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)=0.85cos(2*pi*1000t)

*The parameter for message signal :

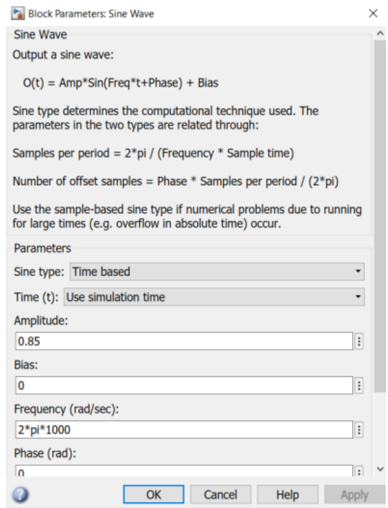


Figure 1.Massage signal parameter

2-carrier signal:

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

The parameter for message signal :

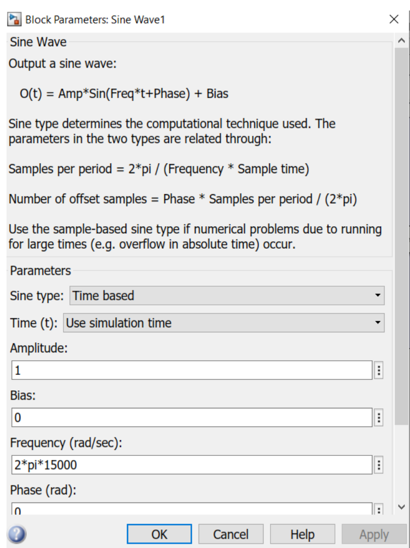


Figure 2.carrier signal parameter

1- Am modulation:

1.1.General block for Am modulation:

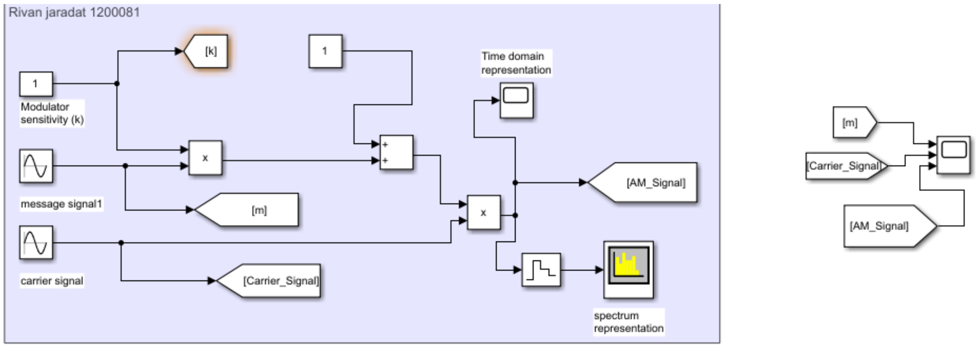


Figure 3.General block for Am modulation

1.2. In Time domain:

1.2.1 When μ = 1:

Ka= μ/Am→1/0.85= 1.176

- Mathematical Representation of AM Signal in Time Domain:
  $s(t) = Ac(1 + Kam(t)) \cos(2\text{pi}f c\ t)$
  $s(t) = (1)(2.17\ (0.85 \cos\ (\ 2\text{pi}(1000)t)) \cos(2\Pi(15\text{k})t)$

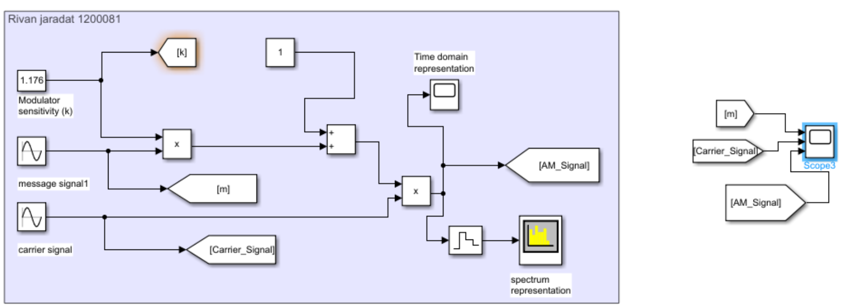


Figure 4.block for Am modulation M=1

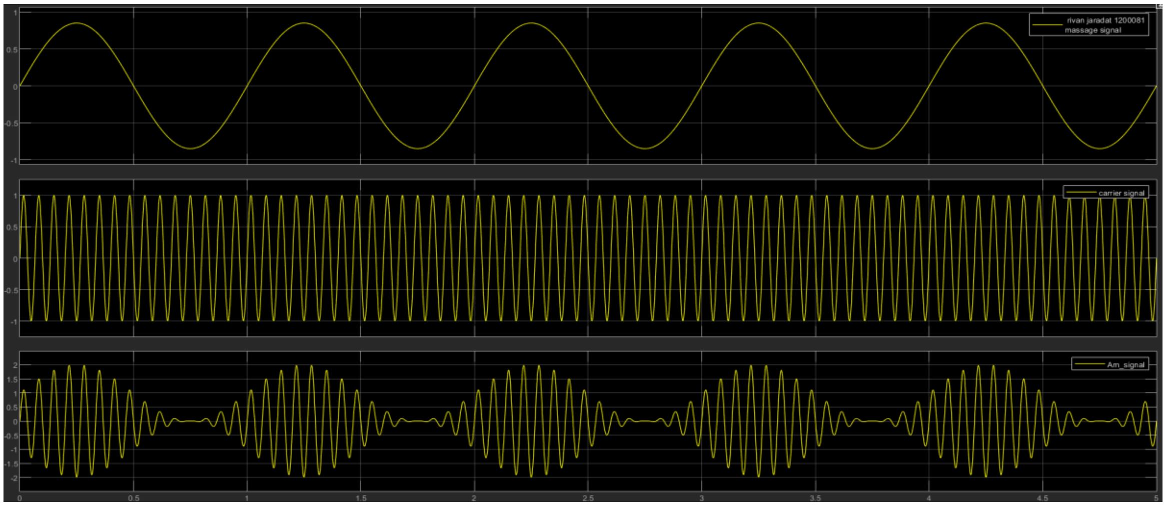


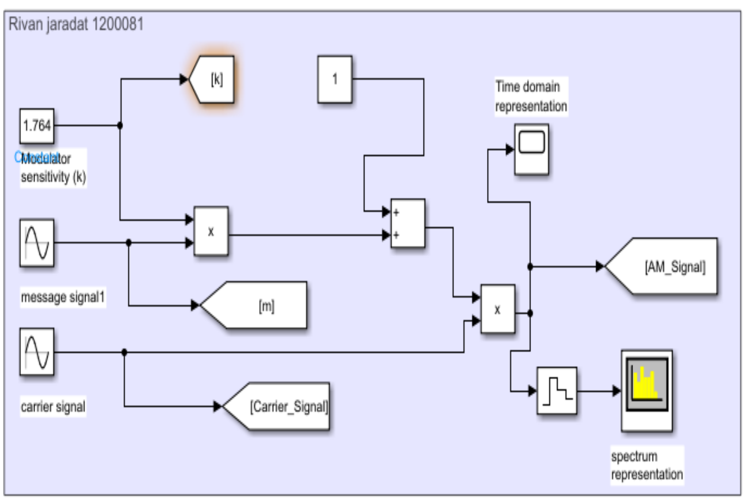
Figure 5.Simulation in Time domain μ=1

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 μ > 1:

Ka= μ/Am→1.5/0.85= 1.764

- Mathematical Representation of AM Signal in Time Domain:
  $s(t) = Ac(1 + Kam(t))\cos(2\text{pi}fc\ t)$
  $s(t) = (1)(2.764\ (0.85\cos(\ 2\text{pi}(1000)t))\cos(2\Pi(15k)t)$



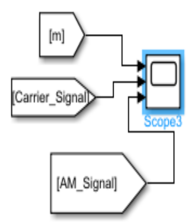


Figure 6.block for Am modulation μ > 1

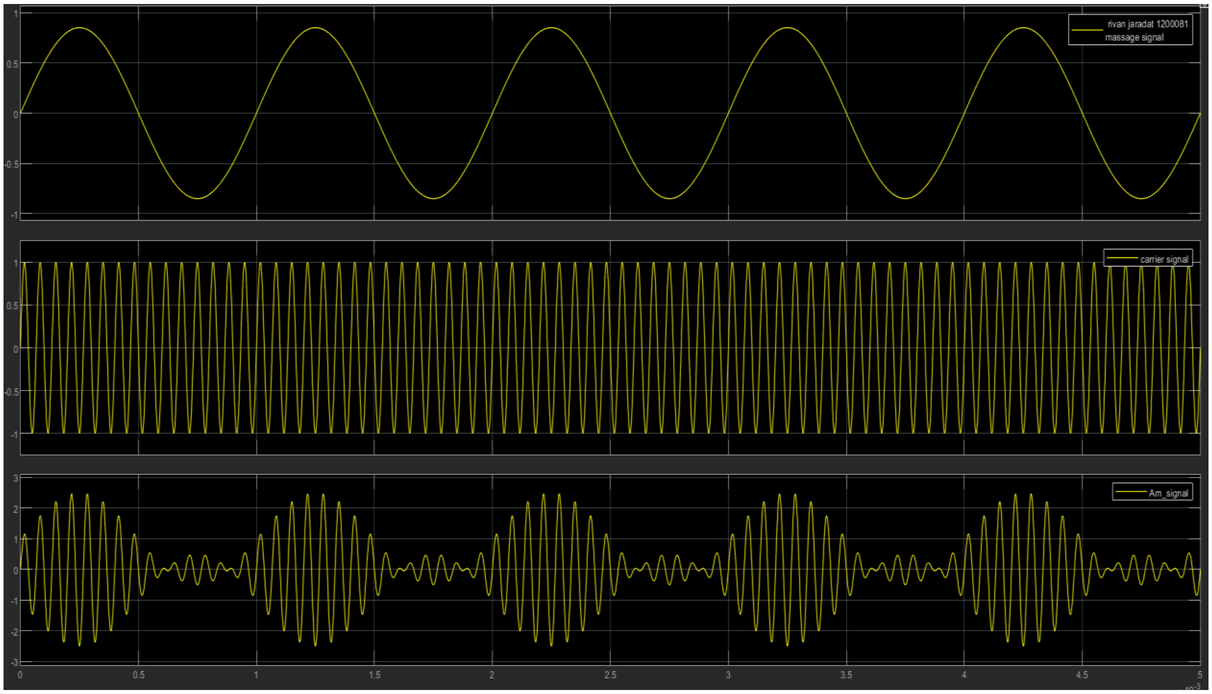


Figure 7.Simulation in Time domain μ>1

1.2.3.When μ <1:

Ka= μ/Am→0.5/0.85= 0.58

- Mathematical Representation of AM Signal in Time Domain:
  $s(t) = Ac(1 + Kam(t))\cos(2\text{pi}fc\ t)$
  $s(t) = (1)(1.588\ (0.85\cos(\ 2\text{pi}(1000)t))\cos(2\Pi(15\text{k})t)$

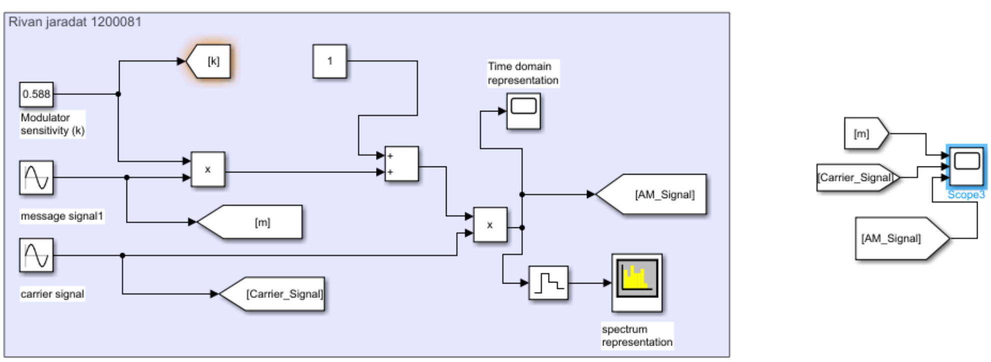


Figure 8.block for Am modulation μ< 1

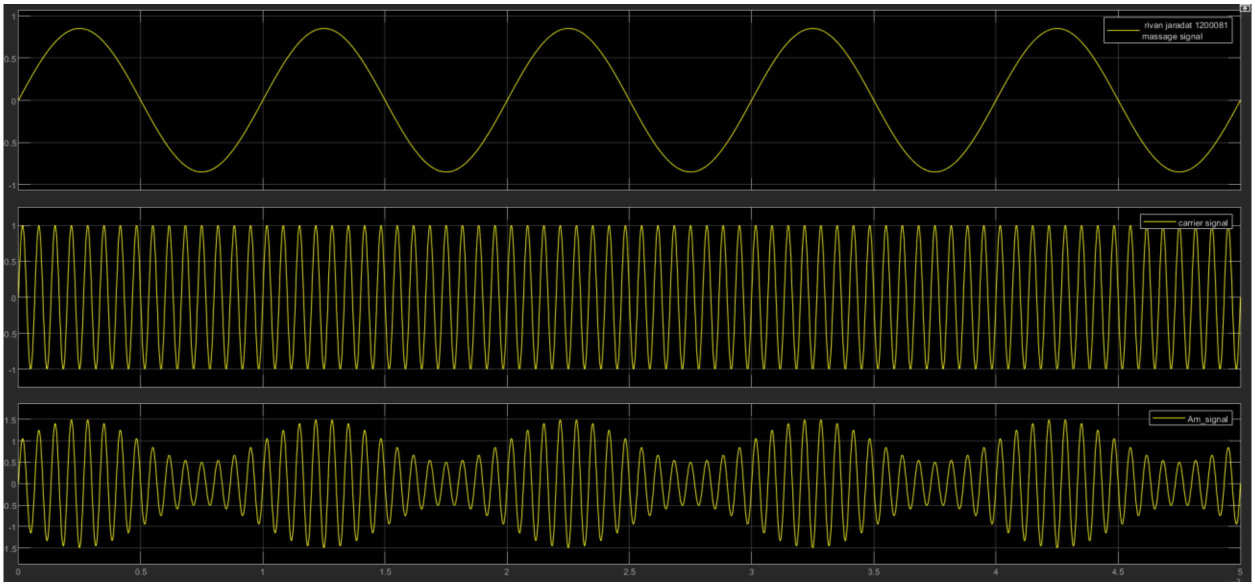


Figure 9.Simulation in Time domain μ<1

1.3 In frequency domain:

1.3.1.When μ <1:

$S(f) = (Ac)/2\,[\,\delta(f - fc) + \delta(f + fc)] + ((Ac)(\mu)/4)\,[\,\delta(f - (fc + fm) + \delta(f + (fc + fm))] + ((Ac)(\mu)/4)\,[\,\delta(f - (fc - fm) + \delta(f + (fc - fm))]$

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

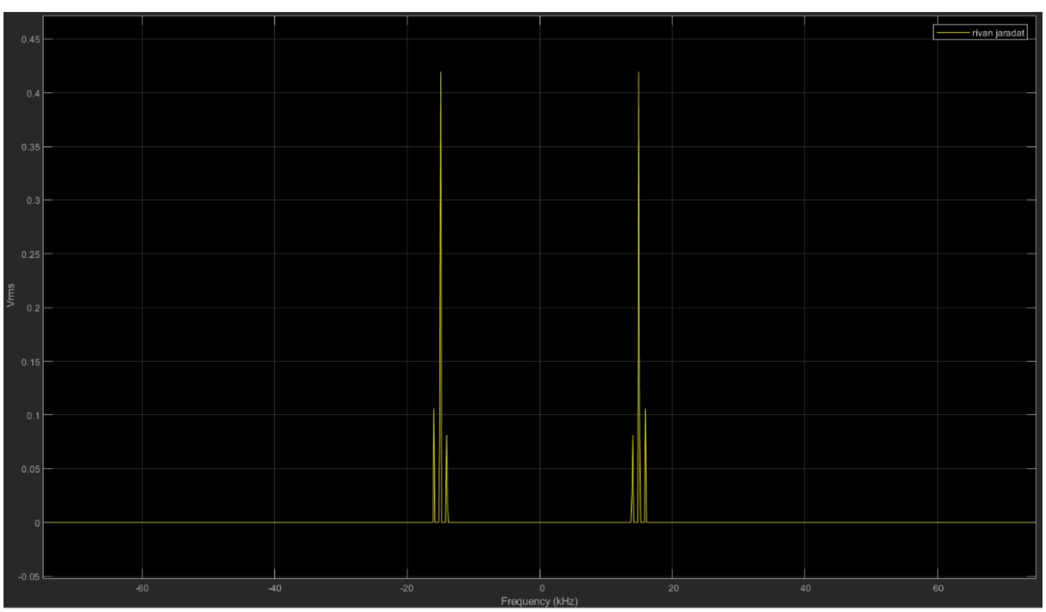


Figure 10.Simulation in frequency domain μ<1

1.3.2.When μ >1:

$S(f) = (Ac)/2\, [\delta(f - fc) + \delta(f + fc)] + ((Ac)(\mu)/4)\, [\delta(f - (fc + fm) + \delta(f + (fc + fm))] + ((Ac)(\mu)/4)\, [\delta(f - (fc - fm) + \delta(f + (fc - fm))]$

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

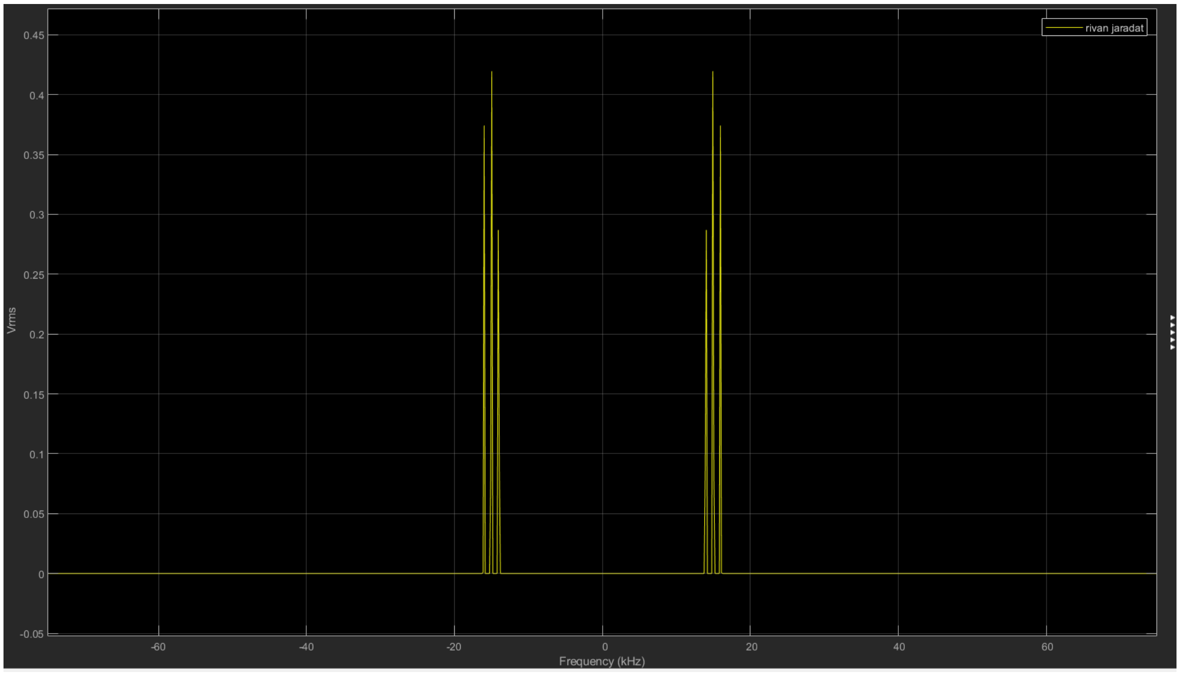


Figure 11.Simulation in frequency domain μ>1

1.3.3. When μ =1:

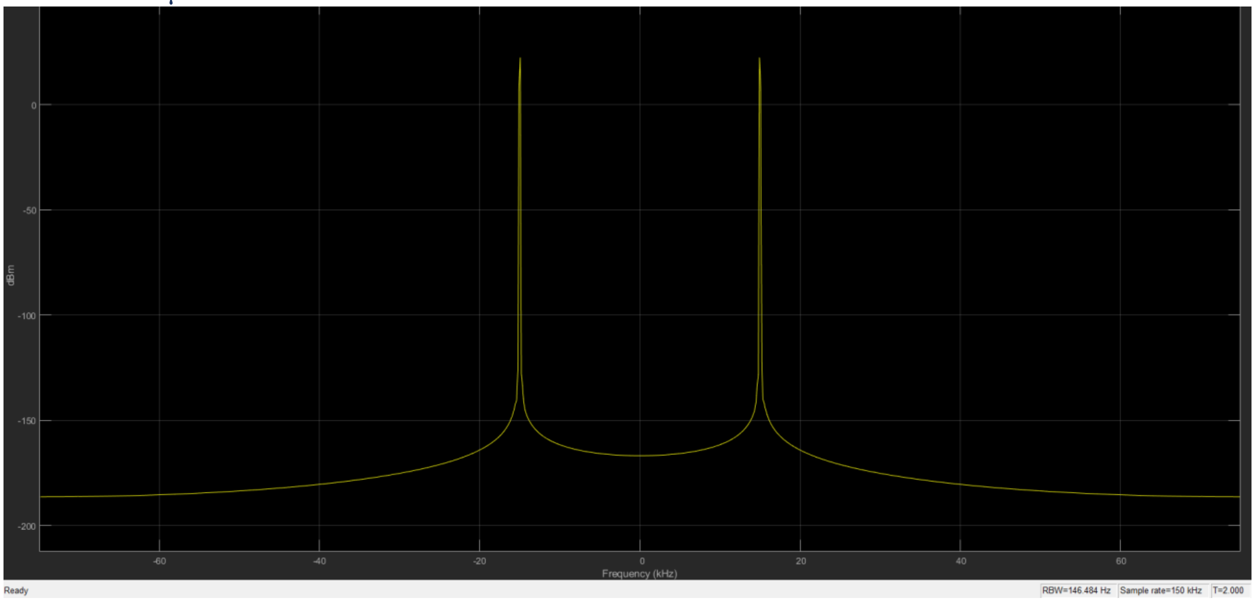


Figure 12.Simulation for carrier signal in frequency domain μ=1

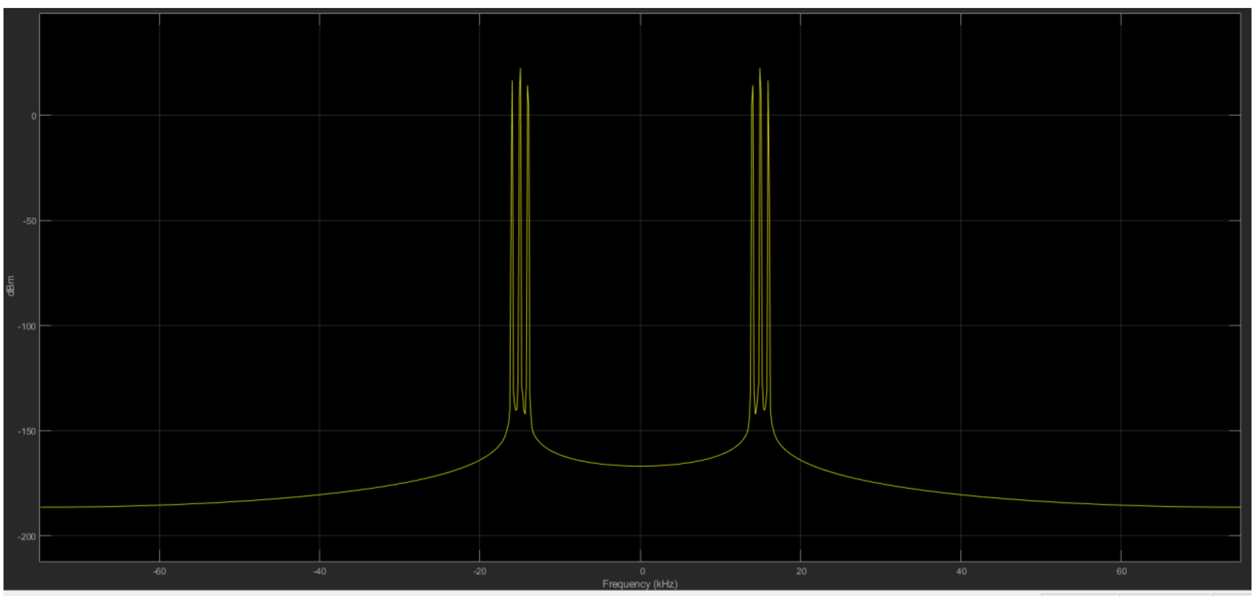


Figure 13.Simulation for message signal in frequency domain μ=1

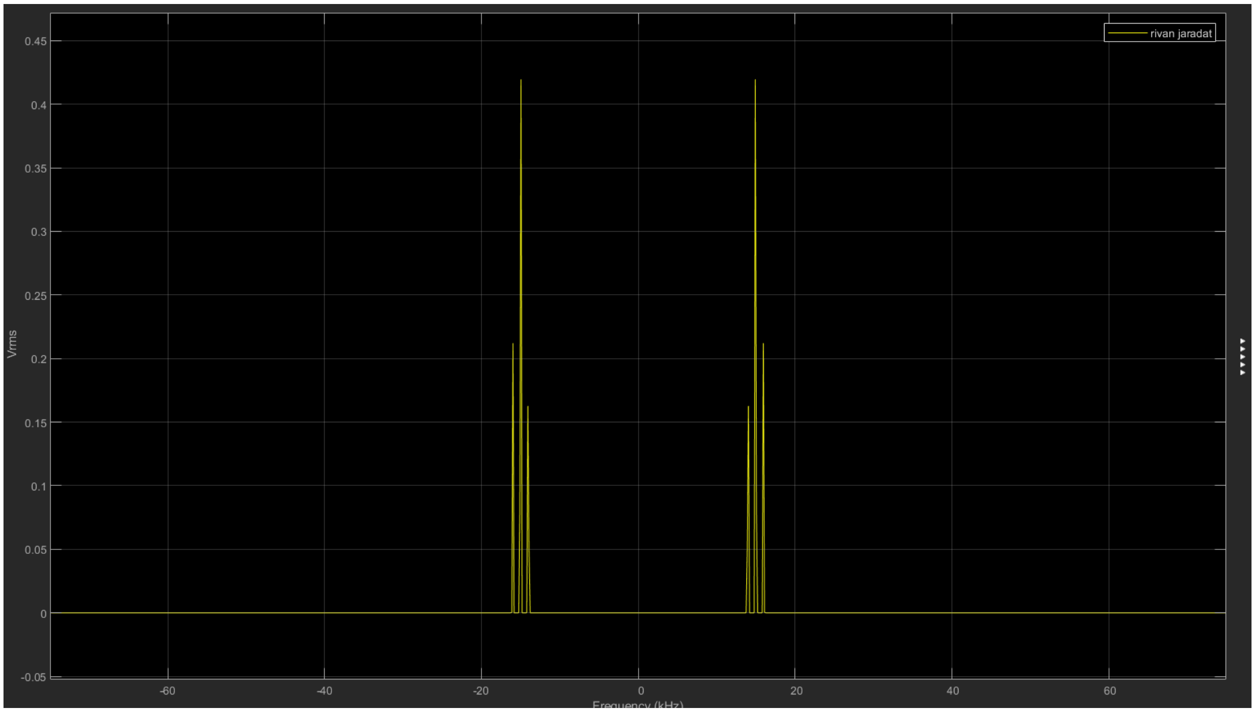


Figure 14.Simulation for s(t) in frequency domain μ=1

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

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

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:

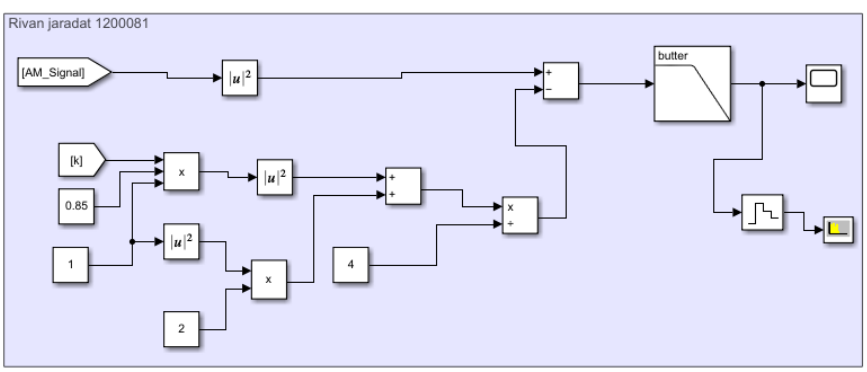


Figure 15.block for envelop detection

2.1.1.When μ >1:

Ka= μ/Am→1.5/0.85= 1.764

Time domain:

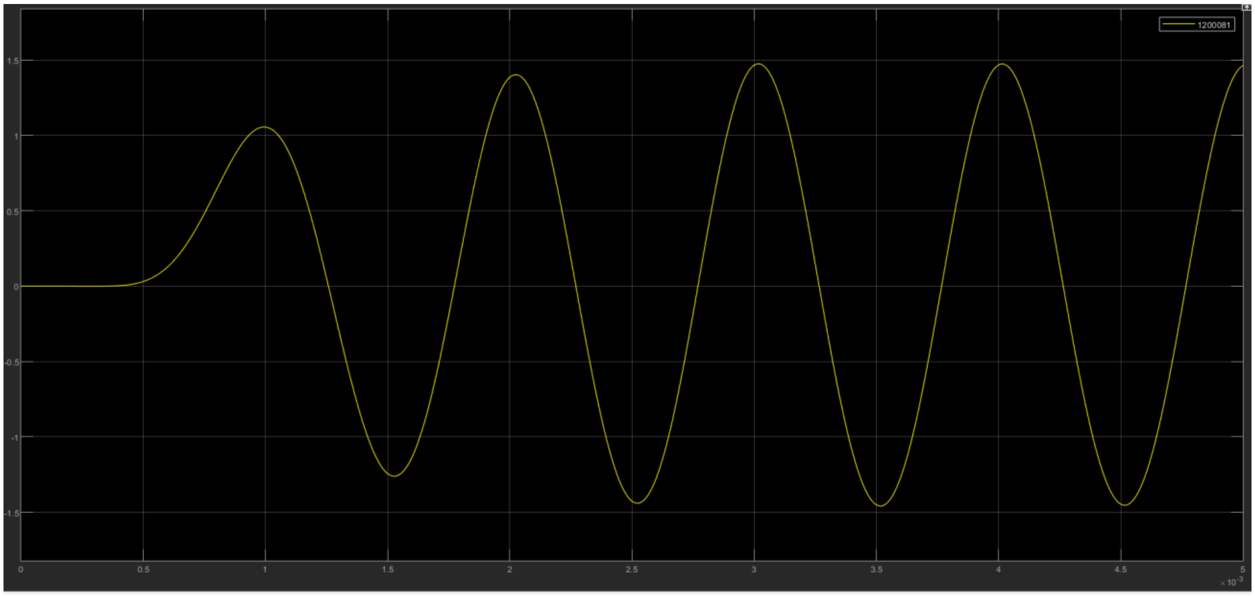


Figure 16.Simulation for envelop detection in time domain μ>1

In frequency domain :

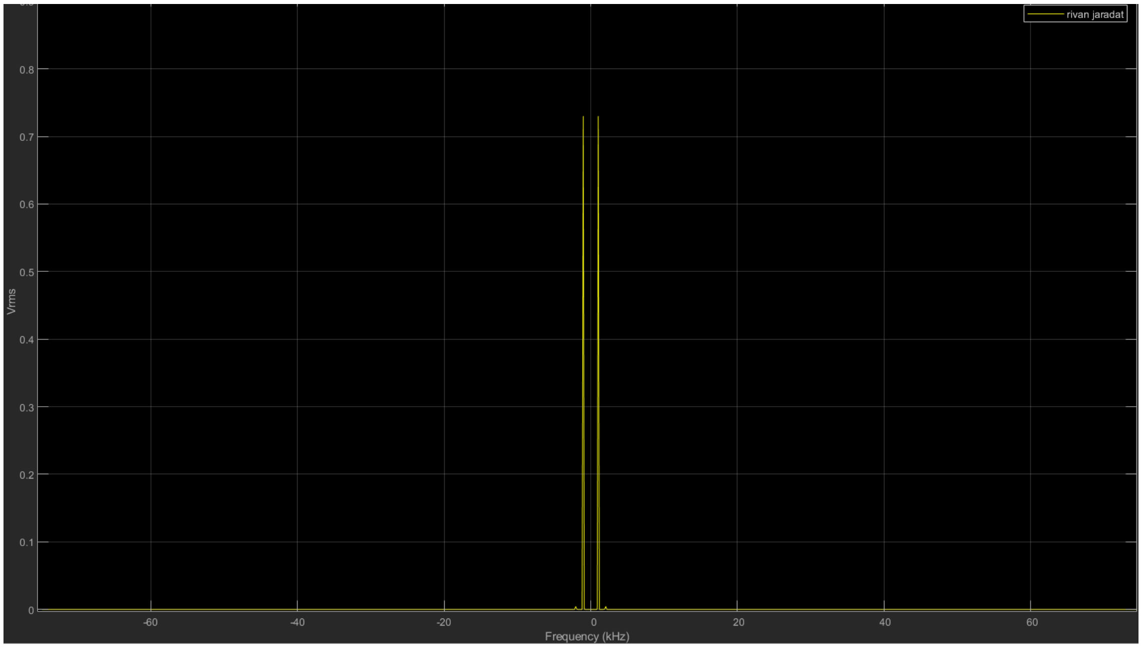


Figure 17.Simulation for envelop detection in frequency domain μ>1

2.1.2.When μ <1:

Ka= μ/Am→0.5/0.85= 0.588

In time domain :

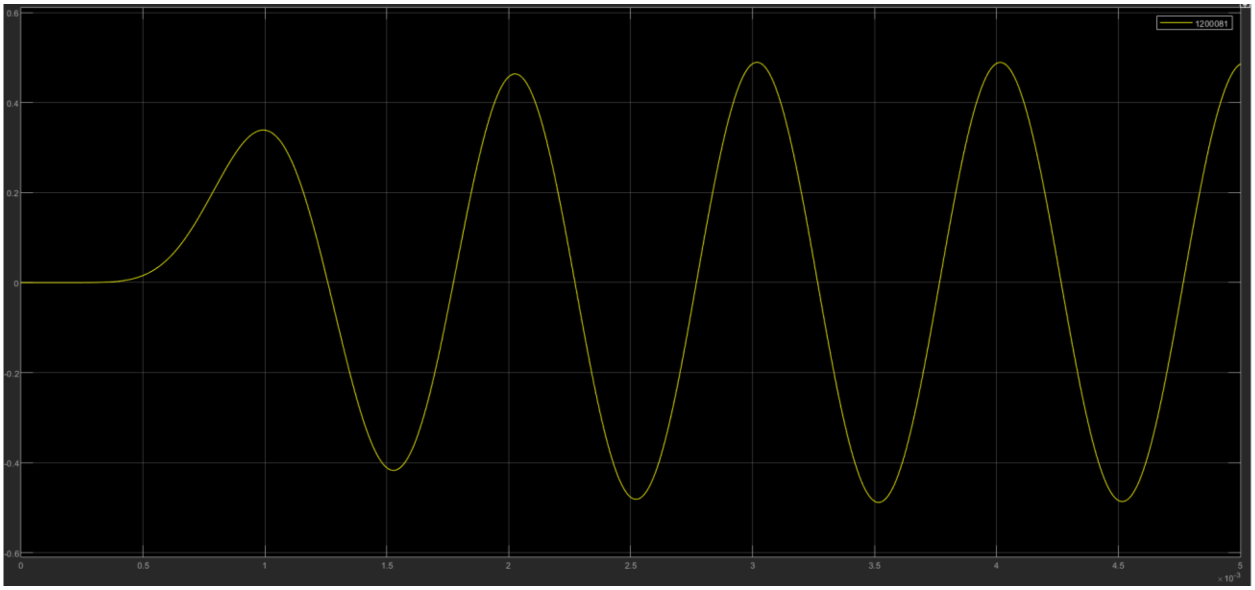


Figure 18.Simulation for envelop detection in time domain μ<1

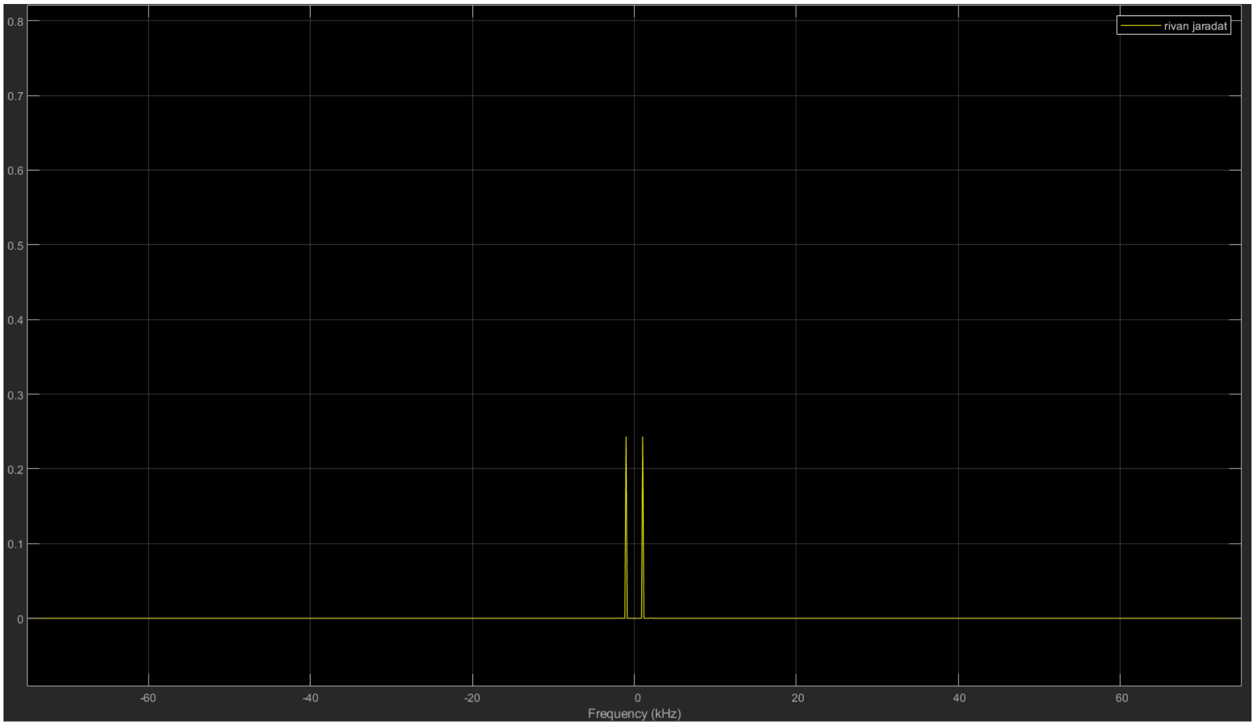


Figure 19.Simulation for envelop detection in frequency domain μ<1

2.1.3.When μ = 1:

Ka= μ/Am→1/0.85= 1.176

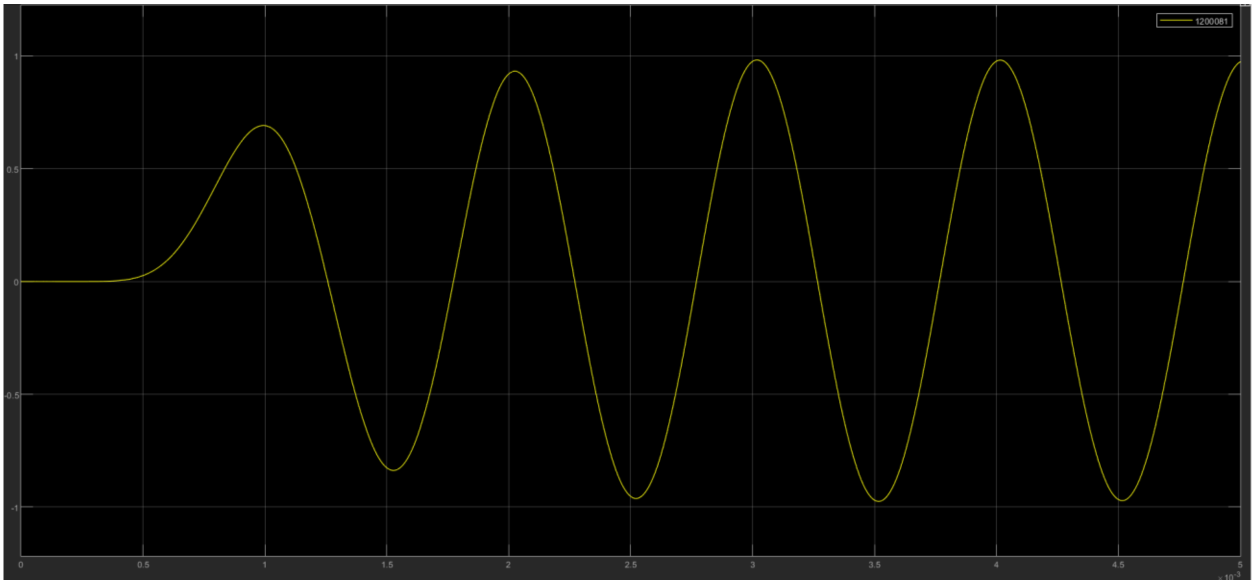


Figure 20.Simulation for envelop detection in time domain μ=1

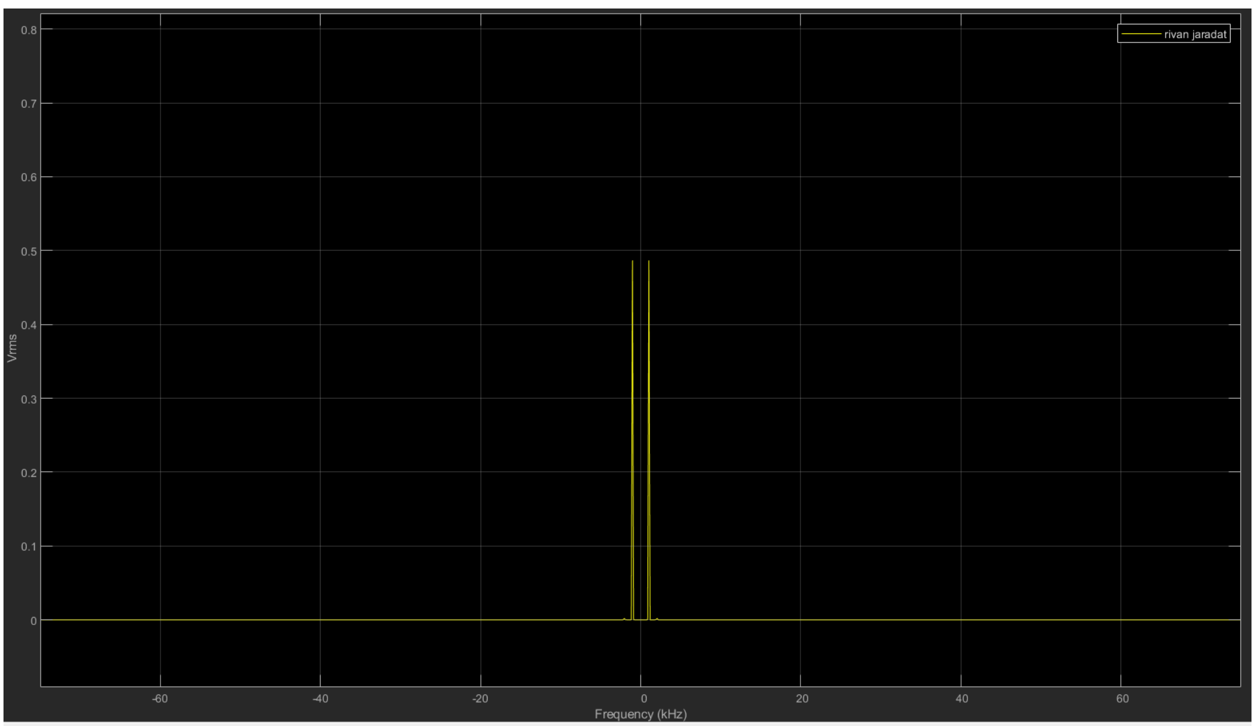


Figure 21.Simulation for envelop detection in frequency domain μ=1

2.2.coherent:

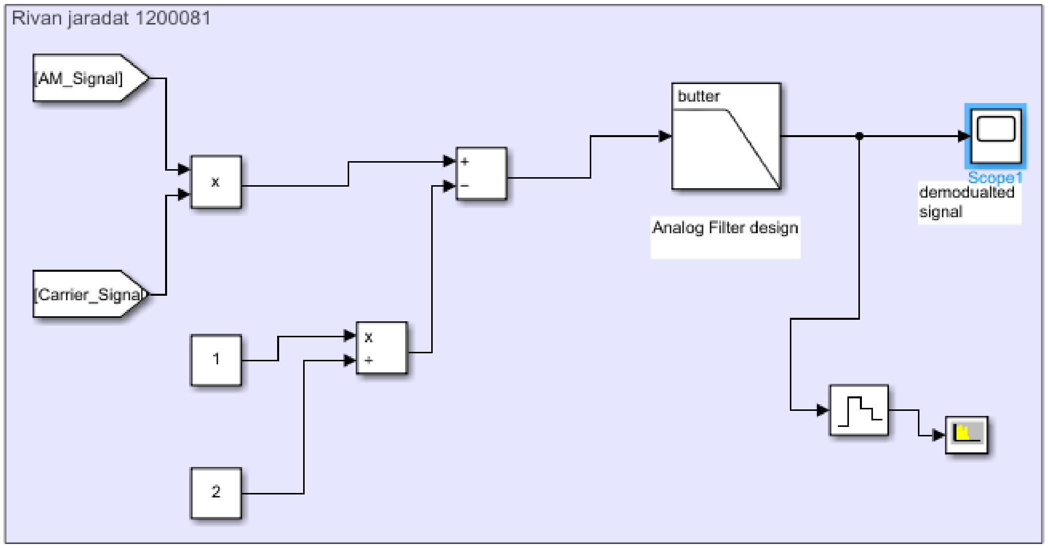


Figure 22.coherent detection block

2.2.1.When μ = 1:

Ka= μ/Am→1/0.85= 1.176

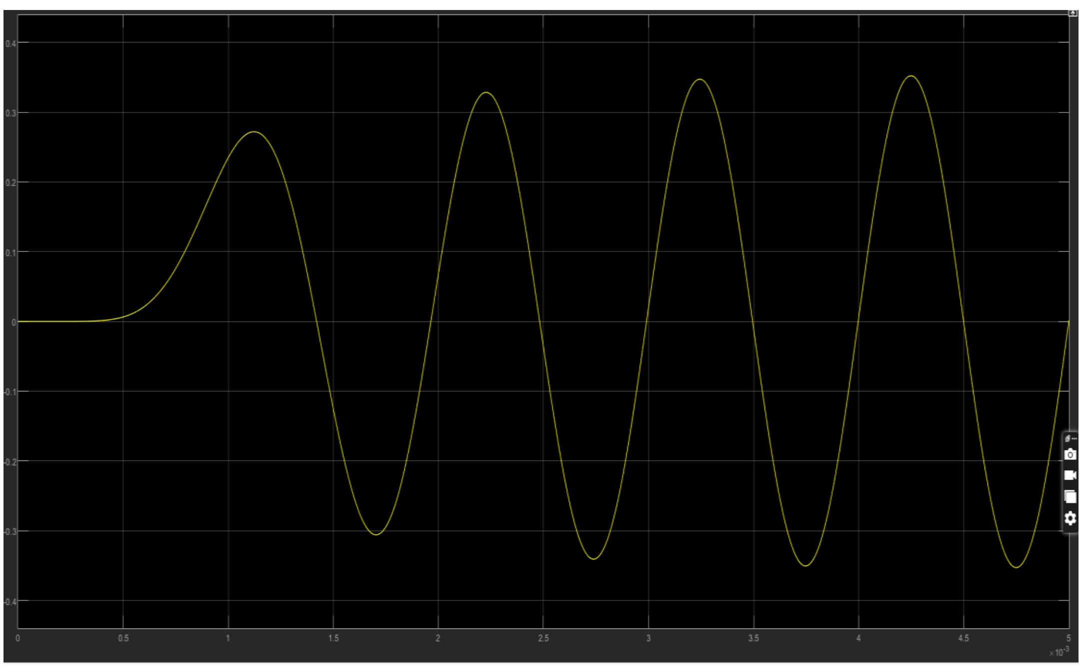


Figure 23.Simulation for coherent detection in time domain μ=1

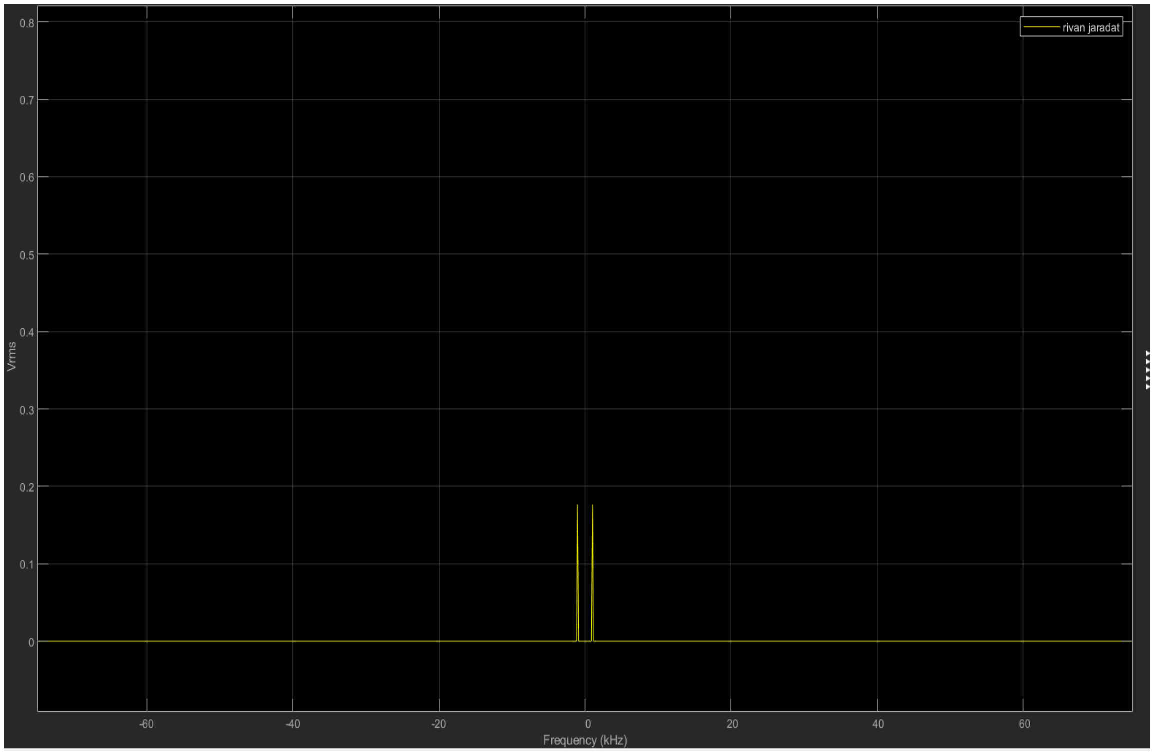


Figure 24.Simulation for coherent detection in frequency domain μ=1

2.2.2.When μ <1:

Ka= μ/Am→0.5/0.85= 0.588

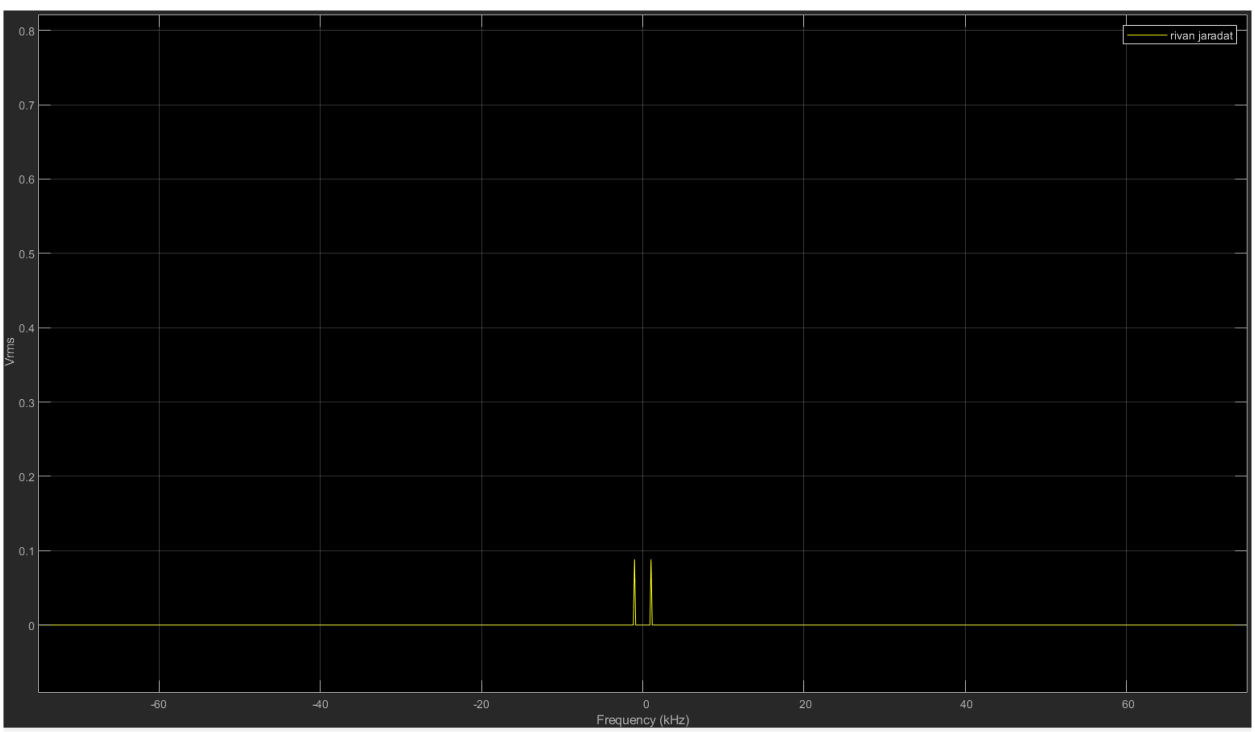


Figure 25.Simulation for coherent detection in frequency domain μ<1

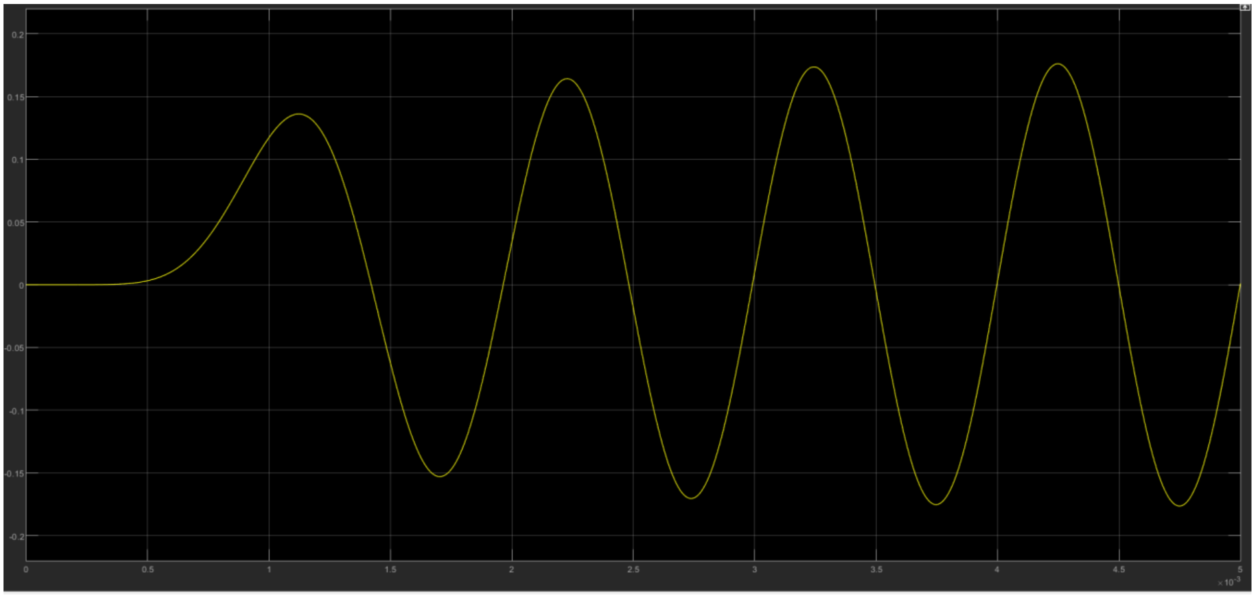


Figure 26.Simulation for coherent detection in time domain μ<1

2.2.3.When μ >1:

Ka= μ/Am→1.5/0.85= 1.764

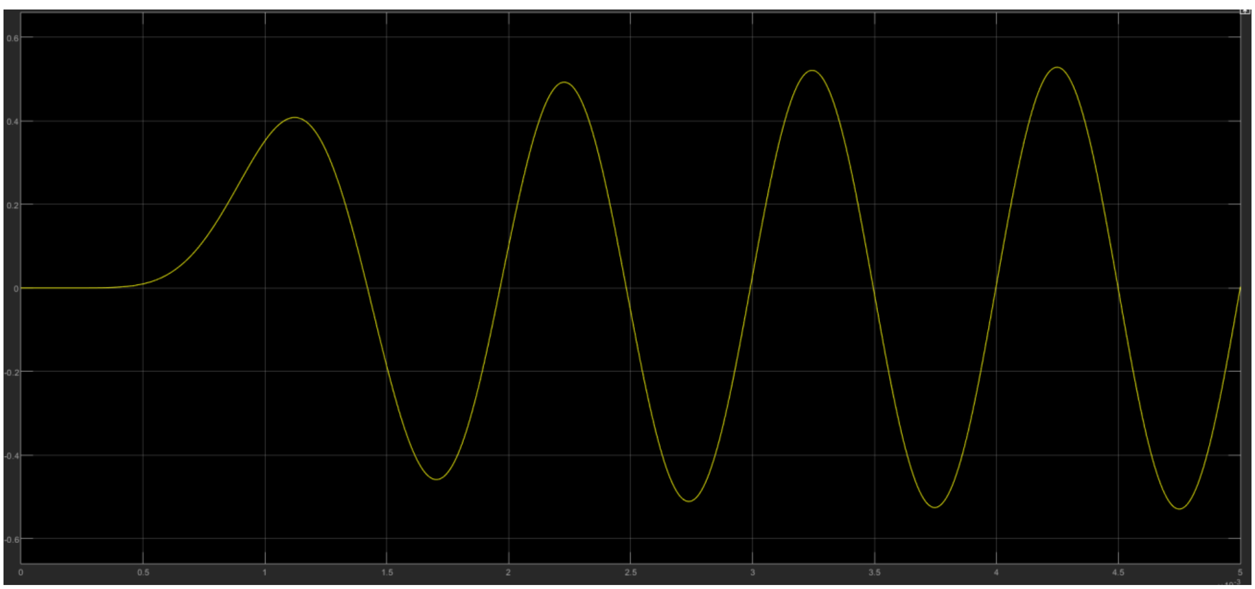


Figure 27.Simulation for coherent detection in time domain μ<1

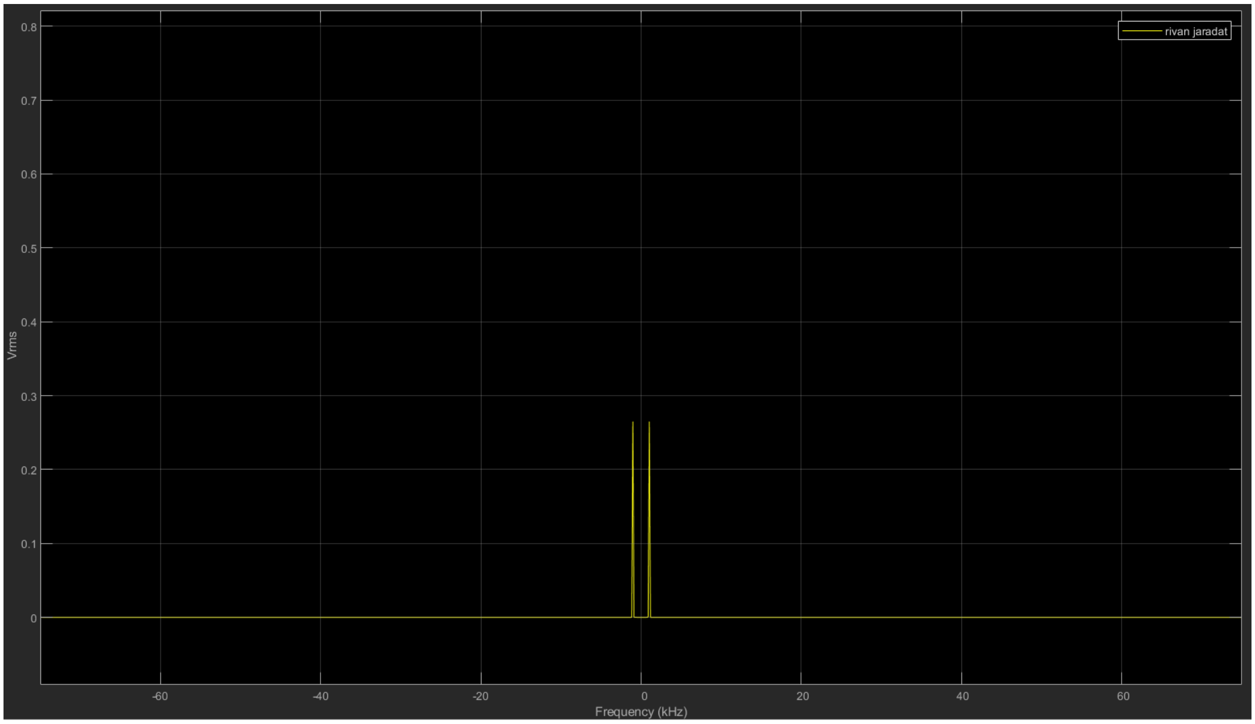


Figure 28.Simulation for coherent detection in frequency domain μ>1

3.All block diagram:

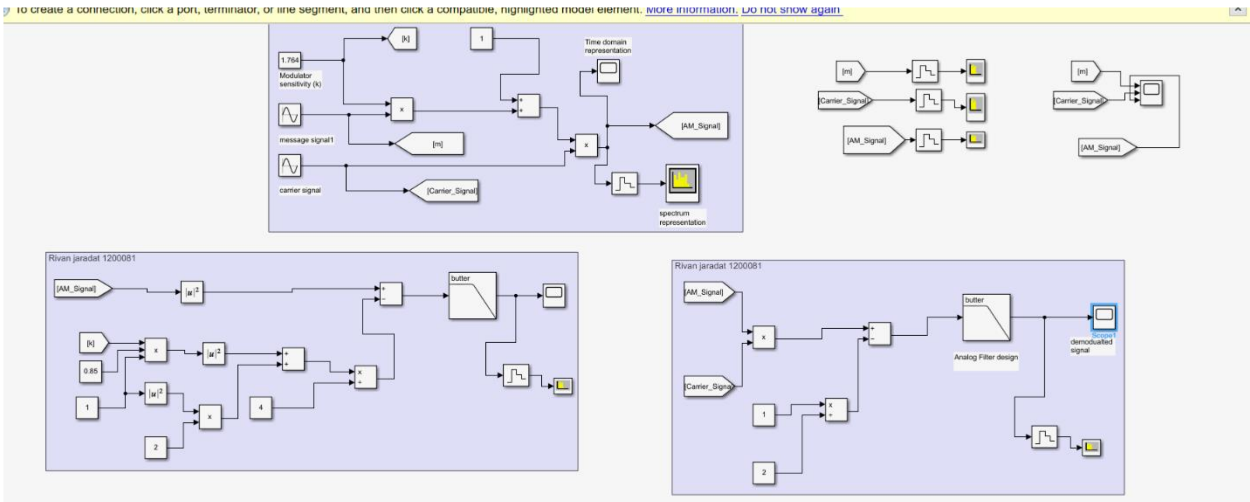


Figure 29.All block diagram