PartA: DSB-LC Modulation Report

Abdelateef Khaled 202001344
Seif Raslan 202000797

1 Introduction

In this report, we analyze the Double Sideband Large Carrier (DSB-LC) modulation technique using MATLAB simulations. The provided MATLAB code generates two message signals, $m_1(t)$ and $m_2(t)$, modulates them using DSB-LC modulation, and plots the resulting signals for different values of the modulation index K_a.

2 Signal Generation

The message signals $m_1(t)$ and $m_2(t)$ are generated using MATLAB. $m_1(t)$ is a piecewise linear function, while $m_2(t)$ is a step function as described in the provided code. These signals are plotted in Figures 1 and 2 as shown below.

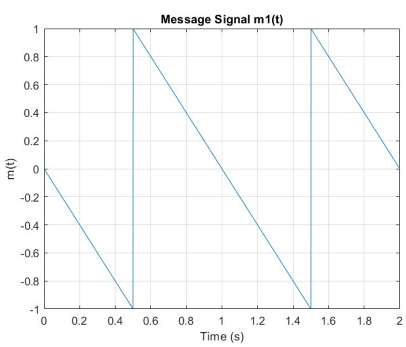

Figure 1: Message Signal $m_1(t)$

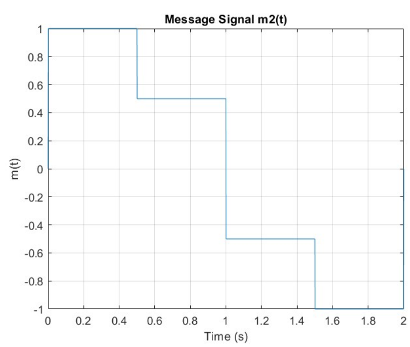

Figure 2: Message Signal $m_2(t)$

3 Modulation

The DSB-LC modulation is performed using the provided MATLAB code with different values of the modulation index K_a. The modulated signals $s_1(t)$ and $s_2(t)$ are plotted for $K_a = 0.5$, $K_a = 1$, and $K_a = 2$. The modulated signal $s(t)$

is generated using a carrier wave of 2 volts amplitude and 10KHz frequency as follows:

$$s(t) = A_c \left[1 + k_a m_i(t)\right] \cos\left(2\pi f_c t\right), \quad for\ i = 1, 2$$

3.1 The Modulated signal $K_a = 0.5$

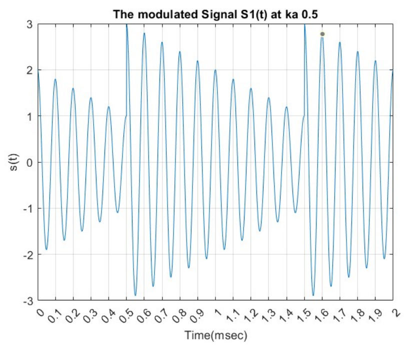

Figure 3: $s_1(t)$ at $K_a = 0.5$

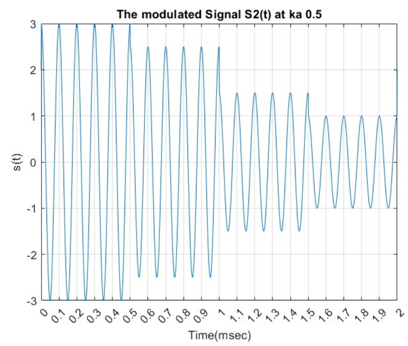

Figure 4: $s_2(t)$ at $K_a = 0.5$

When $K_a = 0.5$, the modulation index, η, is set to $\mathbf{0.5}$.This value of η allows for envelope detection to extract the messages $m_1(t)$ and $m_2(t)$ from the signal. We observe that the messages after modulation are shifted by 2 in amplitude.

3.2 The Modulated signal $K_a = 1$

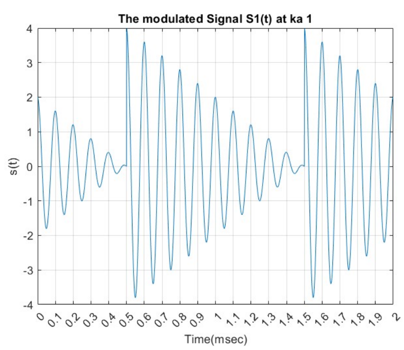

Figure 5: $s_1(t)$ at $K_a = 1$

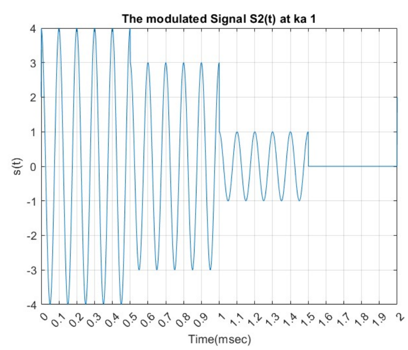

Figure 6: $s_2(t)$ at $K_a = 1$

Increasing K_a to 1 results in a more significant amplitude variation in the modulated signals, increasing to 2 and messages are shifted by 2 in amplitude. The modulated index $\eta = \mathbf{1}$, representing the mid-range modulation index, is the minimum value of η at which envelope detection can successfully recover the messages $m_1(t)$ and $m_2(t)$.

3.3 The Modulated signal $K_a = 2$

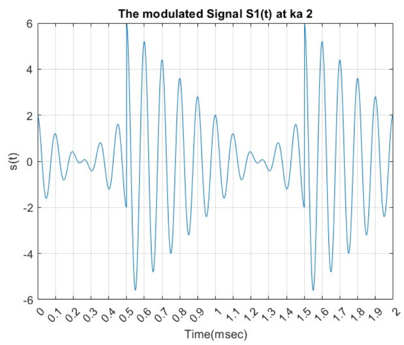

Figure 7: $s_1(t)$ at $K_a = 2$

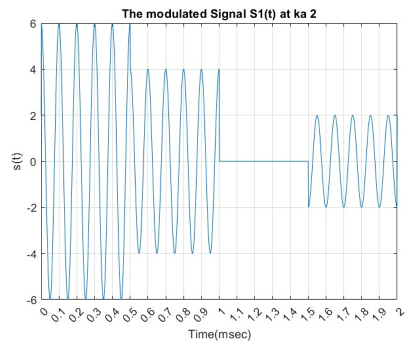

Figure 8: $s_2(t)$ at $K_a = 2$

At $K_a = 2$, the amplitude variation is even more pronounced, increasing to 3, and the messages are shifted by 2 in amplitude. This leads to a higher modulation index of $\eta = \mathbf{2}$. At this value, envelope detection may not reliably return the original messages, as shown in the above figures.

4 Conclusion

The DSB-LC modulation technique was studied through MATLAB simulations. By varying the modulation index, we observed how it affects the amplitude variation in the modulated signals and the effect on performing envelope detection of the messages. We found that when the modulation index is less than or equal to 1, envelope detection can reliably recover the messages from the modulated signals, as shown in sections 3.1 and 3.2. However, when the modulation index exceeds 1, envelope detection may not be able to accurately retrieve the original messages, as shown in section 3.3. This underscores the importance of selecting an appropriate modulation index based on the requirements of the communication system. Overall, the study provides insights into the behavior of DSB-LC modulation and its implications for message transmission and recovery.