Text

Description automatically generated with medium confidenceDigital Communication Systems

**Laboratory Report**

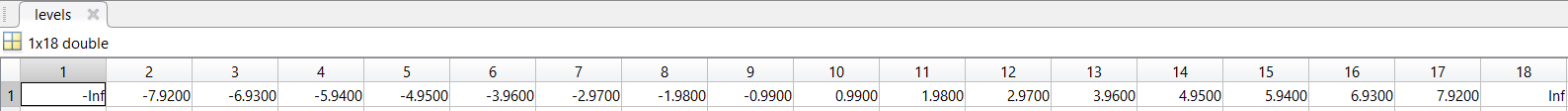
Fall 2021

|  |  |
| --- | --- |
| Laboratory Number: | **06** |
| Laboratory Title: | **Passband Transmission and Detection Pt. 2** |
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| TUID: | **915614617** |

**Description:**

This lab continues Passband Transmission and Detection techniques by examining 16ASK in comparison to 4ASK. Passband modulation extends from baseband modulation, however in passband modulation, the wave spectrum uses a carrier frequency to be transmitted at a higher frequency represented by,

The 16ASK is used to transmit my TUID as a sinusoid, as well as be compared with the 4ASK when noise is added to the modulated signal. By affecting the signal to noise ratio (SNR), I will compare the difference between the outputted demodulated signal error when using a 4ASK versus a 16ASK. Finally, I will perform a power spectrum analysis of the baseband, carrier, modulated (passband), and received (noisy modulated) signals, where the baseband should be the Fourier transform of the original sinusoid, the carrier should modulate at the sampling frequency , and the received signal should retain the transmitted passband signal but with added noise.

**Images:**

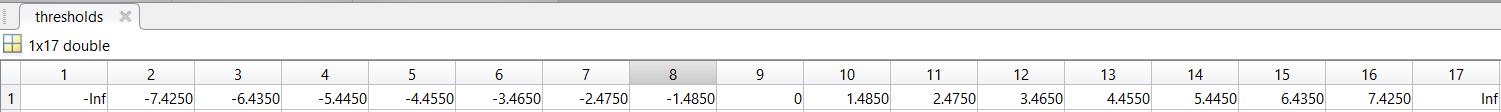
Figure 1. Finding Levels of 16ASK

Figure 2. Finding Thresholds of 16ASK

Chart

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Figure . TUID as a sinusoid

A screenshot of a computer

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Figure . Baseband Signal with peak=Fourier Transform

Graphical user interface

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Figure . Carrier Frequency with Peak=fs

A screenshot of a computer

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Figure . Modulated Signal

A screenshot of a computer

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Figure . Noisy Modulated Signal is approximately the same as modulated signal

**Numerical Tables:**

Table . 16-ASK table with variable SNR vs Mean Absolute Error

|  |  |
| --- | --- |
| 16-ASK | |
| SNR | Mean Absolute Error |
| 20 | 0 |
| 16 | 0 |
| 8 | 0 |
| 4 | 0 |
| 2 | 0 |
| 0 | 0 |
| -2 | 0 |
| -4 | 0 |
| -8 | 0.023 |
| -16 | 0.357 |
| -20 | 0.549 |

**Compared with last week’s 4ASK table**

Table

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Figure 8. Using Excel to calculate the Percent Difference of 4ASK to 16ASK

**Descriptive Answers to Tasks:**

By using a 16ASK sampled with 1000 random samples, there proves to be more error due to the noise becoming larger than the signal error, with more noise generated using a 16ASK. The percent difference is nearly a 200% increase in error from the 16ASK compared to the 4ASK.

**Code:**

### Section 01

The initial parameters are usually defined at the beginning of the program.

clc; clear;

%tuid 915614617

A = 8; % Signal amplitude

rb = 20; % Fundamental frequency of signal

Tb = 1 / rb; % Period of signal

fc = (20+6) \* rb;

Tc = 1 / fc;

fs = 100 \* fc; % Sampling frequency

Ts = 1 / fs; % Sampling period

### Section 03

#### Amplitude Shift Keying (ASK) in the Passband

Suppose there are 4 symbols in the symbol set. Therefore, at least 4 bits are needed to encode the symbols in binary format.

M = 16; % Number of symbols

Nb = ceil(log2(M)); % Number of bits per symbol

### Section 05

#### ASK Correlator Decoder and Detection

% detection

% finding the unique levels

%levels = [-inf, unique(round(dec\_signal, 2)), inf]

levels = 1×18

-Inf -7.9200 -6.9300 -5.9400 -4.9500 -3.9600 -2.9700 -1.9800 -0.9900 0.9900 1.9800 2.9700 3.9600 4.9500 5.9400 6.9300 7.9200 Inf

levels = [-inf, -7.92, -6.39, -5.94, -4.95, -3.96, -2.97, -1.98, -0.99, 0.99, 1.98, 2.97, 3.96, 4.95, 5.94, 6.93, 7.92, inf];

% finding the thresholds

thresholds = (levels(2:end) + levels(1:end-1))/2;