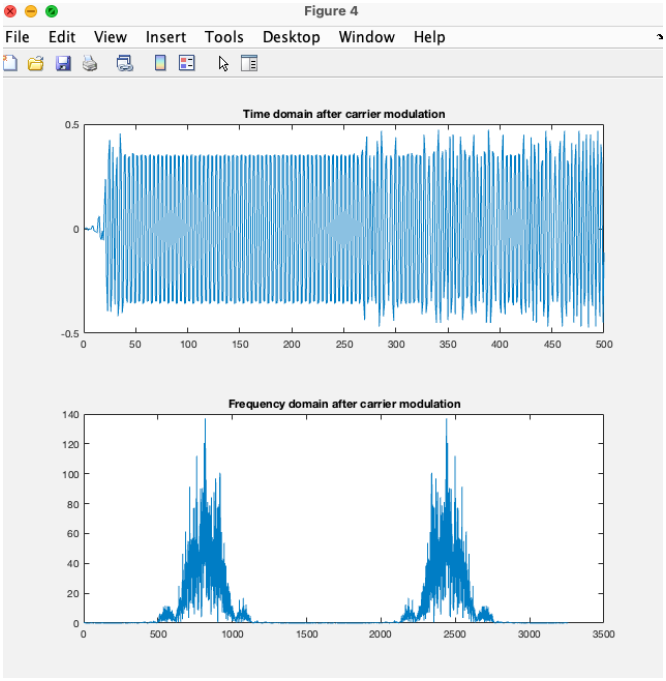
In this module I'm going to implement a receiver which include a FIR bandpass filter, up-sampler, channel divider, lowpass filter, and down-sampler. The reason that we need a FIR bandpass filter is due to after the transmitter generate the QPSK signal, it will carry some white gaussian noise with it, so the bandpass filter will help us to eliminate the extra noise that we set for it and rest part of the signal will let us to recover it easier. Next, the up-sampler will make the symbol rate become 8 times larger than original signal, since we want to make the lower complexity for the lowpass filter in the next stage and avoid aliasing, hence that is the reason we up-sample the signal first. Then we separate the signal into I channel and Q channel by multiply it with a cosine wave and sine wave respectively. After we got the signal for both I channel and Q channel, we let both pass through a lowpass filter, the purpose of this lowpass filter is that this will help us to recover the I channel and Q channel signal. Last, we down-sample 2 times first before we start to implement the rest part of this receiver. By implementing this portion of receiver, I would like to see the result after the signal pass through the bandpass filter and lowpass filter will be reasonable. Since if there are some mistakes happen in this stage of receiver, it would lead to more problem for the rest part of my receiver, eventually, I might not get back the original signal I input to the transmitter.

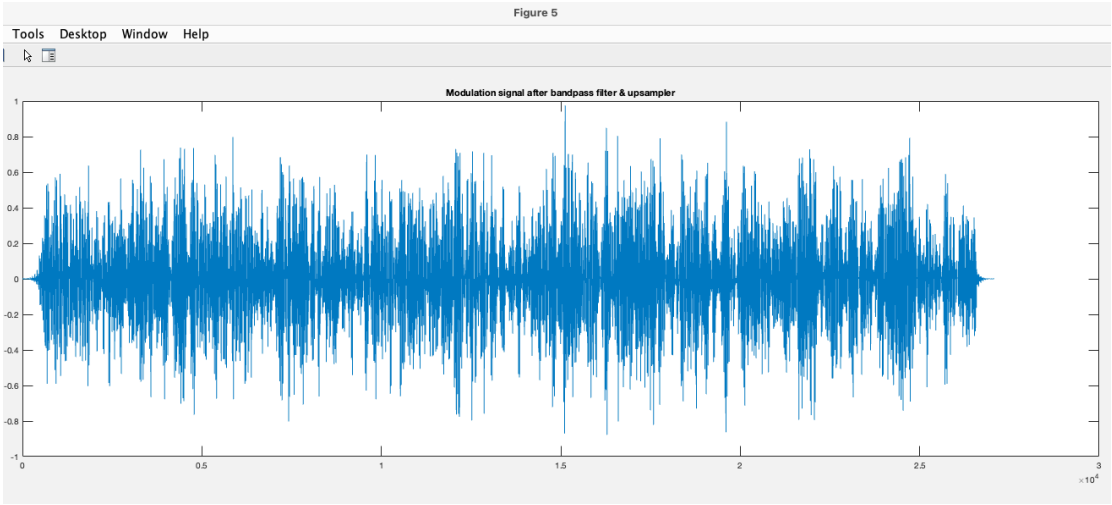
Results:





From figure 1 to figure 3 are the outcome of each stage in the transmitter, which includes the I channel and Q channel signal after the bipolar converter, the waveform of I channel and Q channel in both time domain and frequency domain, and what both signal look like after passing a reshaping filter before they sent into the carrier modulation process.





In figure 4 it tells us that what does the QPSK signal looks like after the modulation process and transition, and it would help us know what the original signal would look like before the noise add into it. Figure 5 is the signal that pass through the bandpass filter and up-sampler I implement into this receiver, we can see that the component of this signal had been eliminated the influence of the white gaussian noise by the filter and 8 times larger than the origin signal due to the up-sampler.

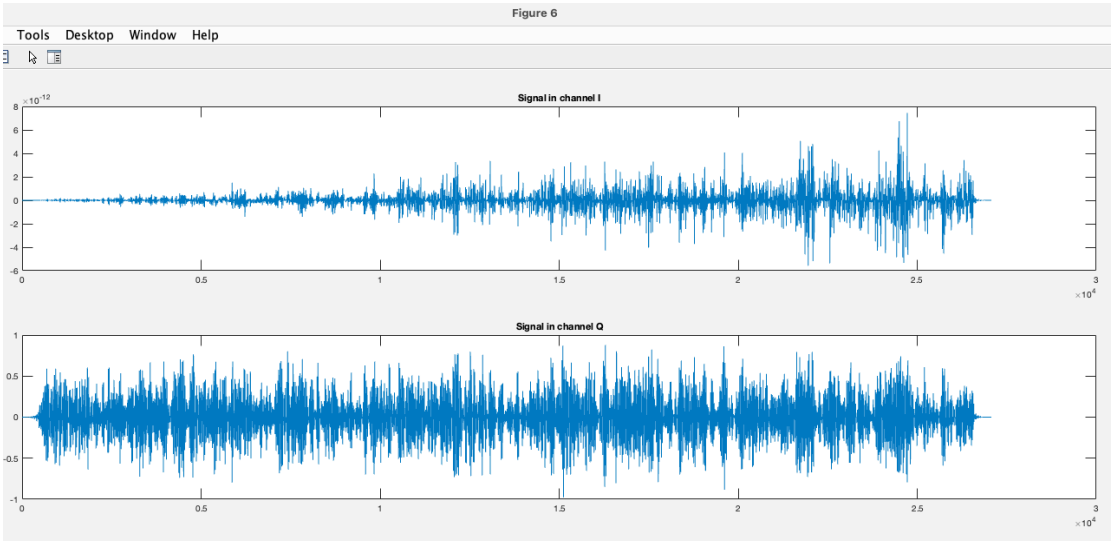


Figure 6
Tools Desktop Window Help
Signal in channel I
Signal in channel Q

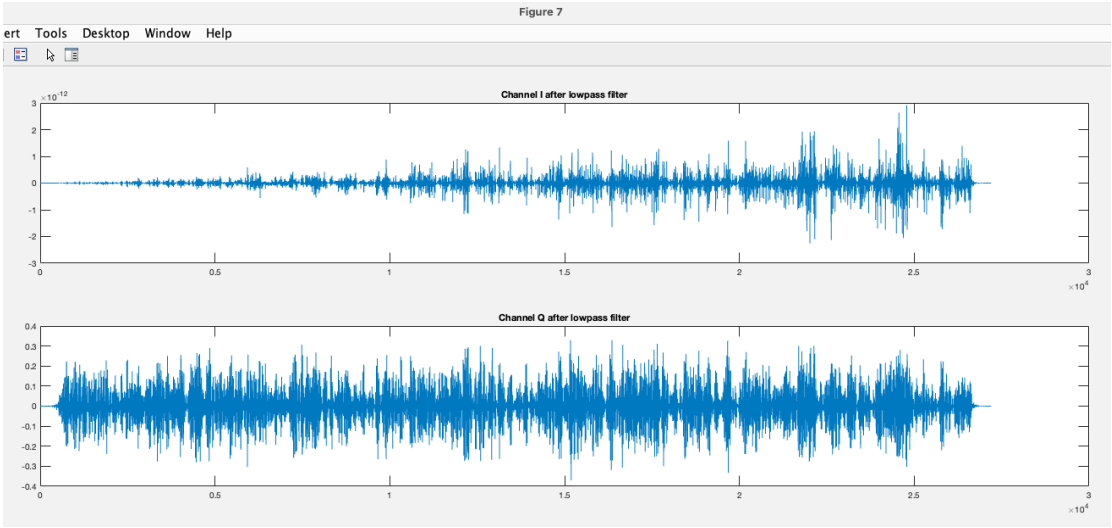


Figure 7
ert Tools Desktop Window Help
Channel I after lowpass filter
Channel Q after lowpass filter

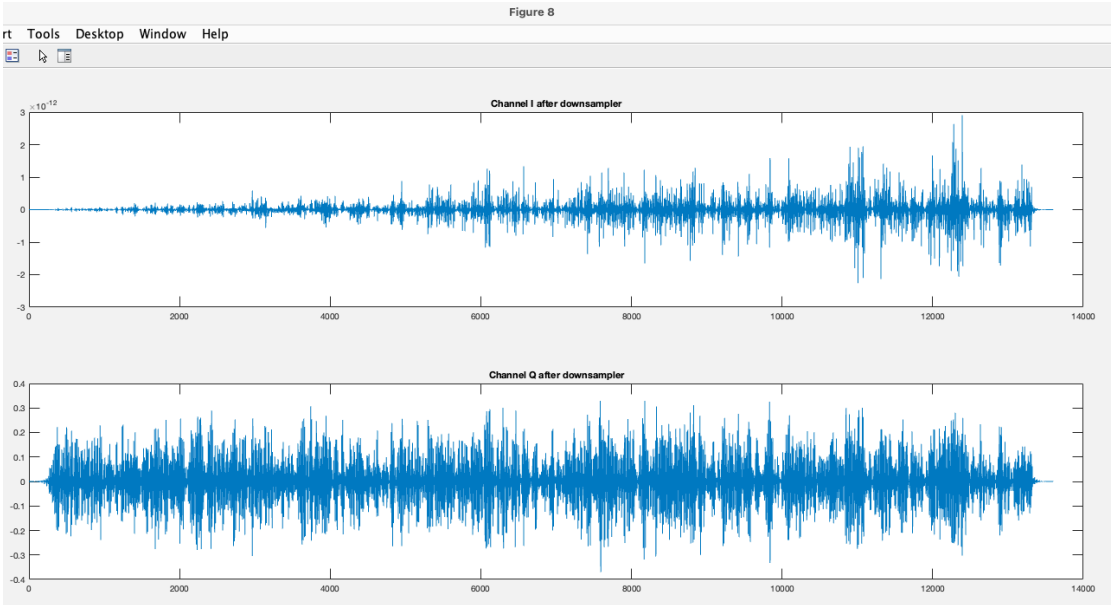


Figure 8
rt Tools Desktop Window Help
Channel I after downsampler
Channel Q after downsampler

For figure 6 to figure 8, it tells me that what is the outcome of each stage in the receiver that I design. The result of the separated the signal into I channel and Q channel shows in figure 6. Next, the result of both signals pass through the lowpass filter shows in figure 7, and the last figure it makes sure that after 2 times of down-sampling, the size of the signal has been smaller for the rest part of the receiver.

Summary:

After implementing this part of receiver, although I cannot know the outcome of the signal has been recovered perfectly or not by this point. I think the result I have for each stage in the receiver does make sense and they are all reasonable for what I learn from the research. Also by doing this project, it gave me the chance to understand how the whole QPSK works and how to implement the transmitter and receiver step by step. Furthermore, I was not so sure what each filter works in this QPSK system in the first place, but after building this receiver and making research of the purpose of each component in this implementation, I believe that I had learn some important knowledge about the signal processing and what it would cause if the system was not well design.