



Faculty of Engineering & Technology
Electrical & Computer Engineering Department
COMMUNICATIONS LAB

ENEE4113

Experiment No. 1

Normal Amplitude Modulation

PreLab-1

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Section: 5

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Software Prelab (Simulink Matlab): Block Simulation (Matlab Simulink):

1-message signal:

$$M(t)=0.85\cos(2*\pi*1000t)$$

*The parameter for message signal :

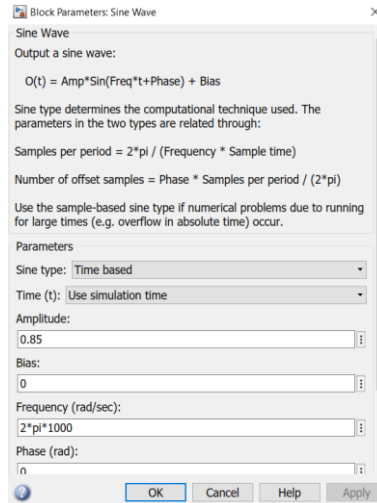


Figure 1.Message signal parameter

2-carrier signal:

$$C(t)=\cos(2*\pi*15000t)$$

The parameter for message signal :

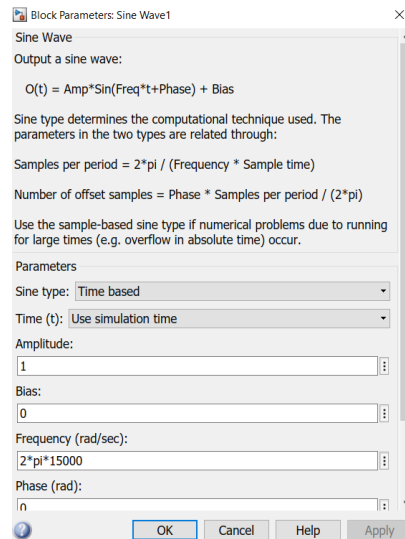


Figure 2.carrier signal parameter

1- Am modulation:

1.1.General block for Am modulation:

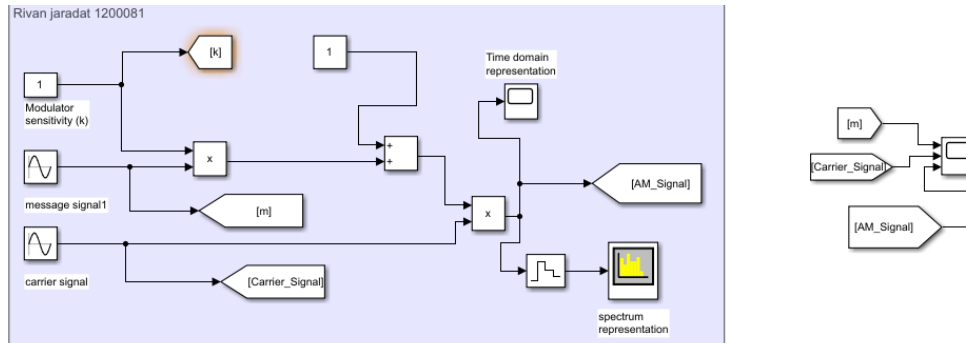


Figure 3.General block for Am modulation

1.2. In Time domain:

1.2.1 When $\mu = 1$:

$$K_a = \mu / A_m \rightarrow 1 / 0.85 = 1.176$$

- Mathematical Representation of AM Signal in Time Domain:

$$s(t) = A_c(1 + K_a m(t)) \cos(2\pi f_c t)$$

$$s(t) = (1)(2.17 (0.85 \cos(2\pi(1000)t)) \cos(2\pi(15k)t)$$

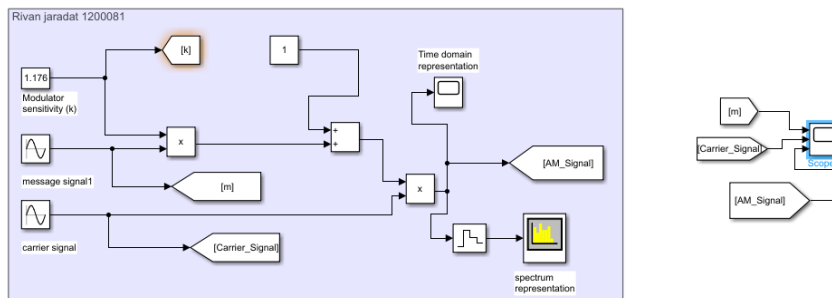


Figure 4.block for Am modulation M=1

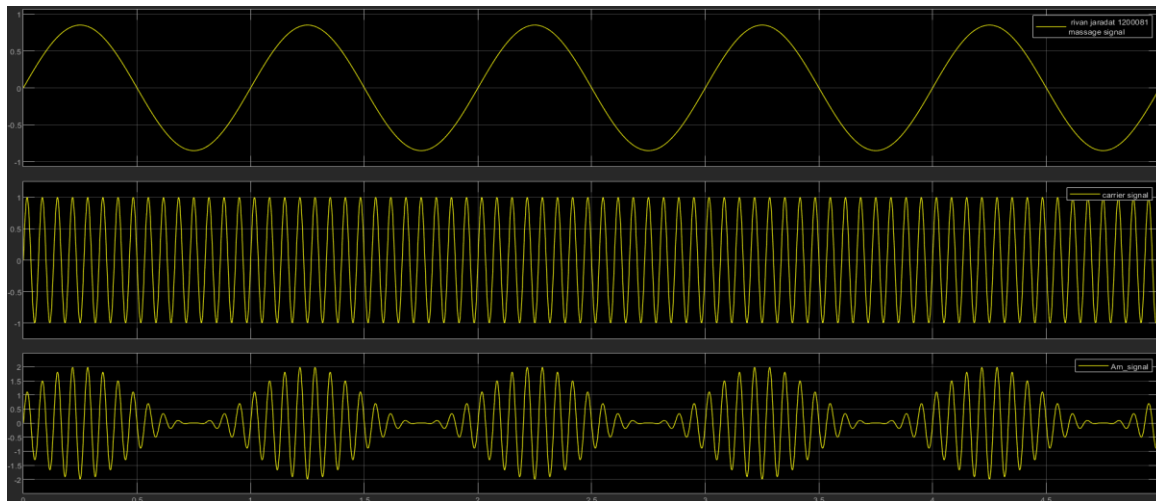


Figure 5. Simulation in Time domain $\mu=1$

From this picture we notice that the amplitude of the Message signal is very close to the value in the message signal equation, and the amplitude of $s(t)$ in picture same as the Mathematical Representation of AM Signal in Time Domain

1.2.2 When $\mu > 1$:

$$K_a = \mu / A_m \rightarrow 1.5 / 0.85 = 1.764$$

- Mathematical Representation of AM Signal in Time Domain:

$$s(t) = A_c(1 + K_a m(t)) \cos(2\pi f_c t)$$

$$s(t) = (1)(2.764 (0.85 \cos(2\pi(1000)t))) \cos(2\pi(15k)t)$$

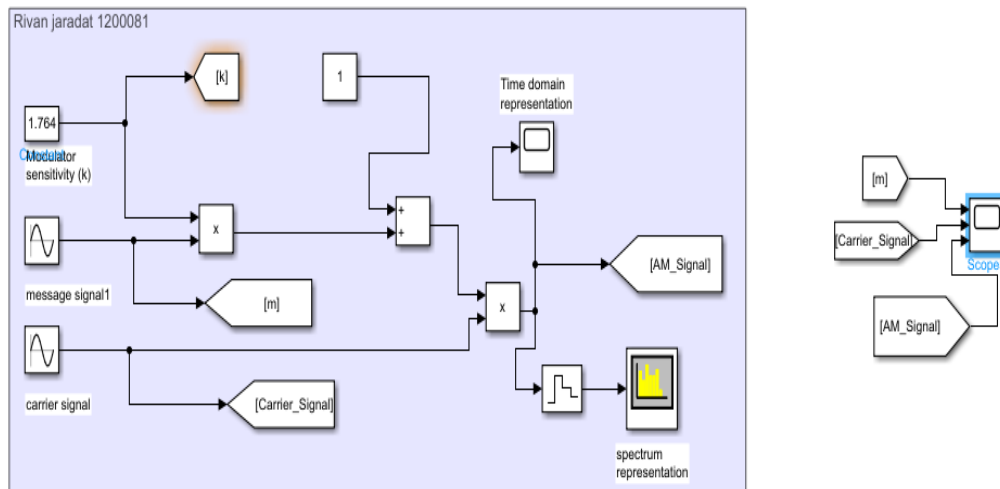


Figure 6. block for Am modulation $\mu > 1$

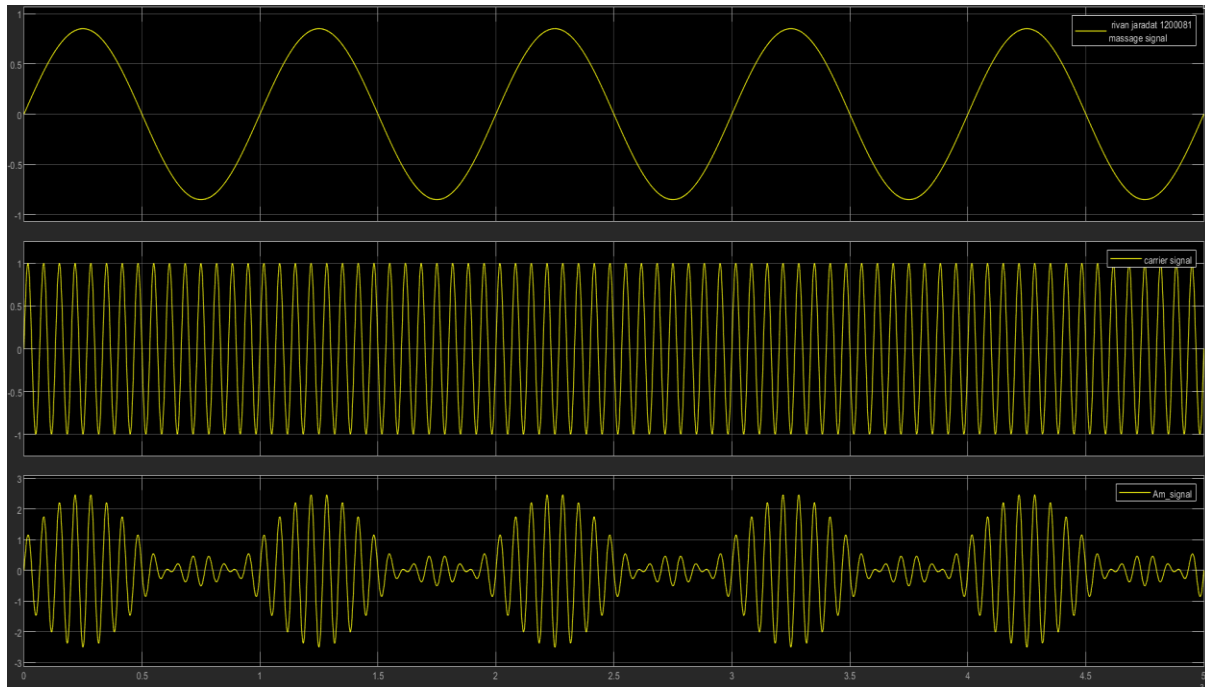


Figure 7. Simulation in Time domain $\mu > 1$

1.2.3. When $\mu < 1$:

$$K_a = \mu / A_m \rightarrow 0.5 / 0.85 = 0.58$$

- Mathematical Representation of AM Signal in Time Domain:

$$s(t) = A_c(1 + K_a m(t)) \cos(2\pi f_c t)$$

$$s(t) = (1)(1.588 (0.85 \cos(2\pi(1000)t))) \cos(2\pi(15k)t)$$

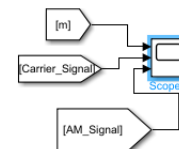
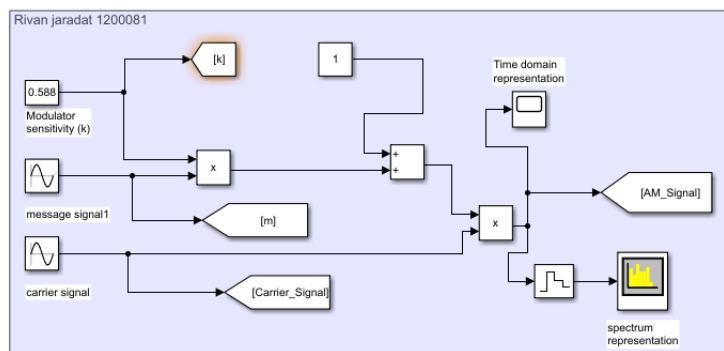


Figure 8. block for Am modulation $\mu < 1$

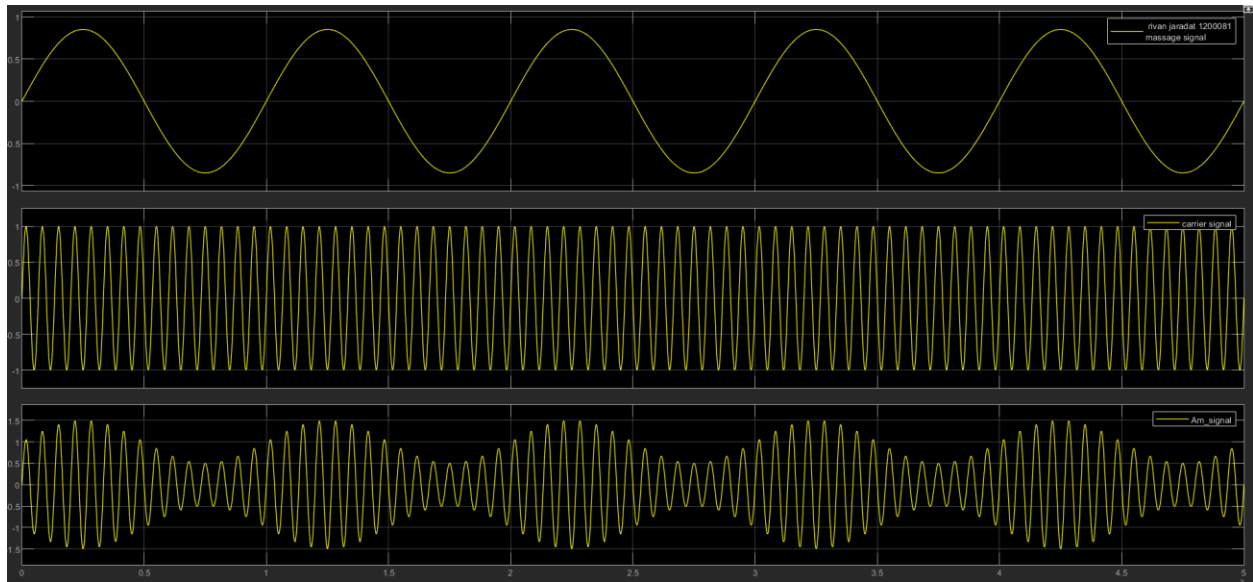


Figure 9. Simulation in Time domain $\mu < 1$

1.3 In frequency domain:

1.3.1. When $\mu < 1$:

$$S(f) = (A_c) / 2 [\delta(f - f_c) + \delta(f + f_c)] + ((A_c) (\mu) / 4) [\delta(f - (f_c + f_m)) + \delta(f + (f_c + f_m))] + ((A_c) (\mu) / 4) [\delta(f - (f_c - f_m)) + \delta(f + (f_c - f_m))]$$

$$= (1) / 2 [\delta(f - 15k) + \delta(f + 15k)] + ((1) (0.5) / 4) [\delta(f - (16k)) + \delta(f + (16k))] + ((1) (0.5) / 4) [\delta(f - (14k)) + \delta(f + (14k))]$$

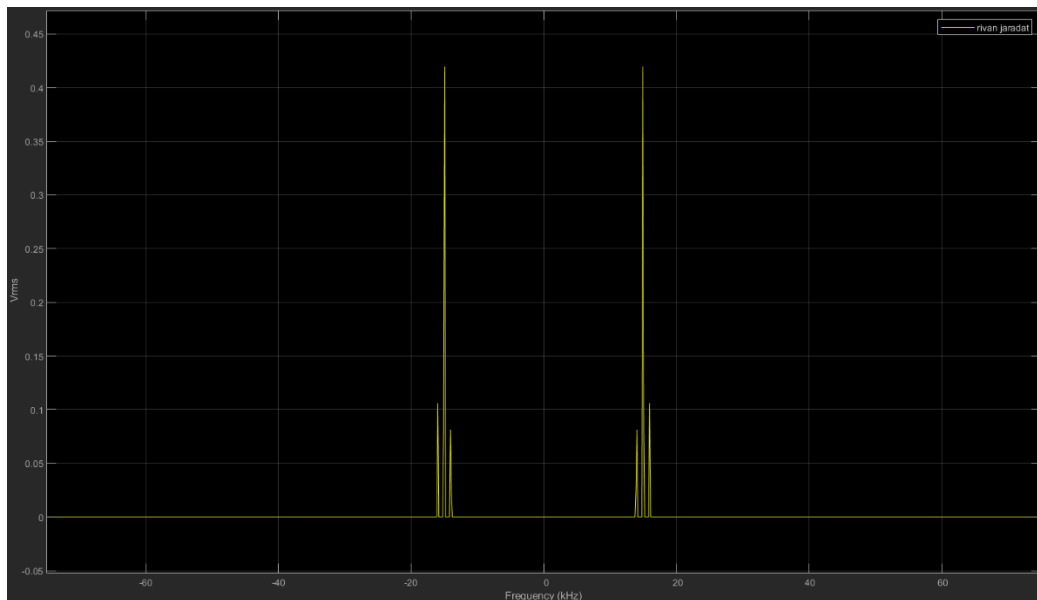


Figure 10. Simulation in frequency domain $\mu < 1$

1.3.2. When $\mu > 1$:

$$S(f) = (A_c) / 2 [\delta (f - f_c) + \delta (f + f_c)] + ((A_c) (\mu) / 4) [\delta (f - (f_c + f_m)) + \delta (f + (f_c + f_m))] + ((A_c) (\mu) / 4) [\delta (f - (f_c - f_m)) + \delta (f + (f_c - f_m))]$$

$$= (1) / 2 [\delta (f - 15k) + \delta (f + 15k)] + ((1) (1.5) / 4) [\delta (f - (16k)) + \delta (f + (16k))] + ((1) (1.5) / 4) [\delta (f - (14k)) + \delta (f + (14k))]$$

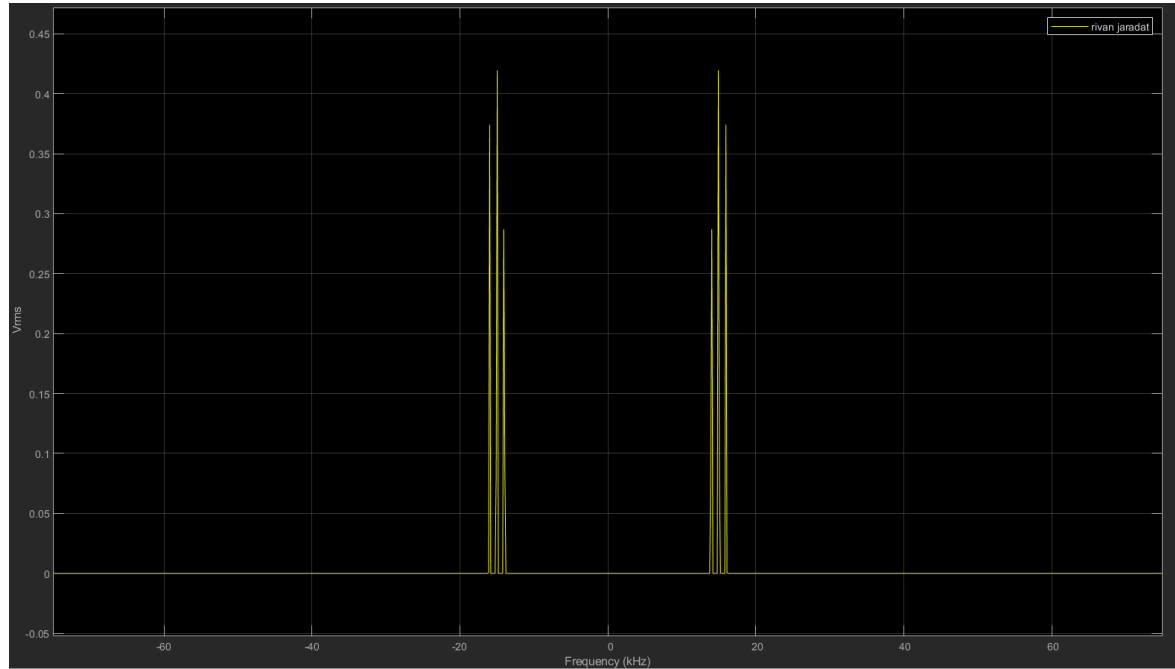


Figure 11. Simulation in frequency domain $\mu > 1$

1.3.3. When $\mu = 1$:

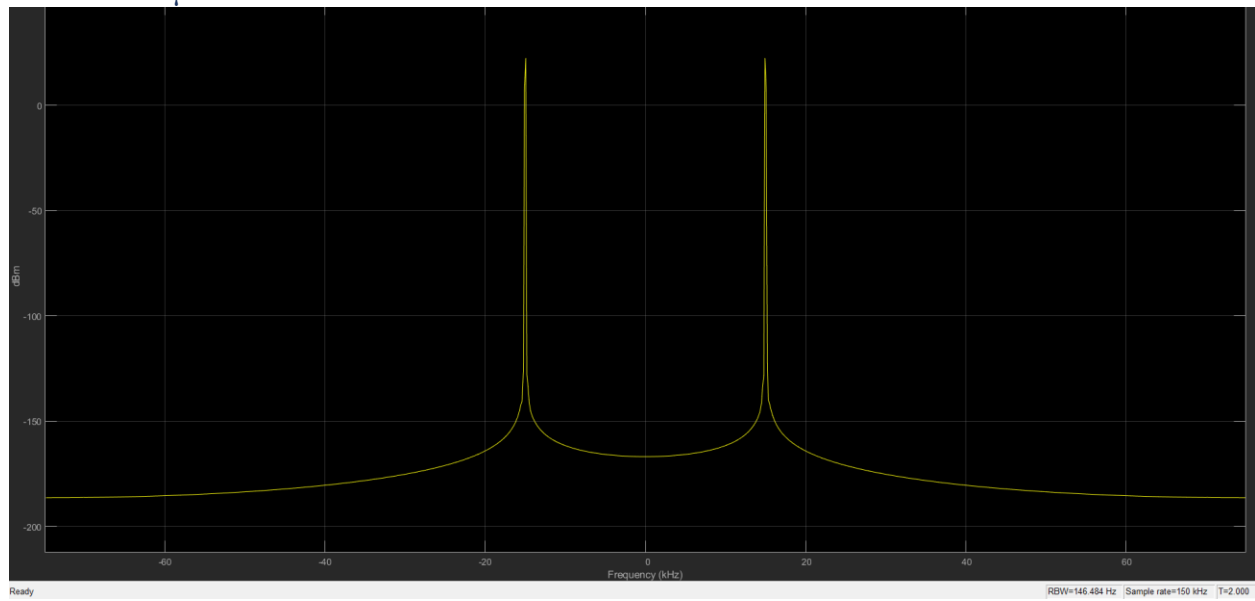


Figure 12. Simulation for carrier signal in frequency domain $\mu=1$

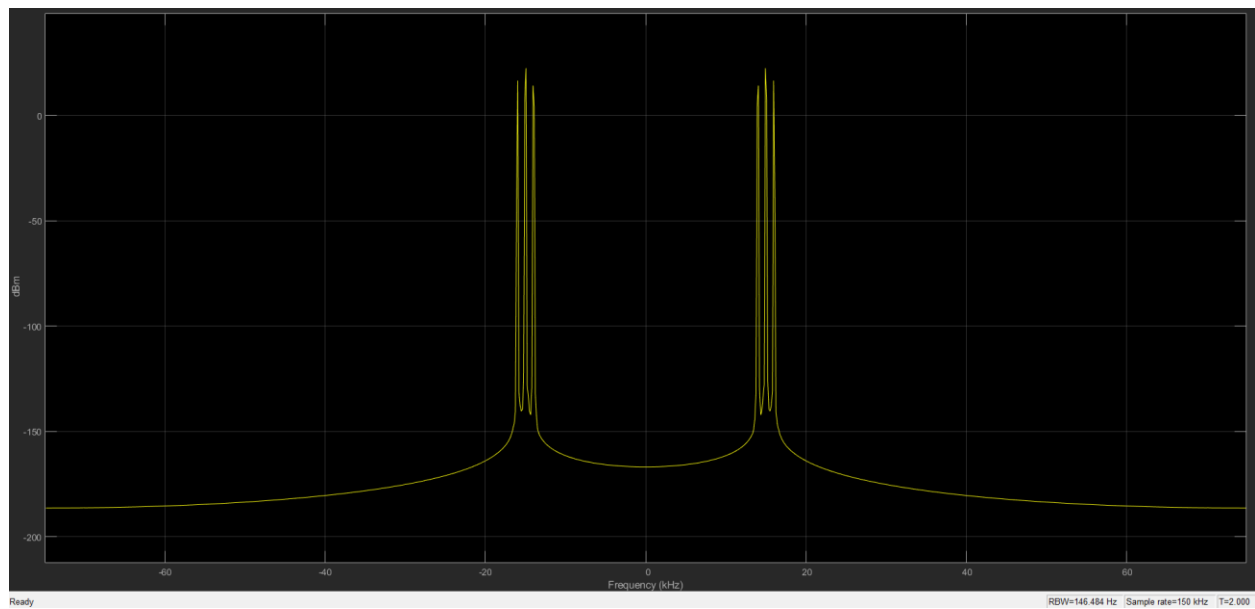


Figure 13. Simulation for message signal in frequency domain $\mu=1$

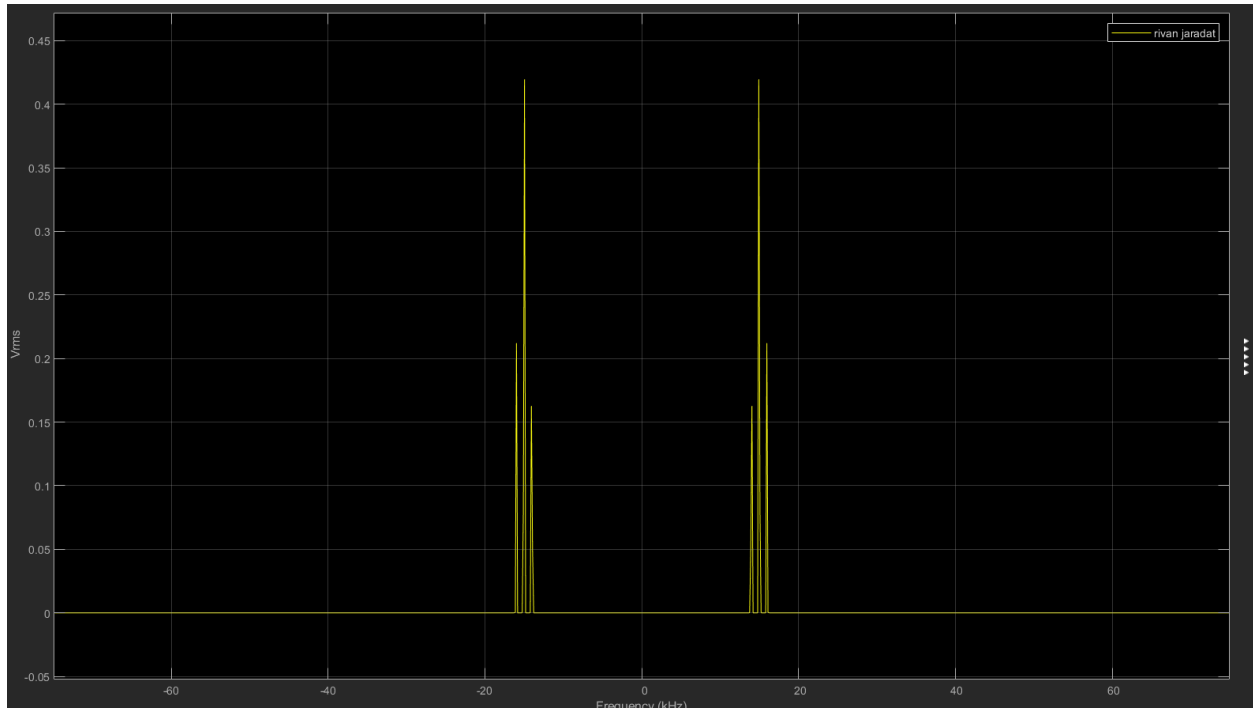


Figure 14. Simulation for $s(t)$ in frequency domain $\mu=1$

$$S(f) = (A_c) / 2 [\delta(f - f_c) + \delta(f + f_c)] + ((A_c) (\mu) / 4) [\delta(f - (f_c + f_m)) + \delta(f + (f_c + f_m))] + ((A_c) (\mu) / 4) [\delta(f - (f_c - f_m)) + \delta(f + (f_c - f_m))] \\ = (1) / 2 [\delta(f - 15k) + \delta(f + 15k)] + ((1) (1) / 4) [\delta(f - (16k)) + \delta(f + (16k))] + ((1) (1) / 4) [\delta(f - (14k)) + \delta(f + (14k))]$$

Note: In previous cases of μ , we notice the convergence of results between simulation and previous mathematical equations, and this indicates accuracy and correctness.

2- demodulation

2.1. Envelop detection:

Here is the general block for envelop detection:

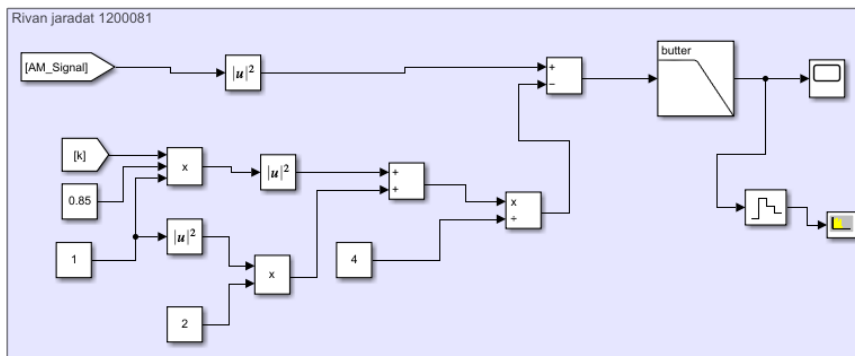


Figure 15. block for envelop detection

2.1.1. When $\mu > 1$:

$$K_a = \mu / A_m \rightarrow 1.5 / 0.85 = 1.764$$

Time domain:



Figure 16. Simulation for envelop detection in time domain $\mu > 1$

In frequency domain :

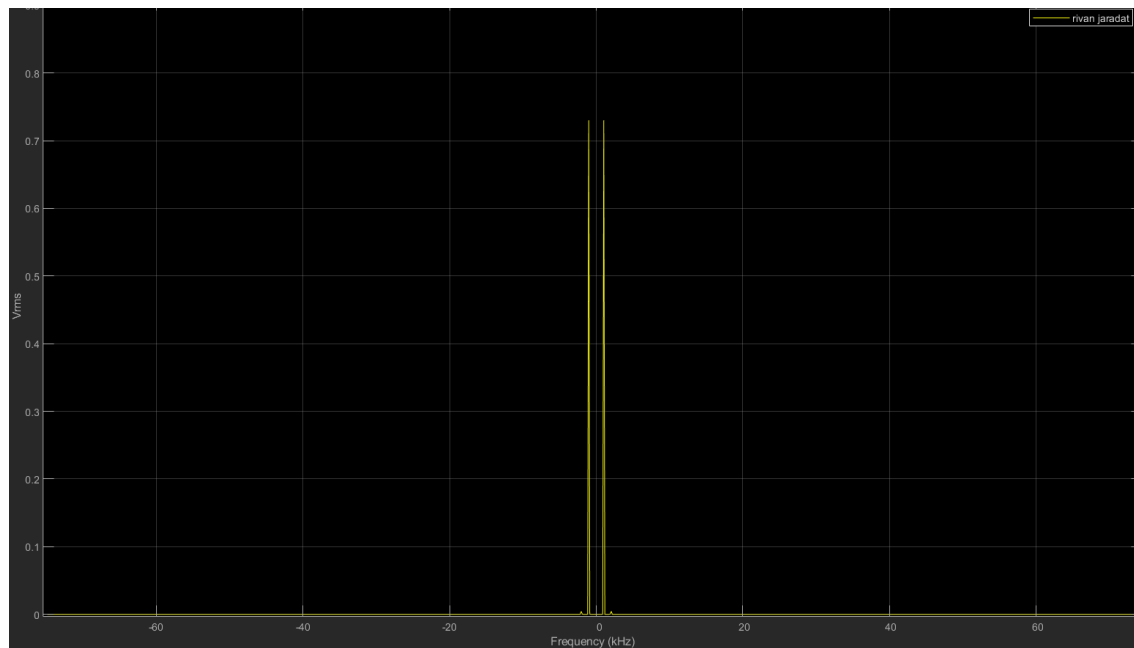


Figure 17. Simulation for envelop detection in frequency domain $\mu > 1$

2.1.2. When $\mu < 1$:

$$K_a = \mu / A_m \rightarrow 0.5 / 0.85 = 0.588$$

In time domain :



Figure 18. Simulation for envelop detection in time domain $\mu < 1$

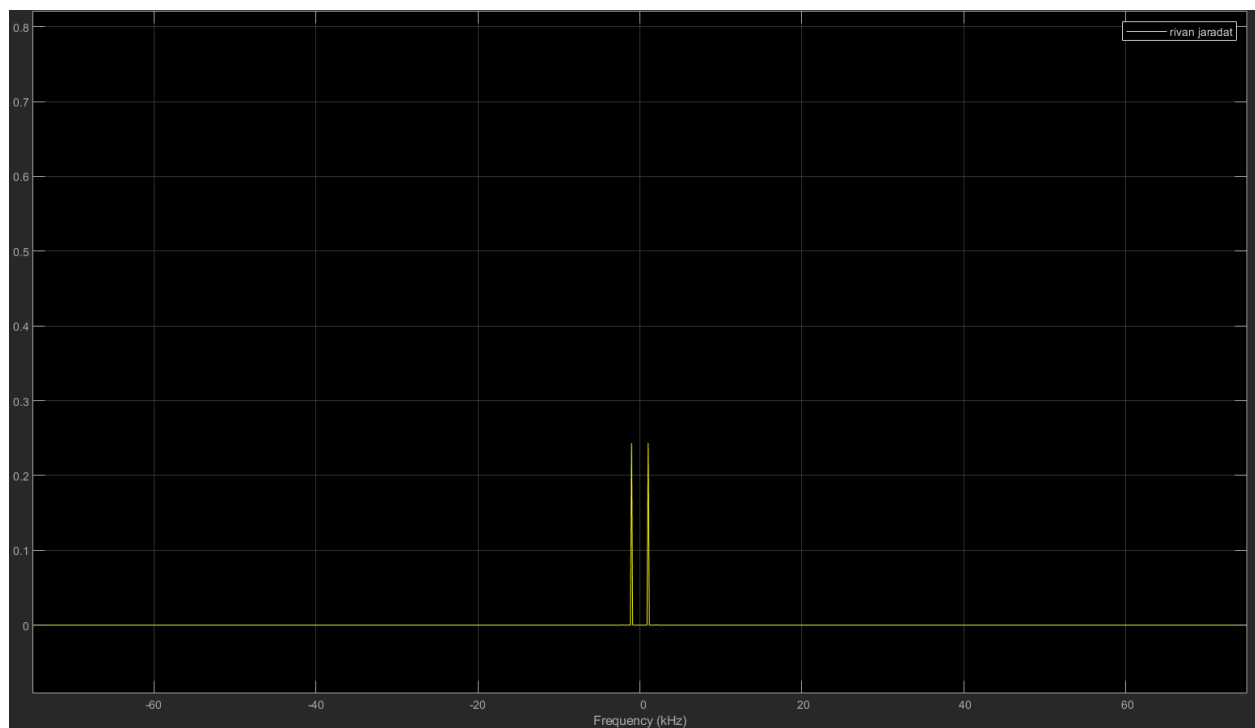


Figure 19. Simulation for envelop detection in frequency domain $\mu < 1$

2.1.3. When $\mu = 1$:

$$Ka = \mu / A_m \rightarrow 1 / 0.85 = 1.176$$



Figure 20. Simulation for envelop detection in time domain $\mu=1$

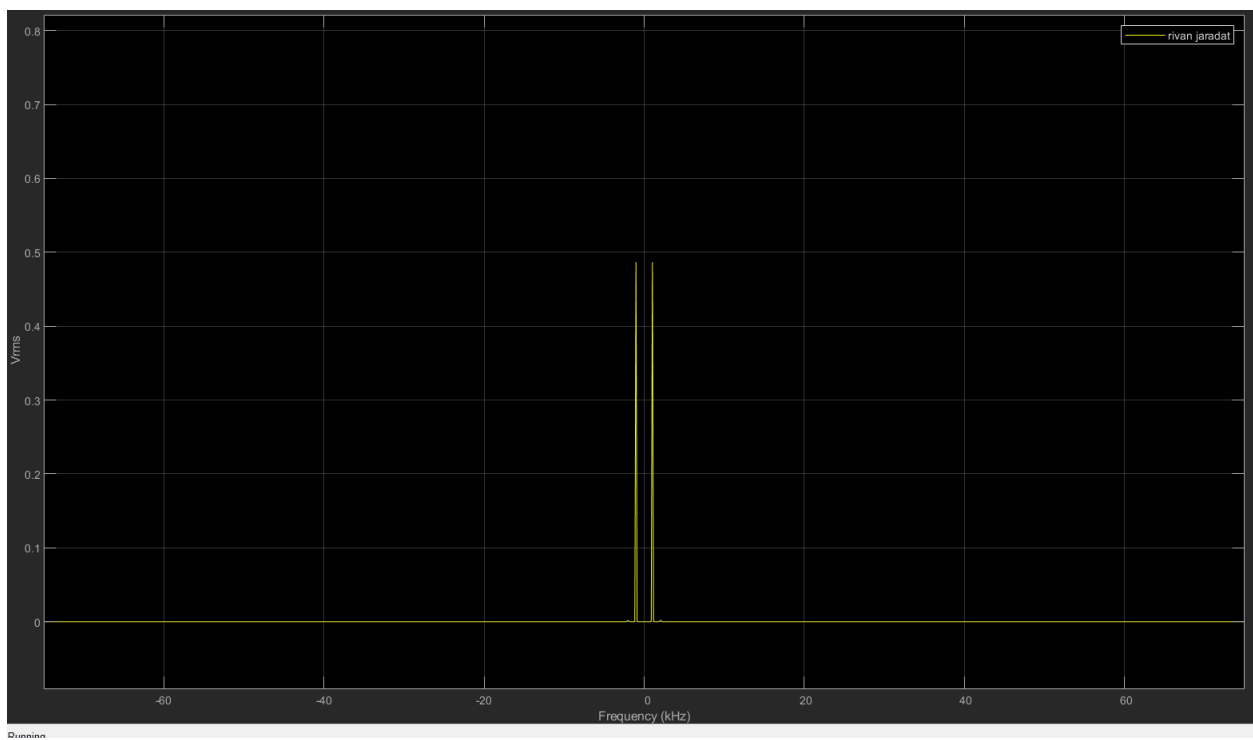


Figure 21. Simulation for envelop detection in frequency domain $\mu=1$

2.2.coherent:

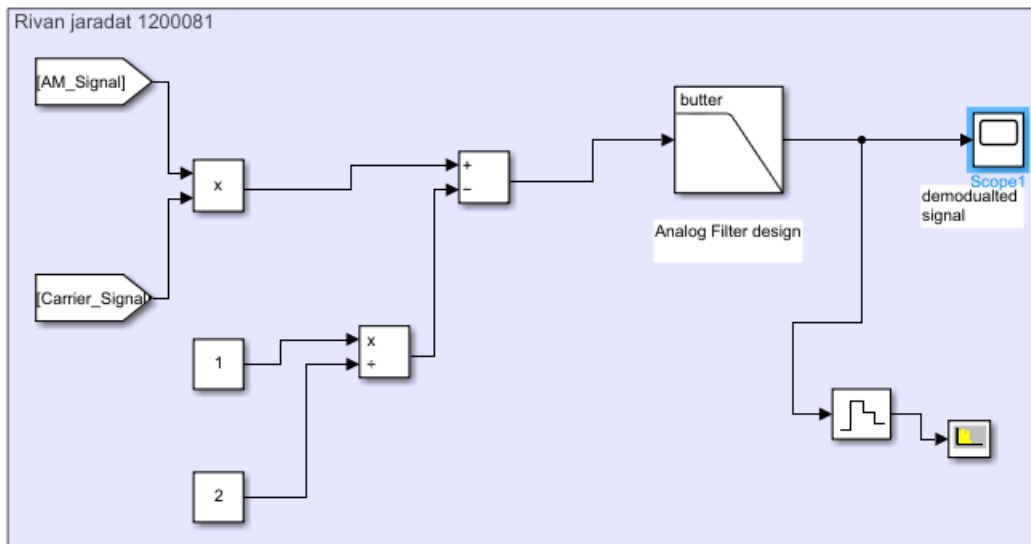


Figure 22.coherent detection block

2.2.1.When $\mu = 1$:

$$K_a = \mu/A_m \rightarrow 1/0.85 = 1.176$$



Figure 23.Simulation for coherent detection in time domain $\mu=1$

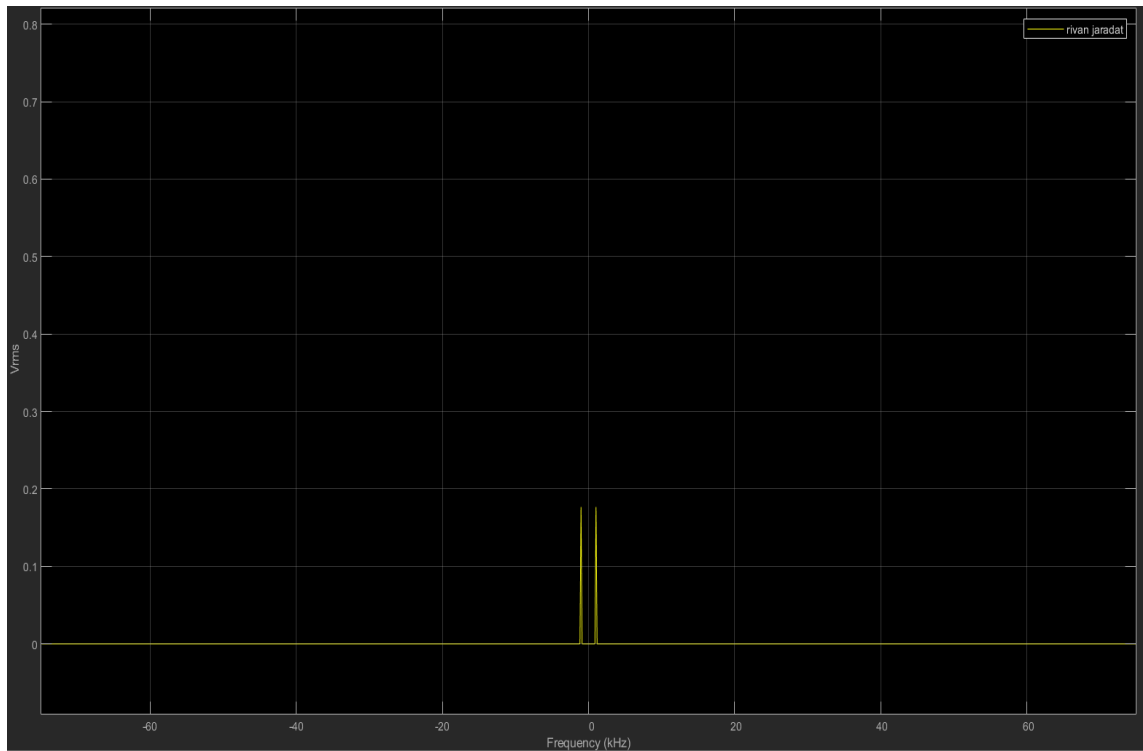


Figure 24. Simulation for coherent detection in frequency domain $\mu=1$

2.2.2. When $\mu < 1$:

$$K_a = \mu / A_m \rightarrow 0.5 / 0.85 = 0.588$$

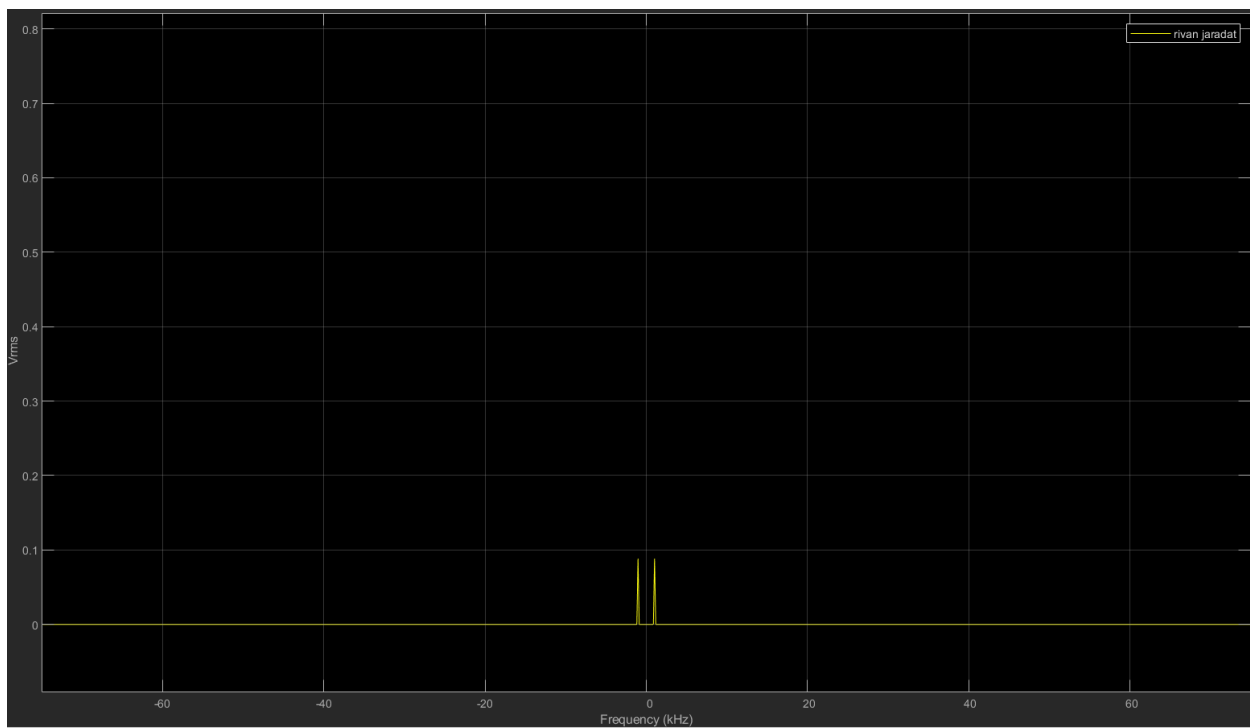


Figure 25. Simulation for coherent detection in frequency domain $\mu < 1$

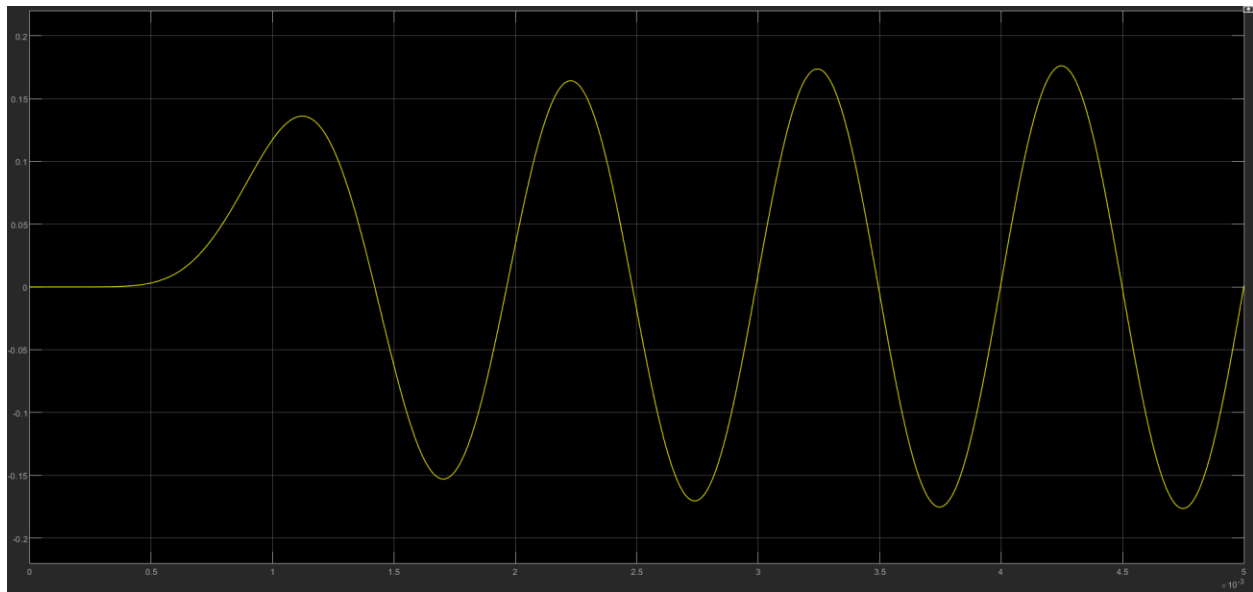


Figure 26. Simulation for coherent detection in time domain $\mu < 1$

2.2.3. When $\mu > 1$:

$$K_a = \mu / A_m \rightarrow 1.5 / 0.85 = 1.764$$

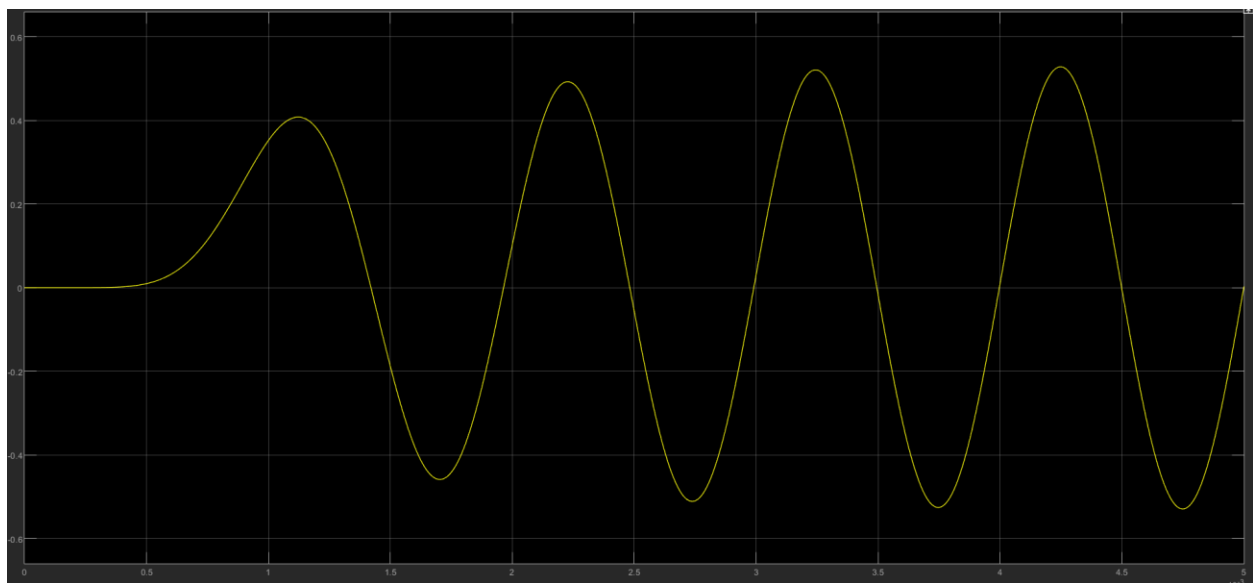


Figure 27. Simulation for coherent detection in time domain $\mu < 1$

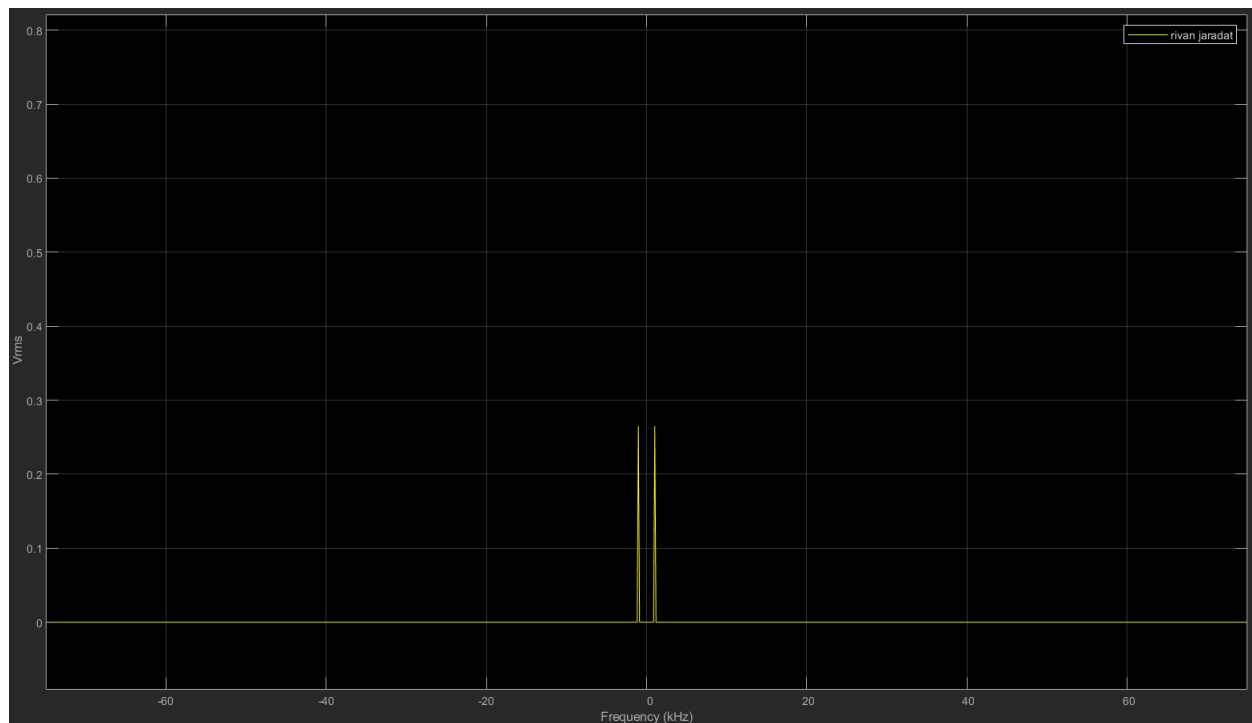


Figure 28. Simulation for coherent detection in frequency domain $\mu > 1$

3.All block diagram:

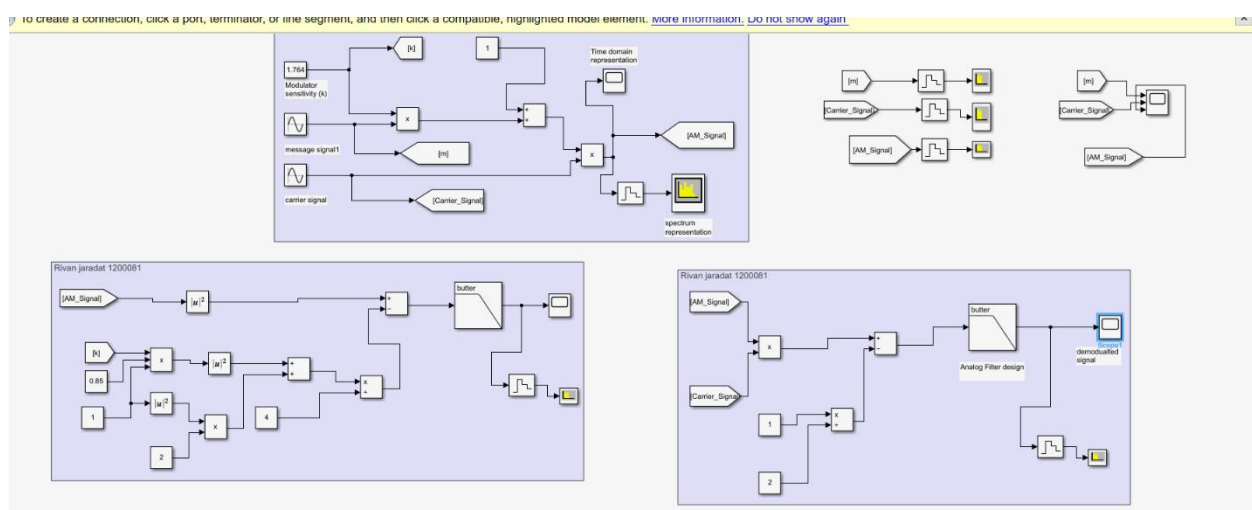


Figure 29.All block diagram