ECE 4705 Lab
Experiment 10 – BPSK Modulation
Julio Ortiz Guzman
ECE4705L_03

ECE 4705L **EXPERIMENT 10**

BPSK MODULATION[1]

OBJECTIVE

To investigate the properties of Phase Shift Keyed (PSK) waveforms using common communications laboratory equipment.

EQUIPMENT

Modulating Function Generator, Oscilloscope, Spectrum Analyzer.

PRE-LAB

Investigate (online, and/or in your class textbook) about PSK (and BPSK, in particular), regarding its generation, and its time and frequency domain characteristics. Write up a 1-2 page summary using equations, and theory plots in time and frequency domains, block diagrams, etc.

LAB

Using the DGxxxx Digital Generator create a Binary Phase Shift Keyed signal and investigate the time and frequency characteristics of that waveform.

- Set up a sinusoidal carrier to 500khz
- Push the 'Mod' button and choose type 'PSK'
- (1) choose a 50khz squarewave data modulation and capture time and frequency domains on the oscilloscope and spectrum analyzer, respectively, (2) repeat for a 10khz squarewave data modulation.

In your report, make sure to note how the spectrum spreads out with increasing modulated data rate. Discuss CDMA and spread-spectrum technologies like GPS.

[1] Based on a lab from Professor Richard Cockrum

LAB RESULTS AND DISCUSSION

1) BPSK Signal with 500kHz Sinusoidal Carrier and 50kHz Squarewave Data Modulation
    a. Time Domain

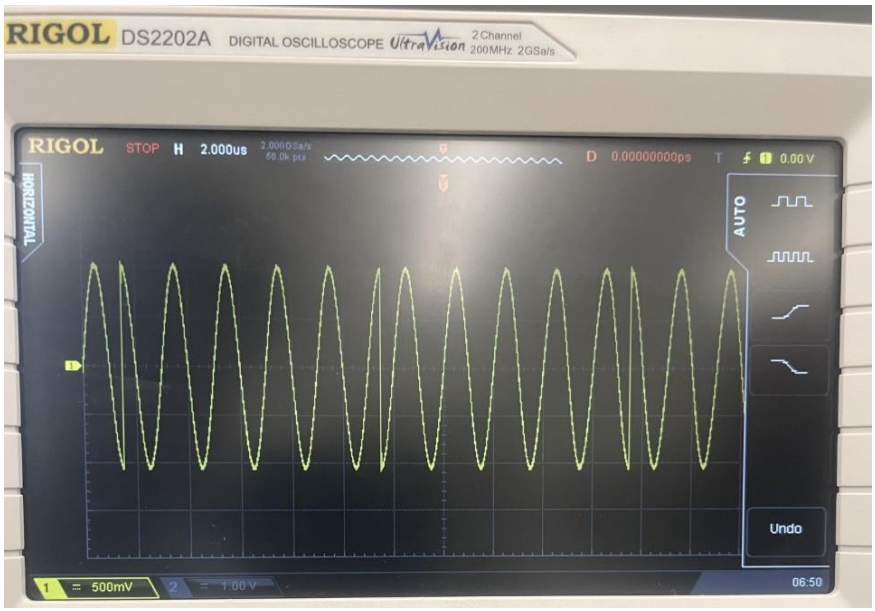

Fig. 1 – BPSK Signal with 50kHz Data Modulation Rate in Time Domain

From the image of the modulated signal in the time domain, the phase shift of the signal can be seen occuring every time the signal is inverted. Three phase reversals occur with a data modulation rate of 50 kHz.

    b. Frequency Domain

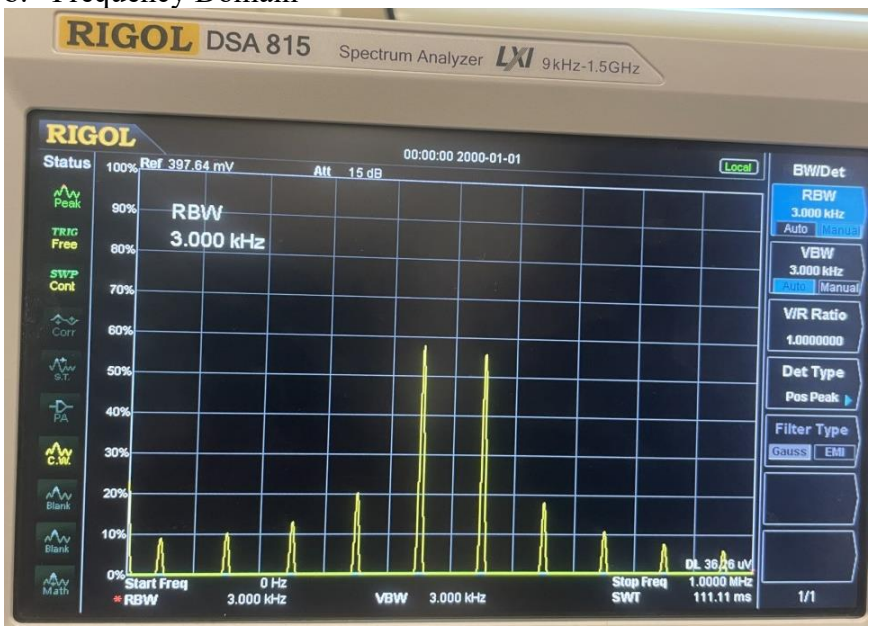

Fig. 2 – Frequency Spectrum for BPSK Signal with 50kHz Data Modulation Rate

From the image of the modulated signal in the frequency domain we can see that, for a 500kHz sinusoidal carrier and a 50kHz squarewave, the spectrum of the signal is centered at 500kHz with amplitude spikes every 50kHz in both directions.

2) BPSK Signal with 500kHz Sinusoidal Carrier and 10kHz Squarewave Data Modulation

a. Time Domain

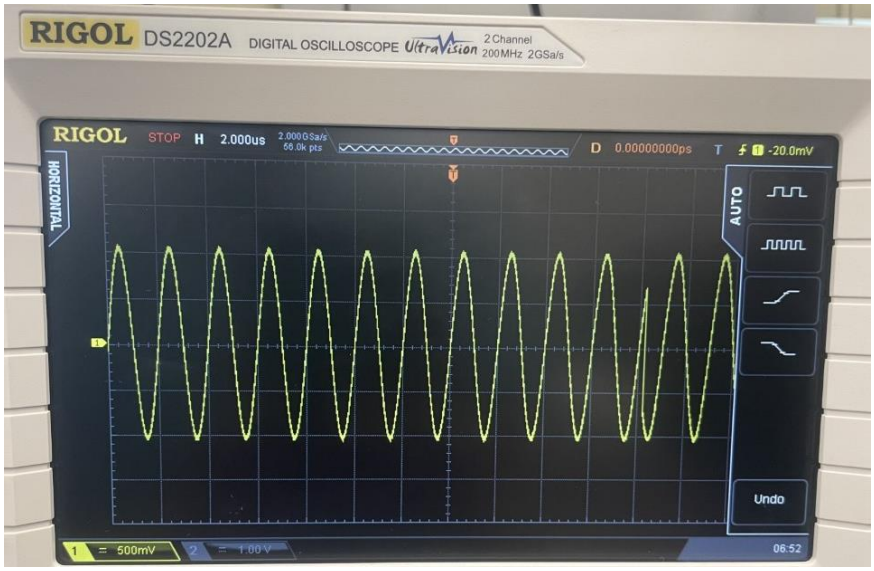

Fig. 3 – BPSK Signal with 10kHz Data Modulation Rate in Time Domain

For a data modulation rate of 10kHz, the time domain signal undergoes less phase reversals than with a 50kHz modulation rate in the same amount of time.

b. Frequency Domain

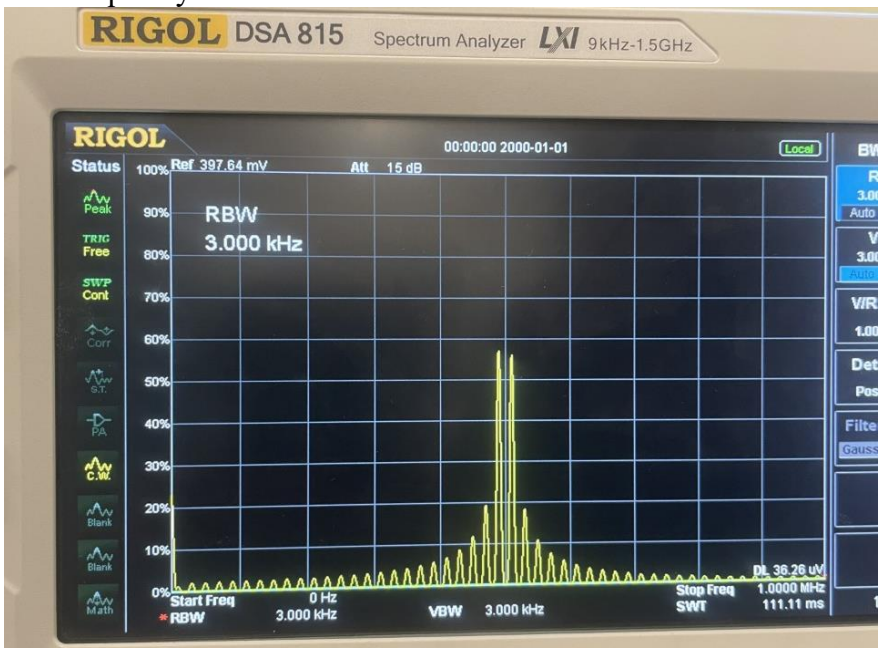

Fig. 4 – Frequency Spectrum for BPSK Signal with 10kHz Data Modulation Rate

As you can see from Fig. 4, by utilizing a smaller data modulation rate the spectrum of the modulated signal remains centered at the carrier frequency but with amplitude spikes spread far closer together across the same span.

Conclusion

Through utilizing the in-class Digital Generator, we were able to create two distinct BPSK modulated signals. Both signals were generated with a 500kHz sinusoidal carrier, however, one signal was data modulated with a squarewave of 50kHz and the other with a 10kHz squarewave. From measuring the spectrum of each signal, we found that the larger the data modulation rate applied to a carrier signal, the further apart the amplitude spikes in the spectrum become. This type of modulation is utilized in what is called Code Division Multiple Access (CDMA). CDMA is a type of modulation that falls under Direct Sequence Spread Spectrum. In CDMA, the entire frequency spread is modulated with data with the key being to be able to extract the desired signal from the spectrum while rejecting the rest as random noise. To transmit a signal using CDMA, a psuedo-code is generated for each channel and established connection, which is data modulated with the information being sent. That signal is then modulated with a carrier which is then amplified and transmitted to a specific receiver. GPS satellites employ a technique combining CDMA and BPSK where multiple satellites are assigned their own unique pseudo-code that is BPSK data modulated before being transmitted, allowing for specific signals to be detected by CDMA.