

**Faculty of Engineering & Technology Electrical & Computer Engineering Department**

**Communication Lab - ENEE4113**

**Experiment 4: Frequency Modulation**

**Prelab #3**

**Student Name**: Maha Maher Mali

**Student ID**: 1200746

**Instructor**: Dr. Ashraf Al\_Rimawi

**Teacher Assistant**: Eng. Mohammed Battat

**Section**: 4

**Date**: 7-8-2023

Contents

[Software Prelab (Simulink MATLAB) 5](#_Toc142581308)

[Extract the message signal m(t) from s(t) 5](#_Toc142581309)

[Plot 5 cycle from Message signal m(t) and s(t) 6](#_Toc142581310)

[Block Diagram 6](#_Toc142581311)

[Message Signal 7](#_Toc142581312)

[Modulated signal s(t) 8](#_Toc142581313)

[Differentiate s(t) with respect to t and plot ds(t)/dt 10](#_Toc142581314)

[By Hand Solution 10](#_Toc142581315)

[Using Simulink 11](#_Toc142581316)

[Apply ds(t)/dt to an ideal envelope detector 13](#_Toc142581317)

[By Hand Solution 13](#_Toc142581318)

[Extract message signal by using phase-locked loop (PLL) 14](#_Toc142581319)

[Block Diagram 14](#_Toc142581320)

[In time Domine 14](#_Toc142581321)

[In frequency Domine 15](#_Toc142581322)

[Extract the message signal by using the envelop detector 16](#_Toc142581323)

[Block Diagram 16](#_Toc142581324)

[In Time Domine 16](#_Toc142581325)

[In frequency Domine 17](#_Toc142581326)

**Table of Figures**

[Figure 1:Stepes to Extract the message signal m(t) from s(t) 5](#_Toc142581271)

[Figure 2:Message Signal 6](file:///C:\Users\Lenovo\Desktop\ENEE4113-PreLab3-EXP4%20-%20Copy.docx#_Toc142581272)

[Figure 3: FM Modulation Block Diagram 6](file:///C:\Users\Lenovo\Desktop\ENEE4113-PreLab3-EXP4%20-%20Copy.docx#_Toc142581273)

[Figure 4: Message Signal in Time domine 7](#_Toc142581274)

[Figure 5: Frequency Domine 7](file:///C:\Users\Lenovo\Desktop\ENEE4113-PreLab3-EXP4%20-%20Copy.docx#_Toc142581275)

[Figure 6: Modulated signal In Time Domine 8](#_Toc142581276)

[Figure 7: Modulated signal in frequency Domine 9](#_Toc142581277)

[Figure 8: Differentiate s(t) 10](#_Toc142581278)

[Figure 9: Block Diagram to Differentiate s(t) 11](#_Toc142581279)

[Figure 10: Differentiate s(t) in time domine 11](file:///C:\Users\Lenovo\Desktop\ENEE4113-PreLab3-EXP4%20-%20Copy.docx#_Toc142581280)

[Figure 11: Differentiate s(t) in frequency domine 12](#_Toc142581281)

[Figure 12: Apply ds(t)/dt to an ideal envelope detector 13](#_Toc142581282)

[Figure 13:FM Demodulation by PLL Block Diagram 14](#_Toc142581283)

[Figure 14: Demodulated signal in time domine 14](file:///C:\Users\Lenovo\Desktop\ENEE4113-PreLab3-EXP4%20-%20Copy.docx#_Toc142581284)

[Figure 15: Demodulated signal in frequency domine 15](#_Toc142581285)

[Figure 16::FM Demodulation by using the envelop detector Block Diagram 16](#_Toc142581286)

[Figure 17: Demodulated signal in time domine 16](#_Toc142581287)

[Figure 18: Demodulated signal in time domine 17](file:///C:\Users\Lenovo\Desktop\ENEE4113-PreLab3-EXP4%20-%20Copy.docx#_Toc142581288)

# Software Prelab (Simulink MATLAB)

## Extract the message signal m(t) from s(t)

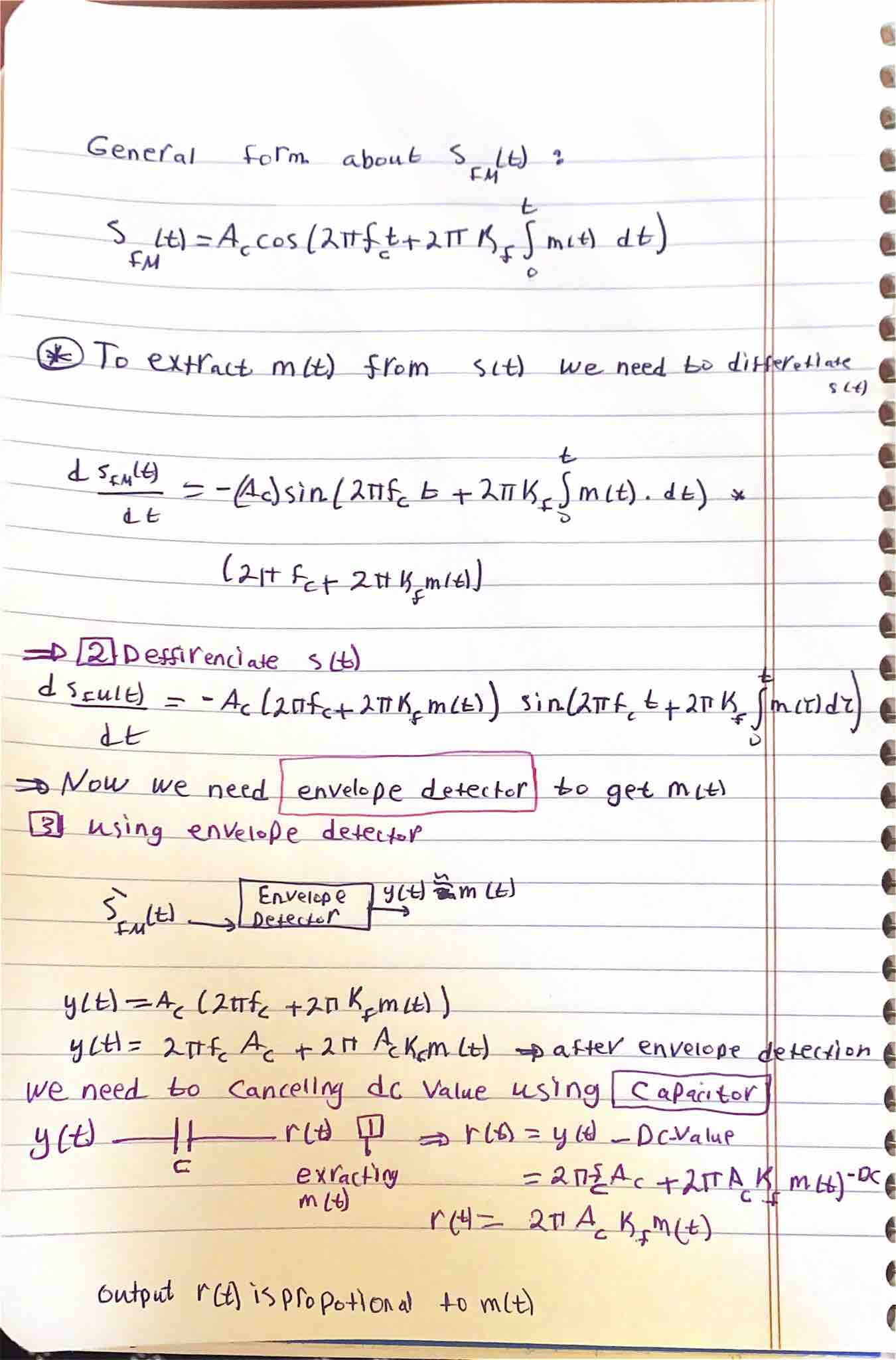


Figure :Stepes to Extract the message signal m(t) from s(t)

The figure shows the calculation to find the message signal:

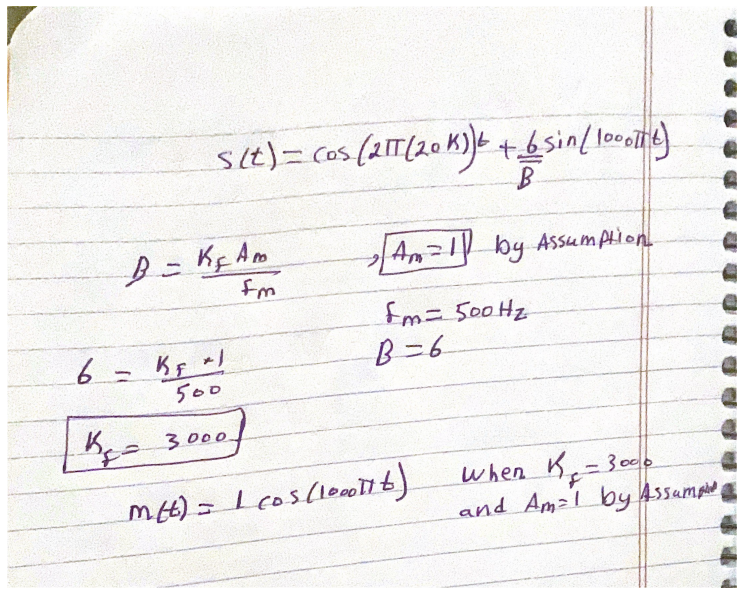


Figure 2:Message Signal

## Plot 5 cycle from Message signal m(t) and s(t)

### Block Diagram

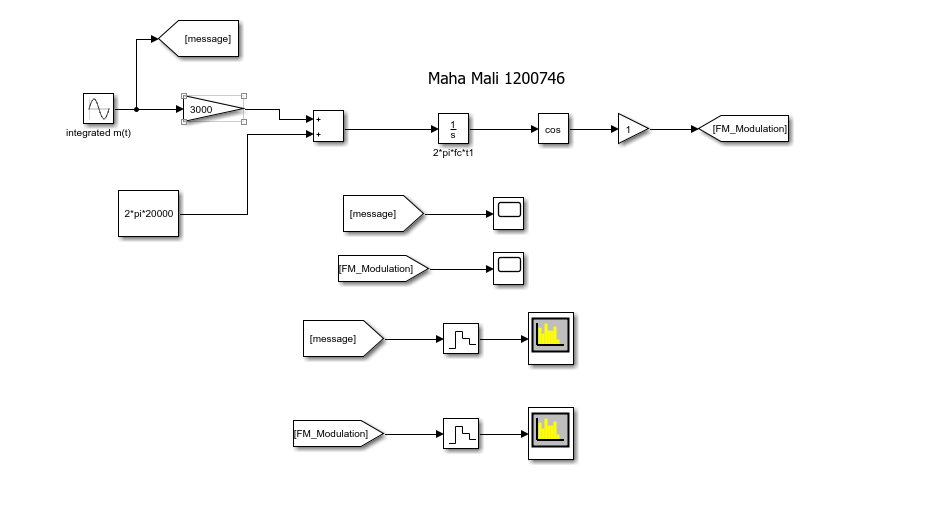


Figure 3: FM Modulation Block Diagram

### Message Signal

#### Time Domine

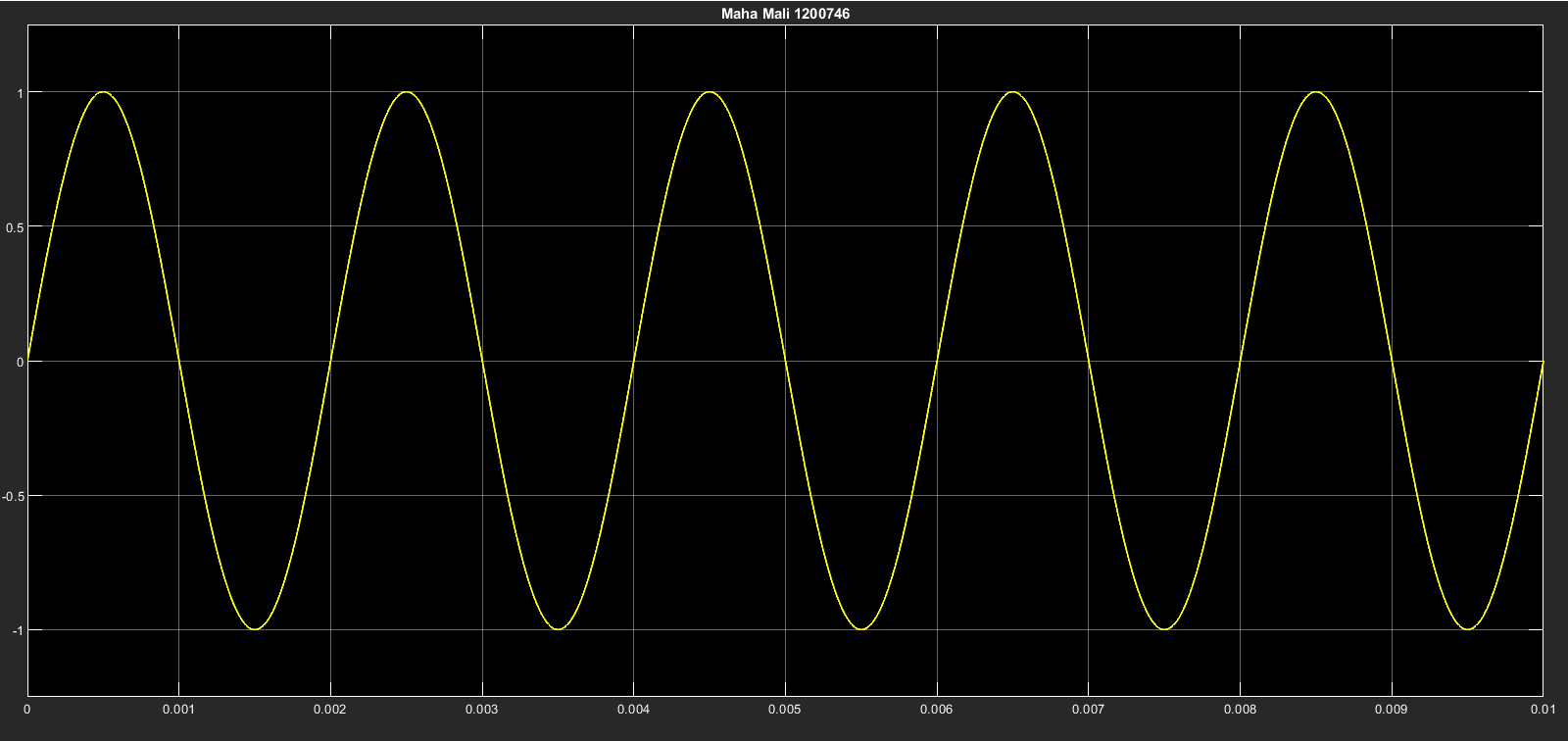


Figure 4: Message Signal in Time domine

From this graph we notice that we got the m(t) that we calculate it by hand with amplitude 1 .

#### Frequency Domine

Figure 5: Frequency Domine

The figure 5 show that we have two delta one at 500 Hz, and another on -500 Hz , according the equation for m(f).

### Modulated signal s(t)

#### Time Domine

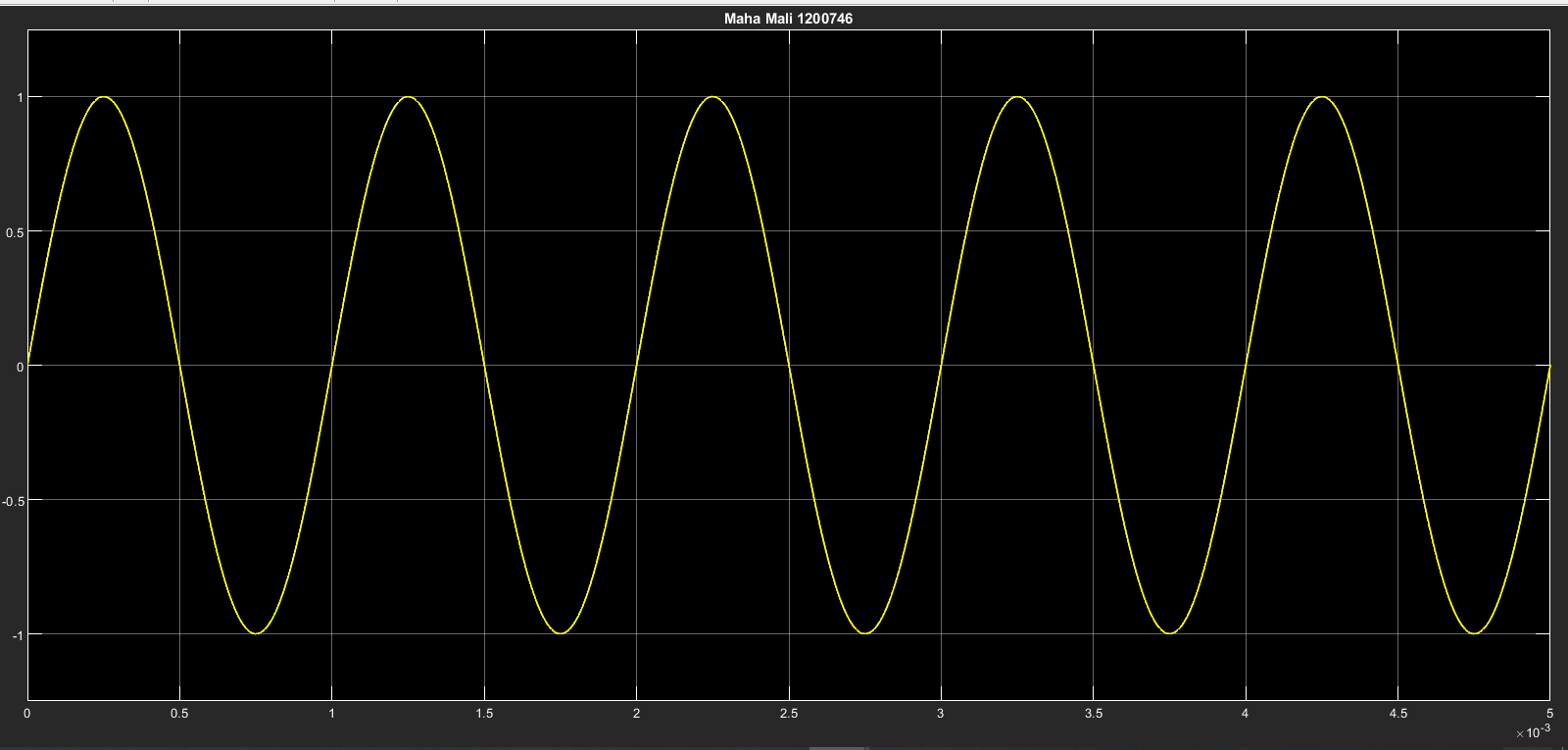


Figure 6: Modulated signal In Time Domine

#### Frequency Domine

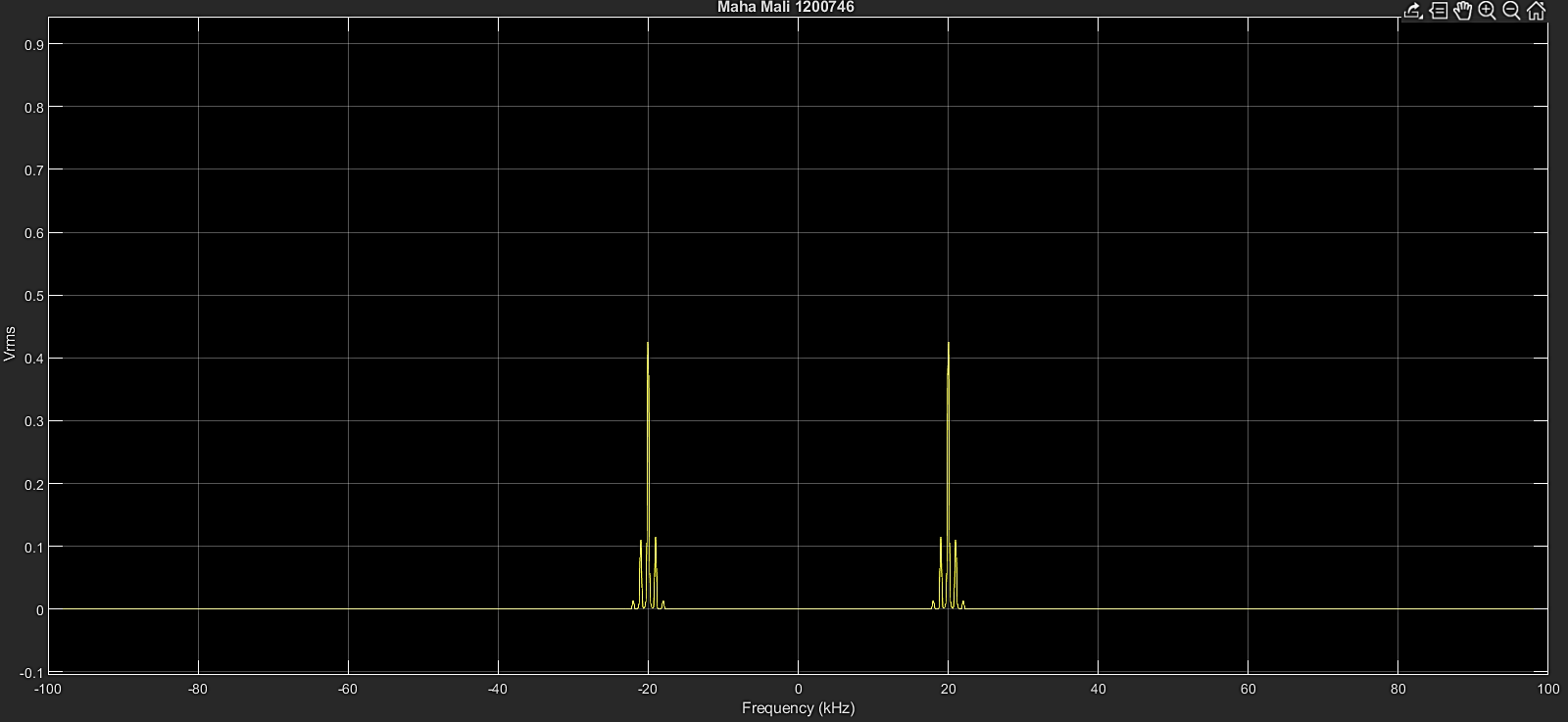
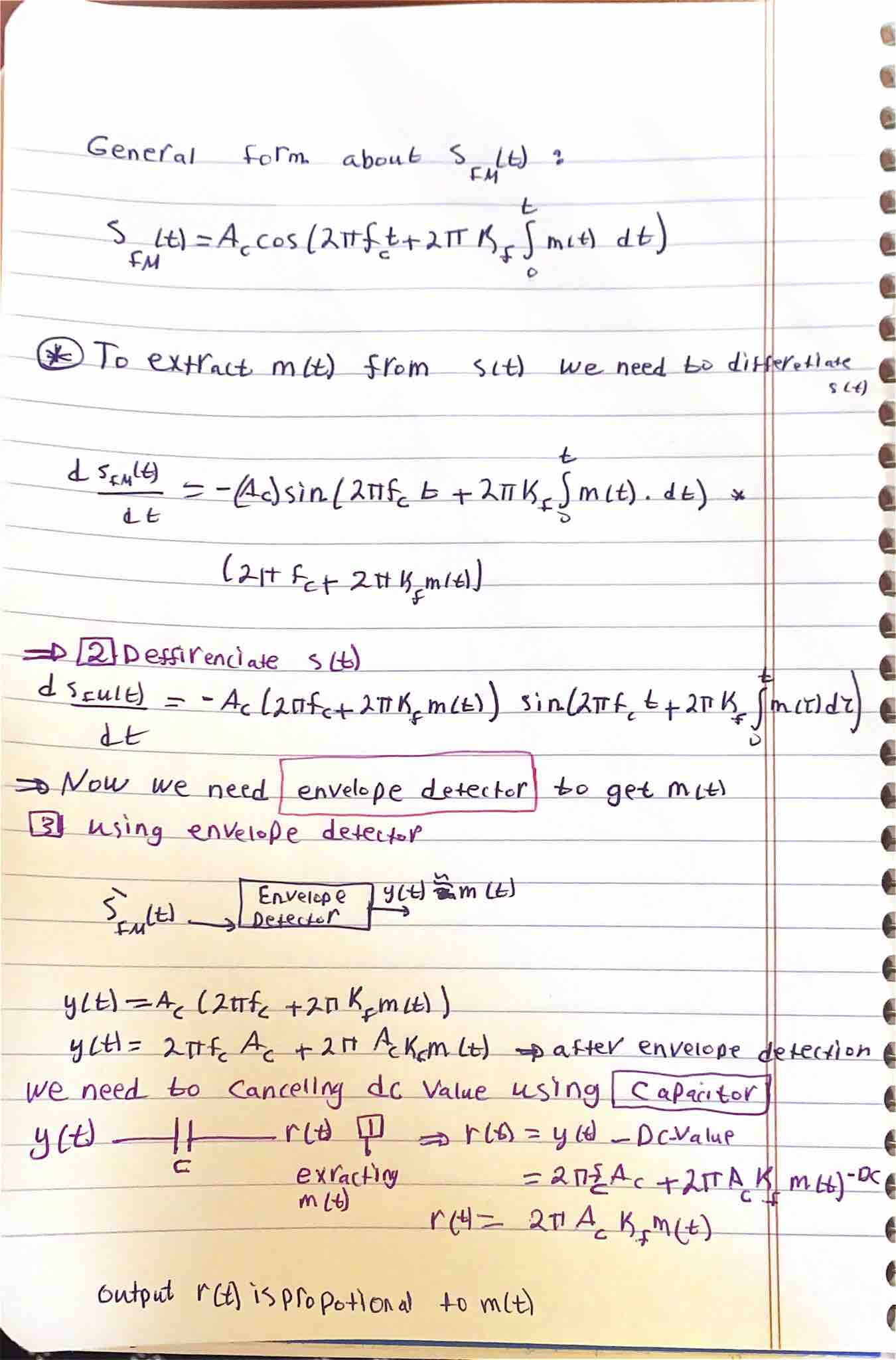


Figure 7: Modulated signal in frequency Domine

## Differentiate s(t) with respect to t and plot ds(t)/dt

### By Hand Solution



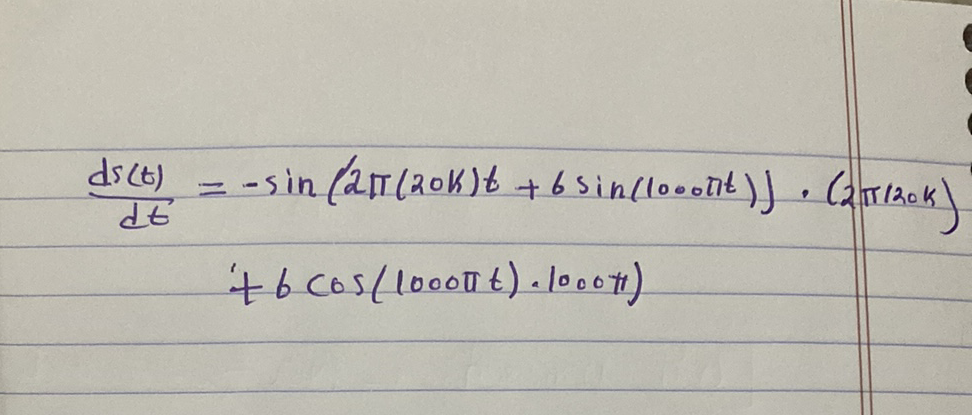


Figure 8: Differentiate s(t)

The differentiation of function s(t) unveils a transition from a rapidly changing frequency modulation (FM) waveform to a slower amplitude modulation (AM) pattern. The original FM waveform, characterized by a 20,000 Hz carrier frequency and modulation, evolves into the derivative waveform ds(t)/dt. This shift from FM to AM-like behavior is a result of differentiation's emphasis on higher frequencies and its impact on reshaping signal traits

### Using Simulink

#### Block Diagram

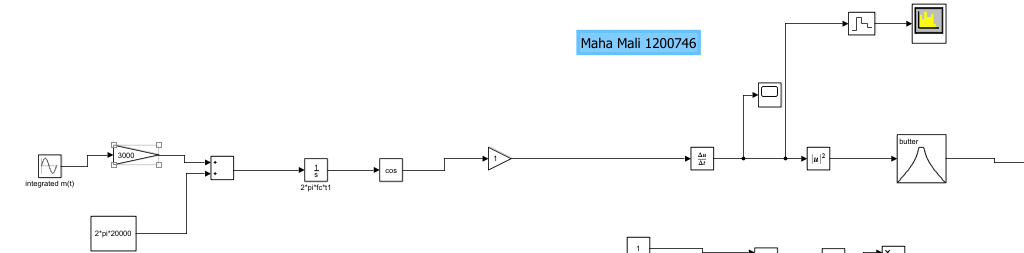


Figure 9: Block Diagram to Differentiate s(t)

#### Time domine

Figure 10: Differentiate s(t) in time domine

##### Frequency domine

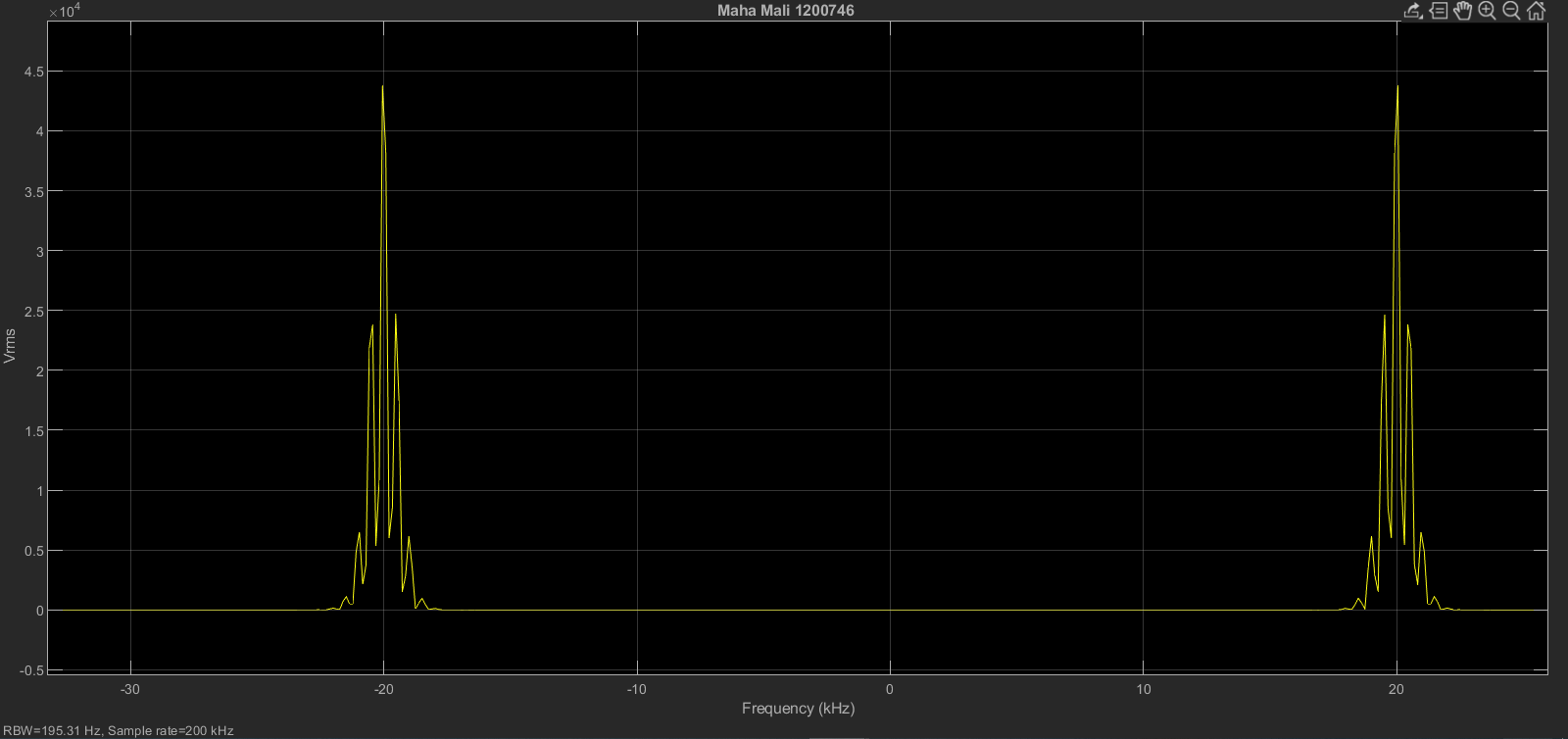


Figure 11: Differentiate s(t) in frequency domine

## Apply ds(t)/dt to an ideal envelope detector

### By Hand Solution

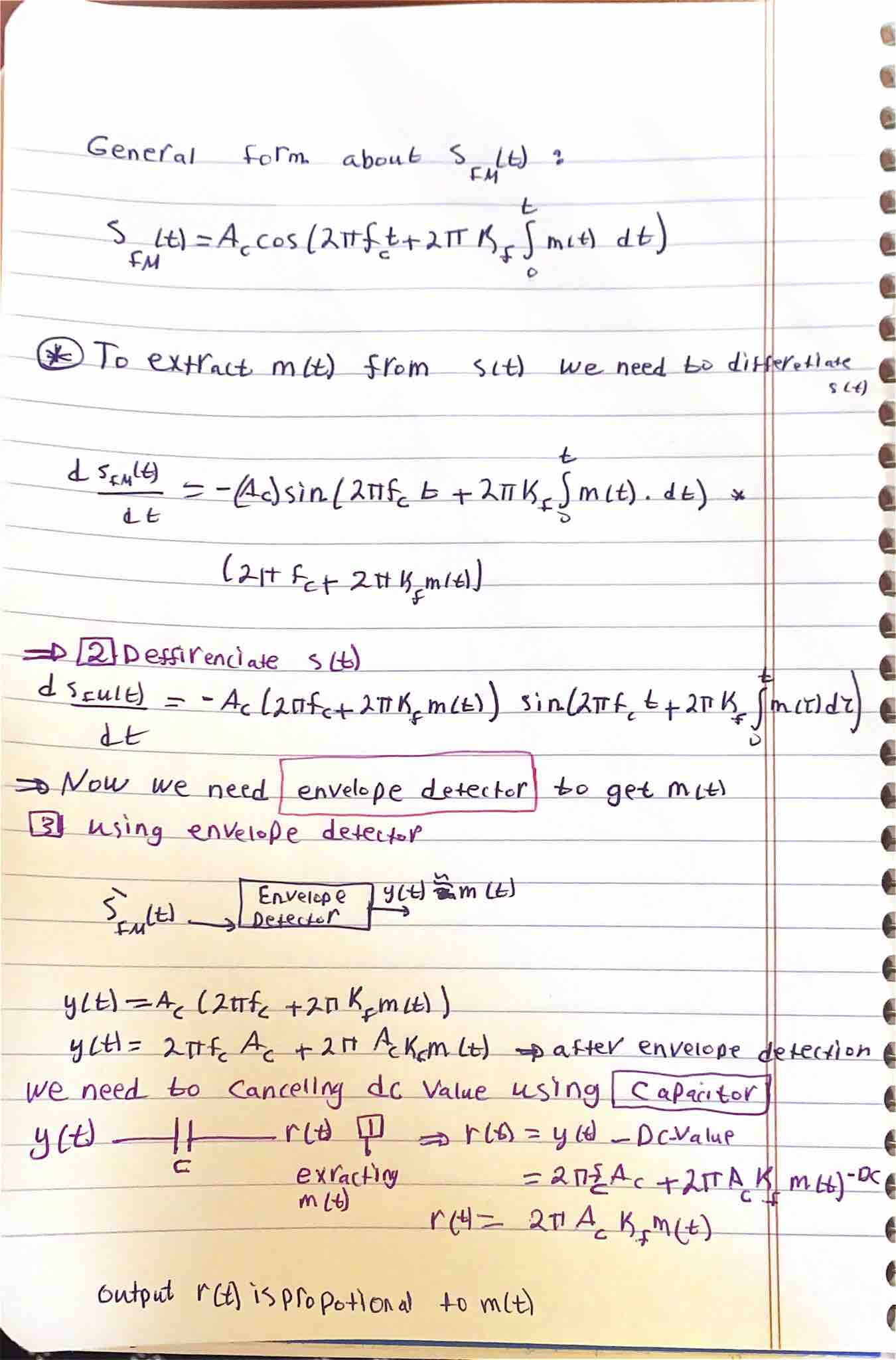


Figure 12: Apply ds(t)/dt to an ideal envelope detector

## Extract message signal by using phase-locked loop (PLL)

### Block Diagram

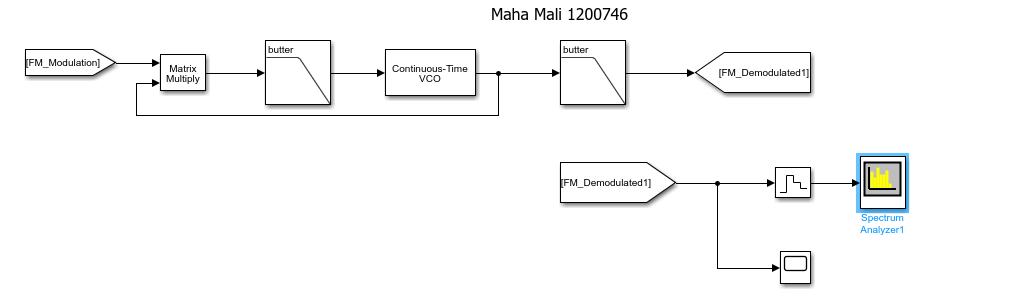


Figure 13:FM Demodulation by PLL Block Diagram

### In time Domine

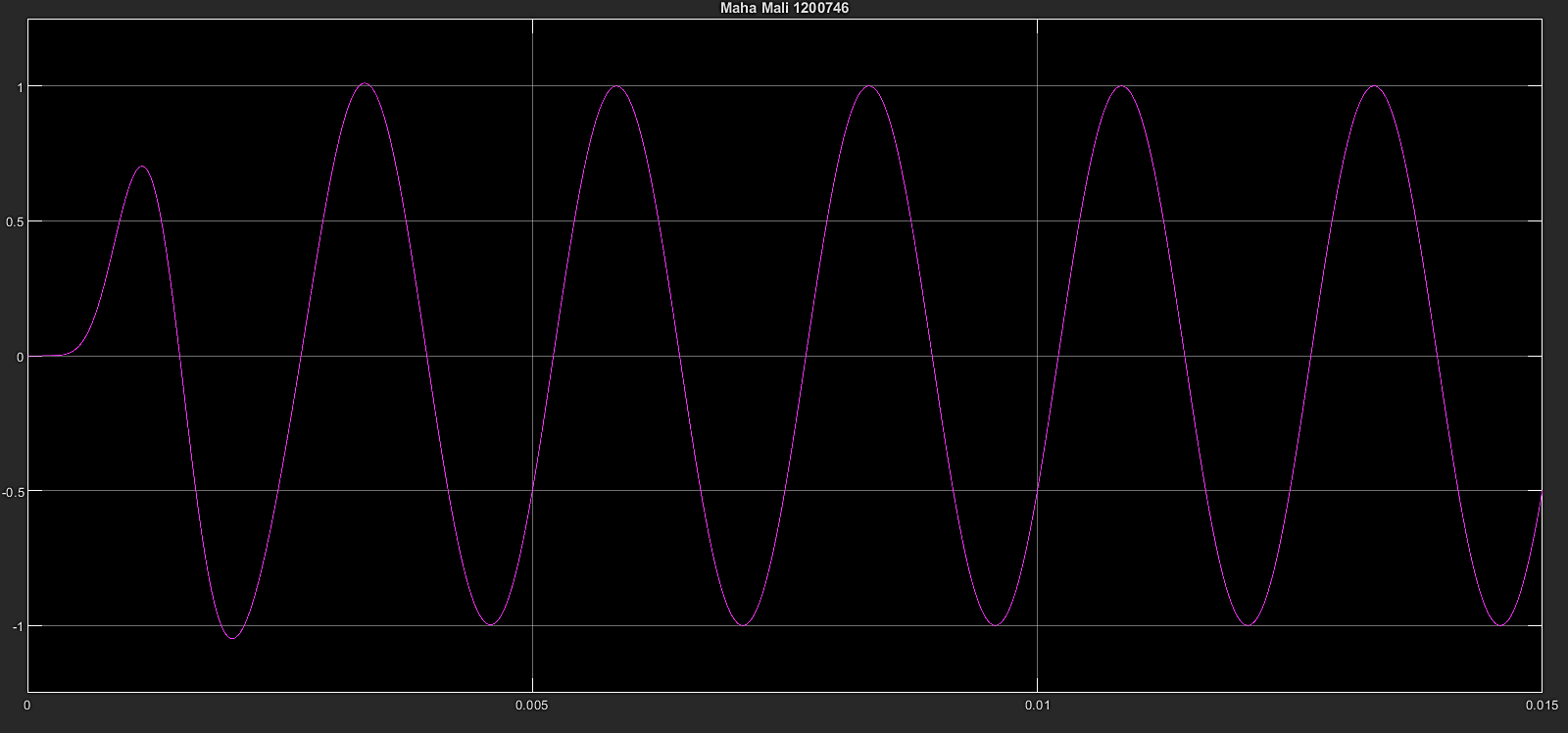


Figure 14: Demodulated signal in time domine

The figure 14 shows the amplitude of the demodulated signal has the same amplitude of message signal which is 1.

### In frequency Domine

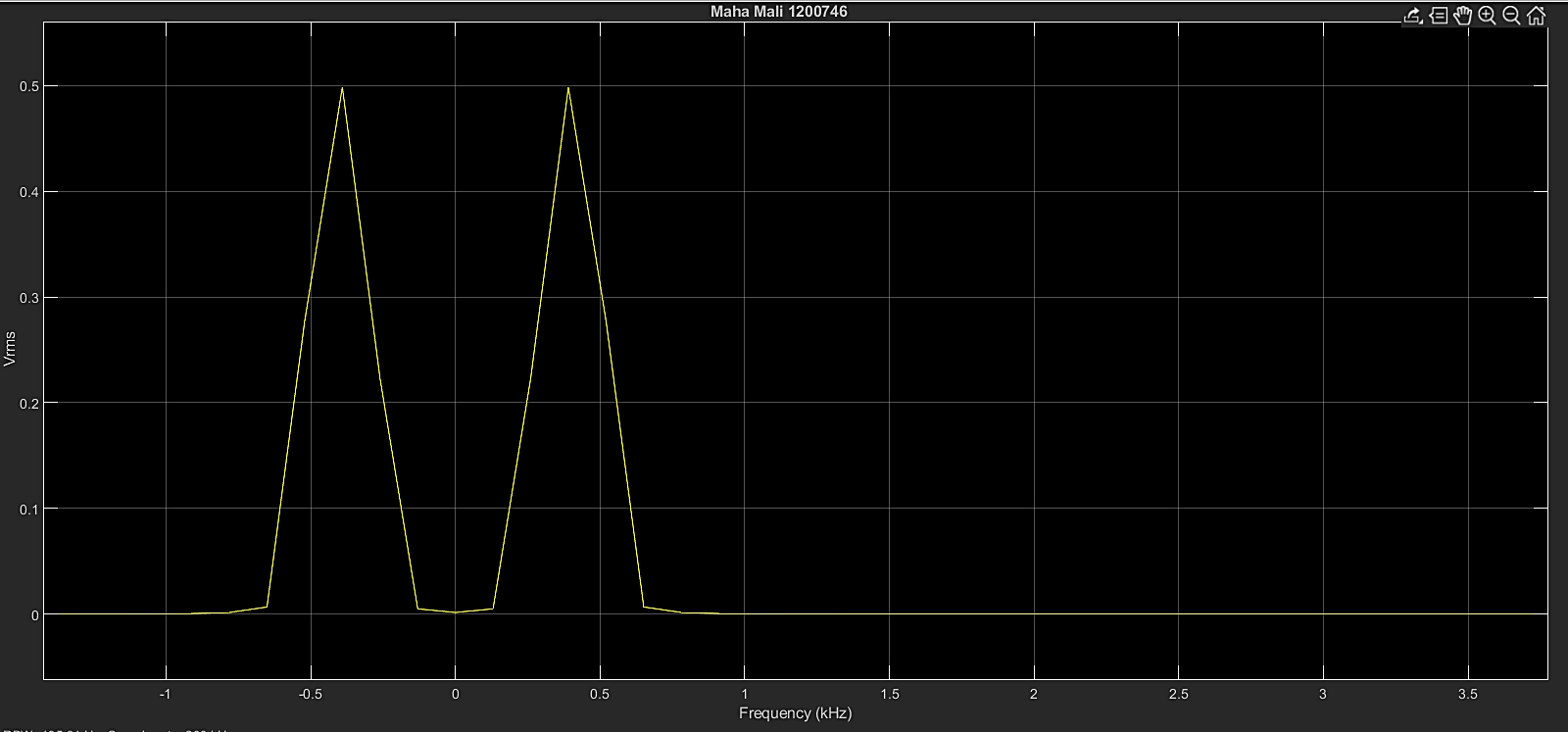


Figure 15: Demodulated signal in frequency domine

The figure show that the demodulated signal has the same frequency of message signal which is 500 Hz.

## Extract the message signal by using the envelop detector

### Block Diagram

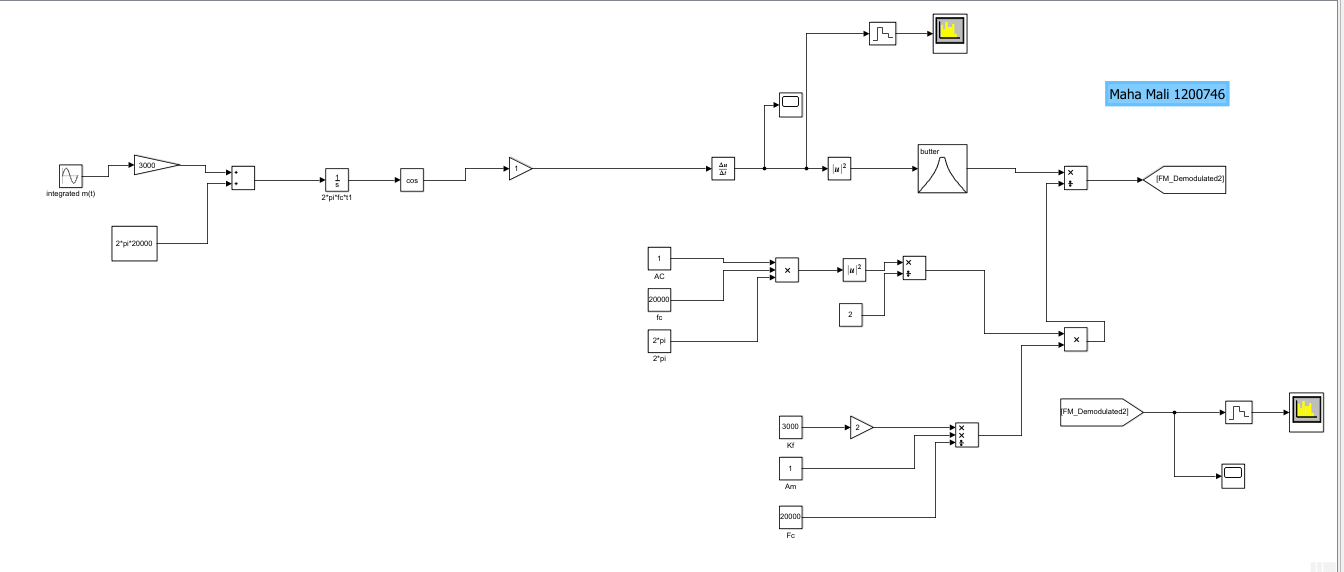


Figure 16::FM Demodulation by using the envelop detector Block Diagram

### In Time Domine

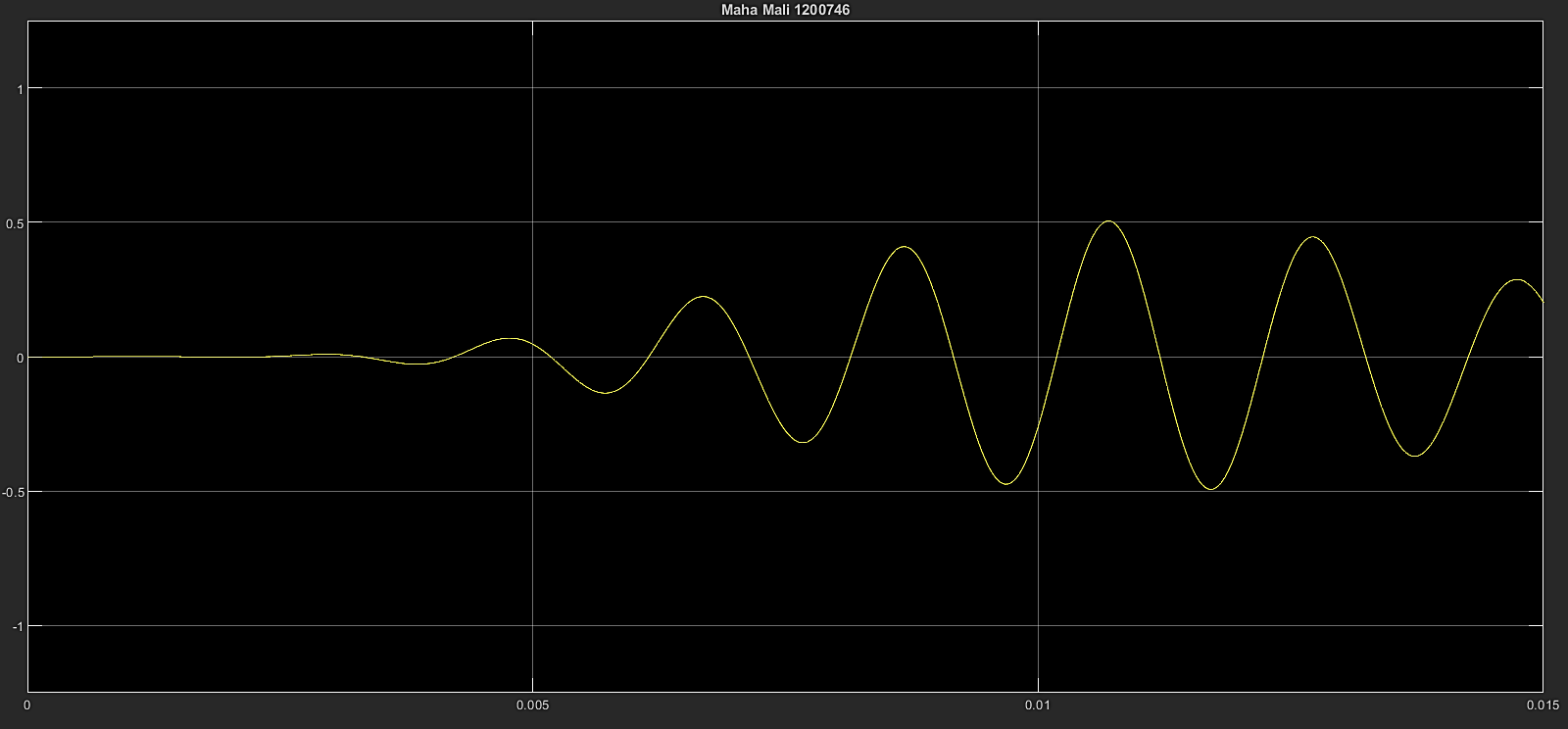


Figure 17: Demodulated signal in time domine

### In frequency Domine

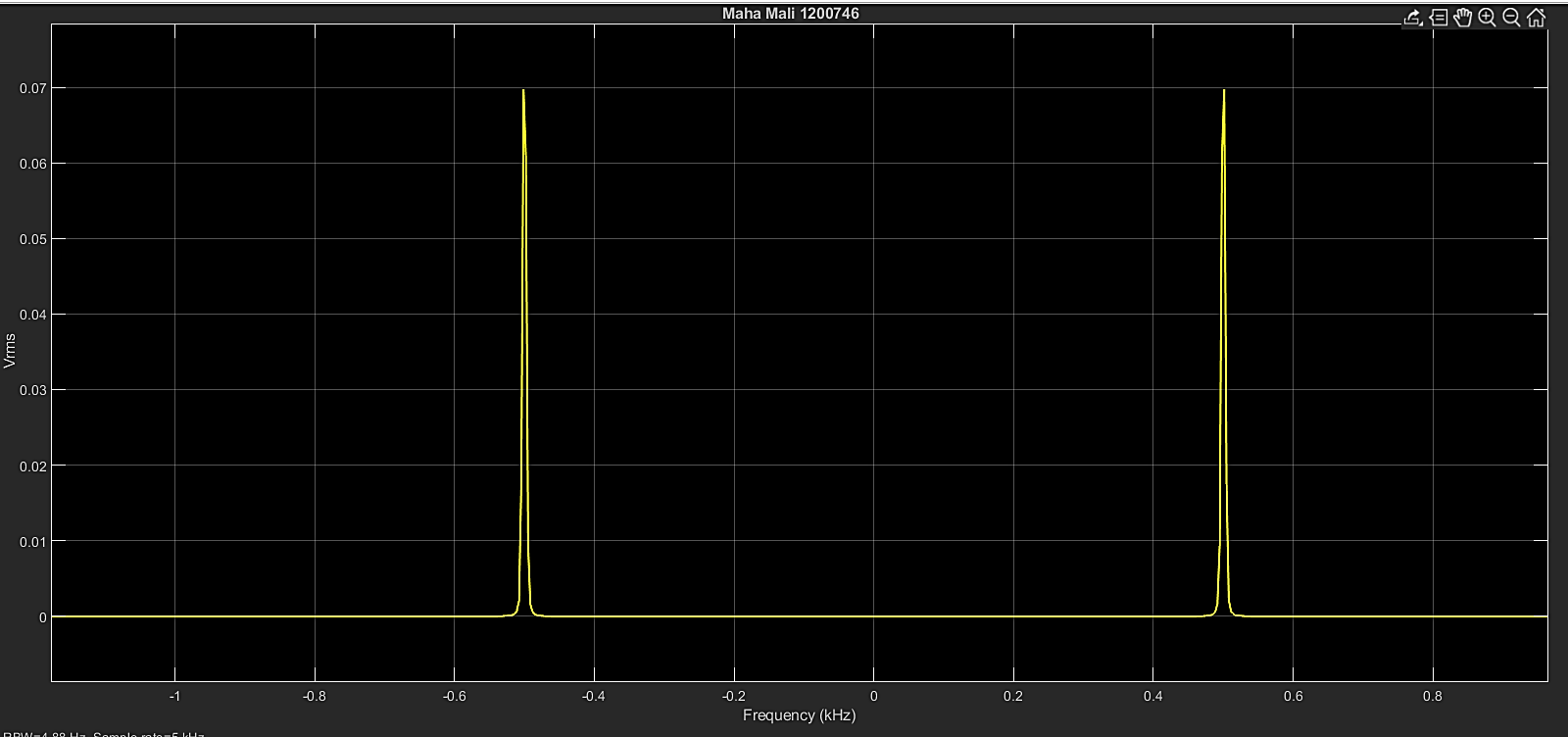


Figure 18: Demodulated signal in time domine

The figure show that the demodulated signal has the same frequency of message signal which is 500 Hz.