FACULTY OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

ENEE 4113, Communication Laboratory

Experiment. 6 Prelab

Pulse Amplitude Modulation (Sampling)

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T.A:

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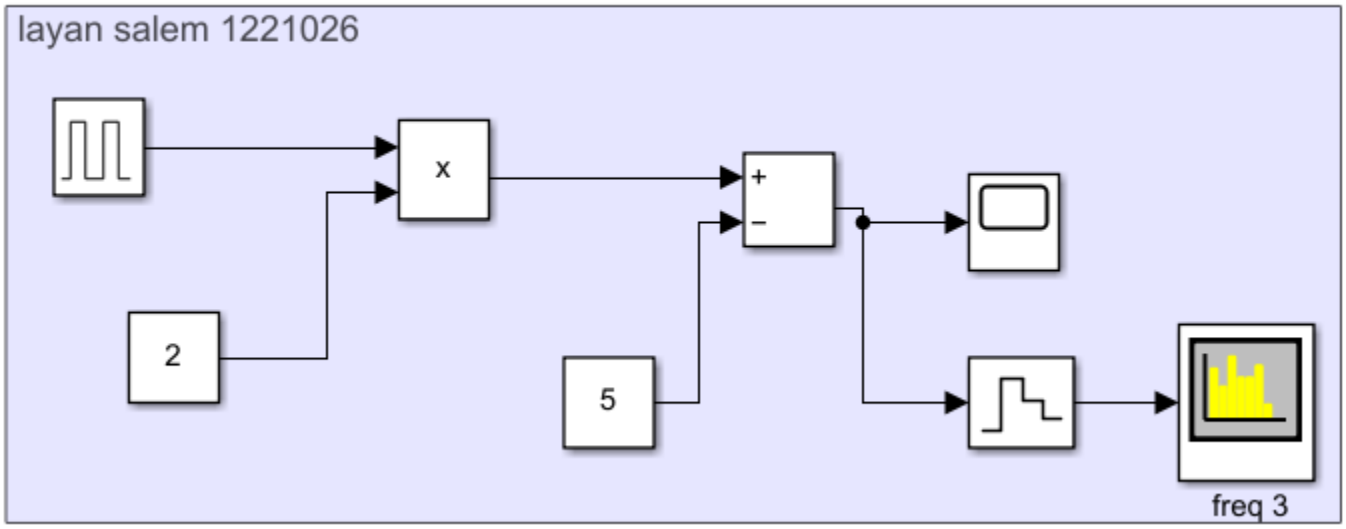
1 Table Content

Simulation and Data analysis

Part 1: Time and Frequency Characteristics of pulse Modulation :



Here , the pulse generator block generate a pulse equal to 1, then it is multiplied by 2, then all values are subtracted by 2.

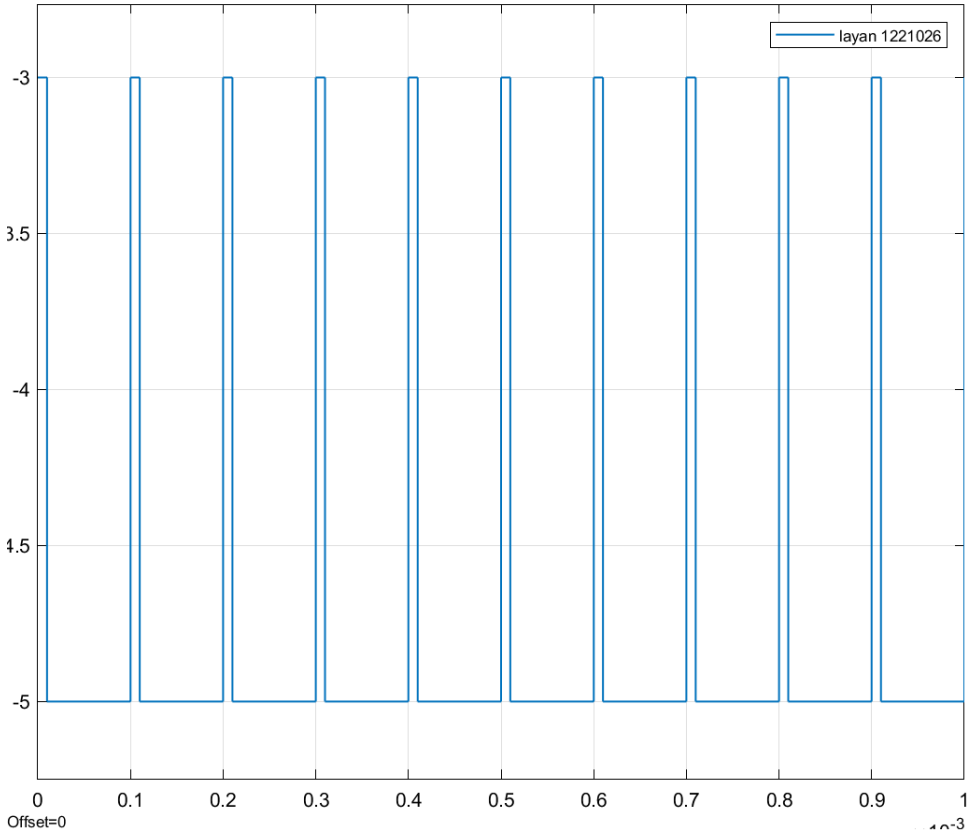
Note : Constants here can have any value.

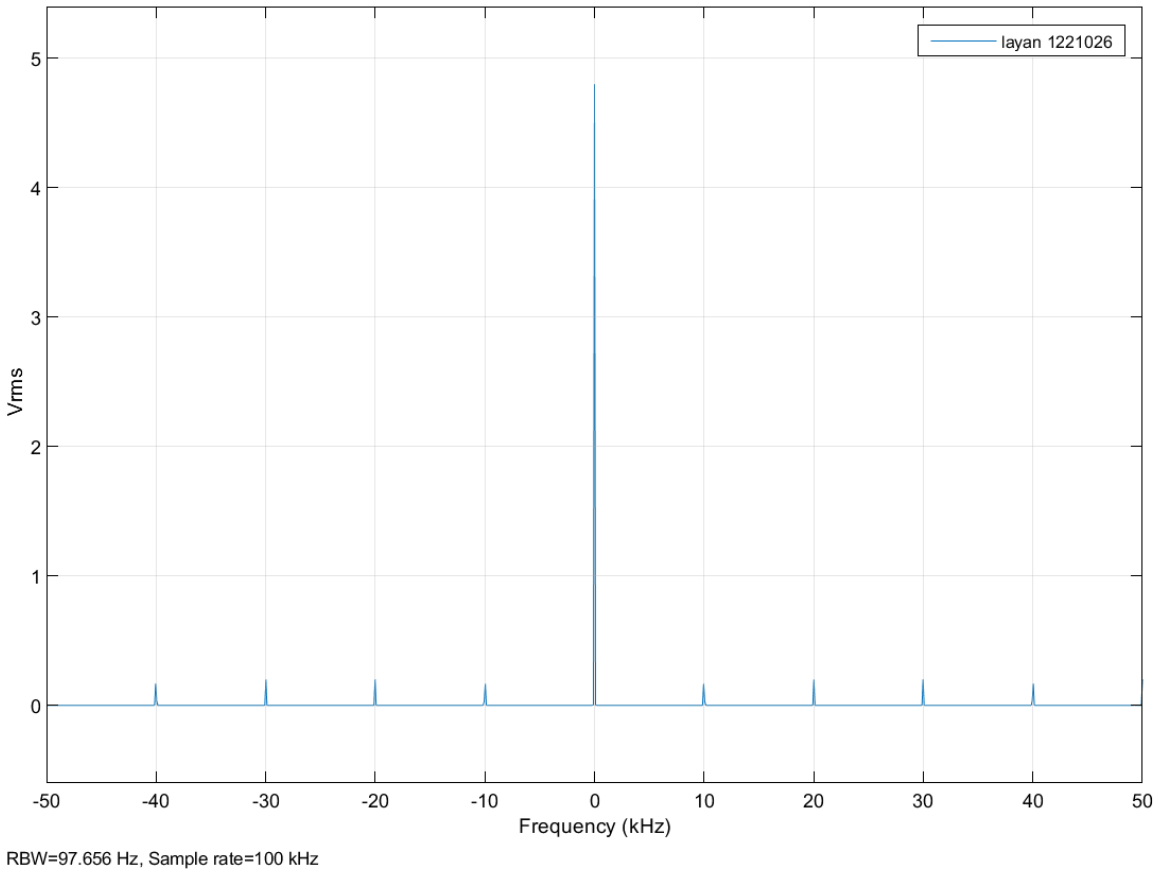
In this part period of the pulse generator was set to (0.0001 = 1/10000).

Duty cycle is defined as the ratio of time a load or circuit is ON (Amplitude ≠ 0) compared to the time the load or circuit is OFF (Amplitude = 0).

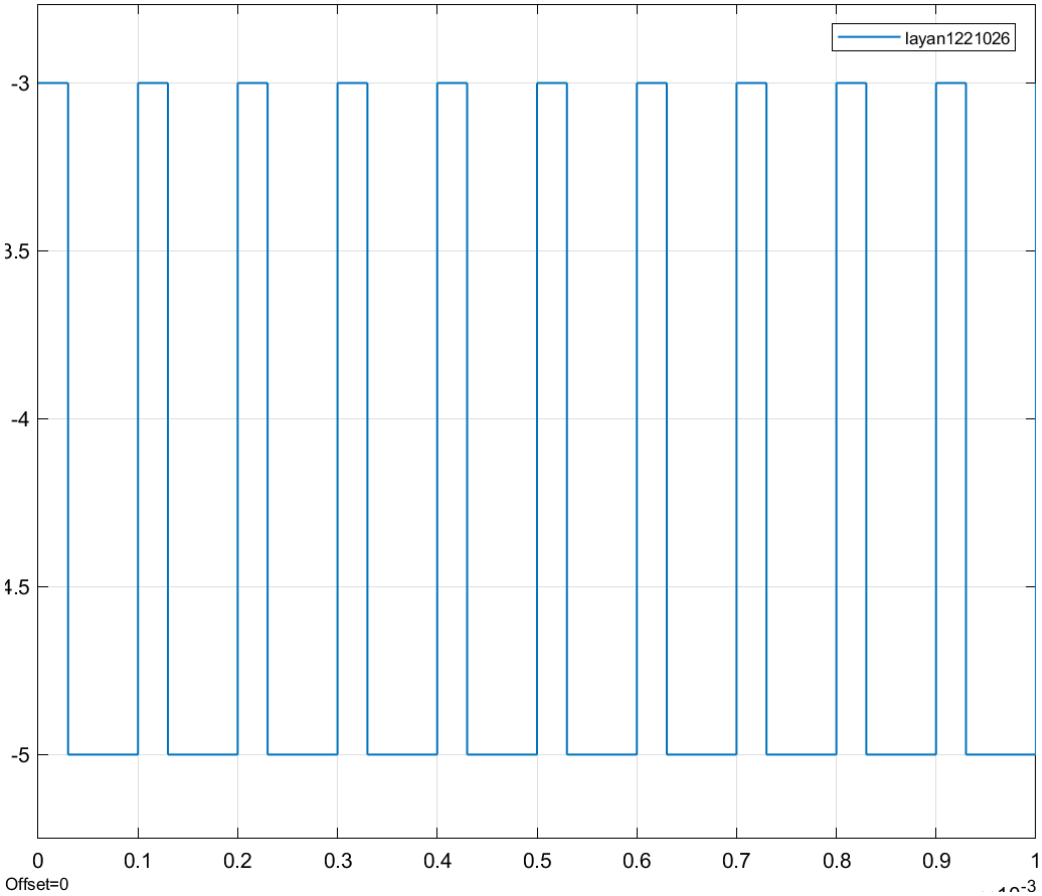
In this part we viewed the time and frequency domain of different duty cycles as follows:

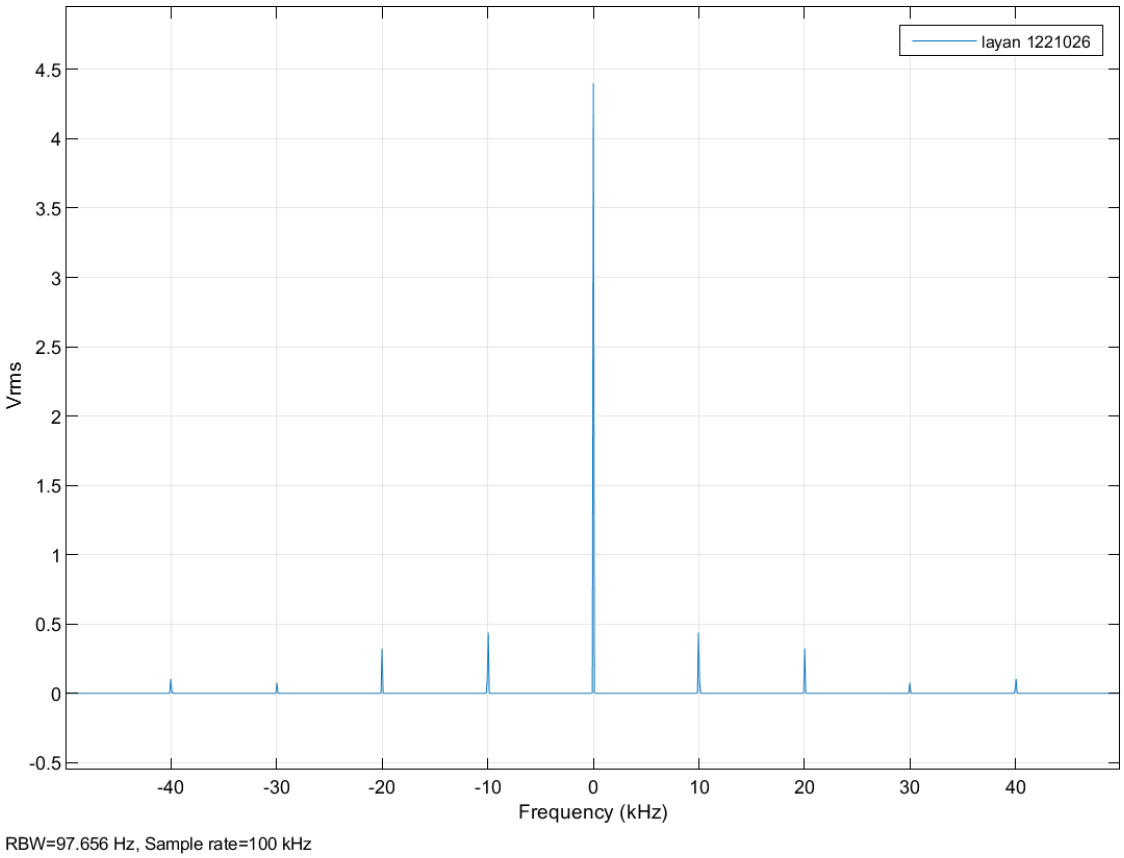
→At 10% duty cycle





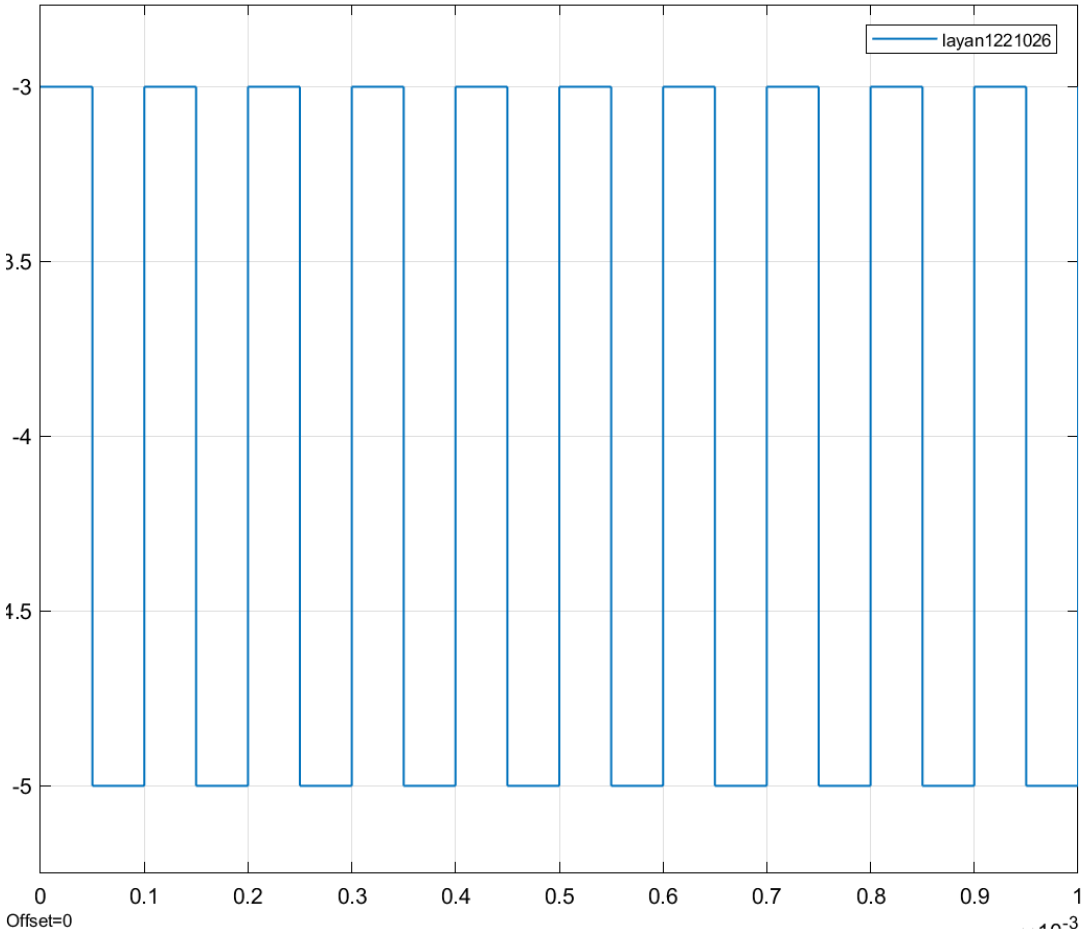
→At 30% duty cycle

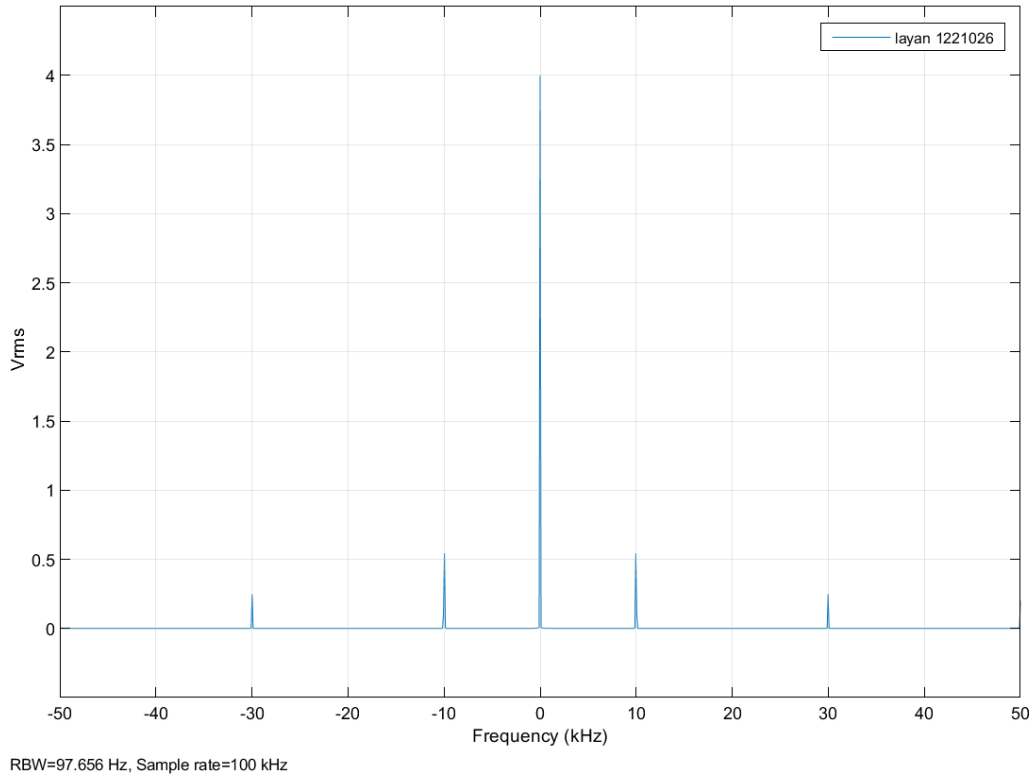




RBW=97.656 Hz, Sample rate=100 kHz

→At 50% duty cycle

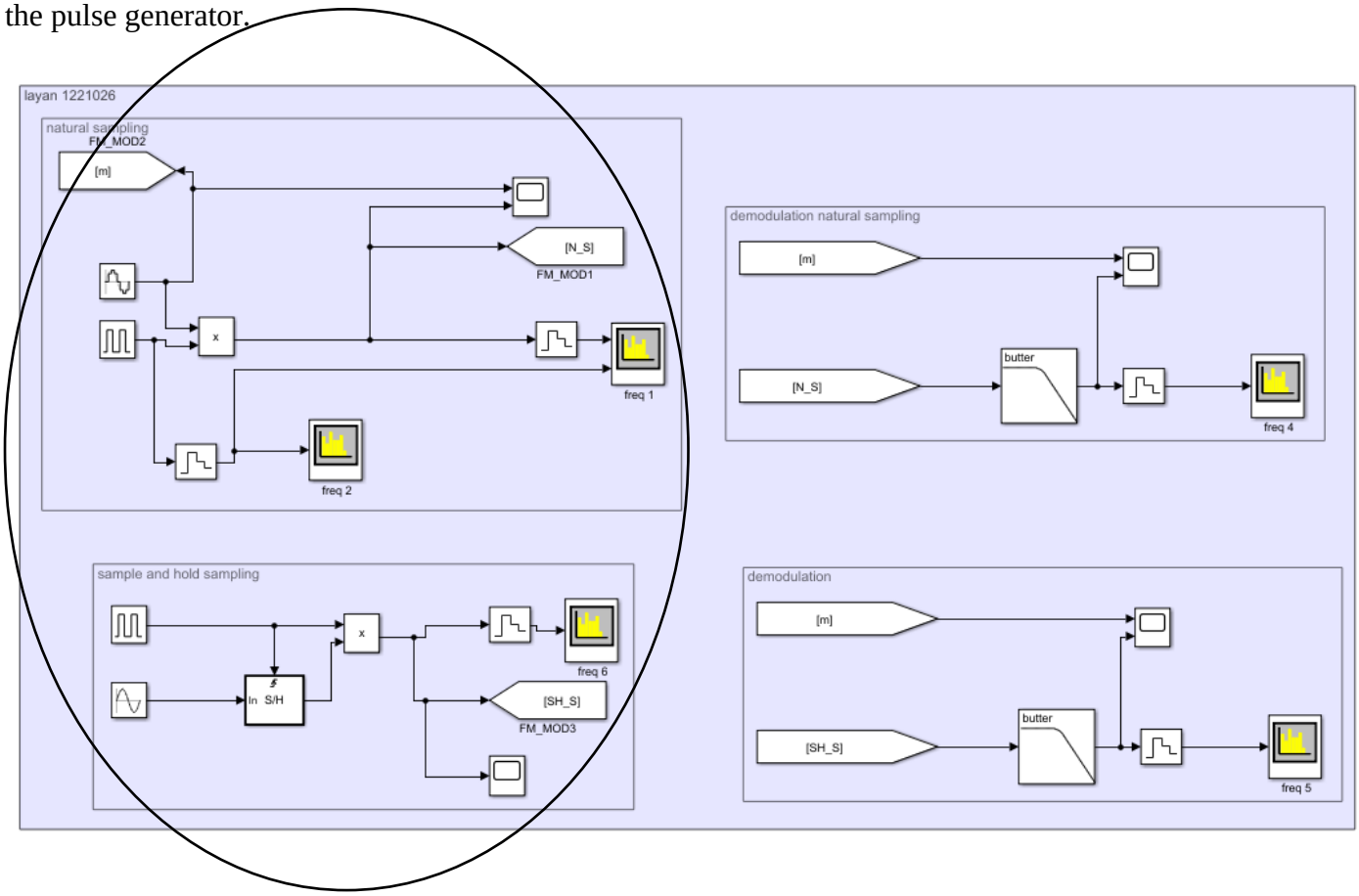




Part 2: Characteristics of Pulse Amplitude Modulation (PAM) :

Sampling refers to the process of converting the signal from continuous time and continuous amplitude into discrete time and continuous amplitude sequence.

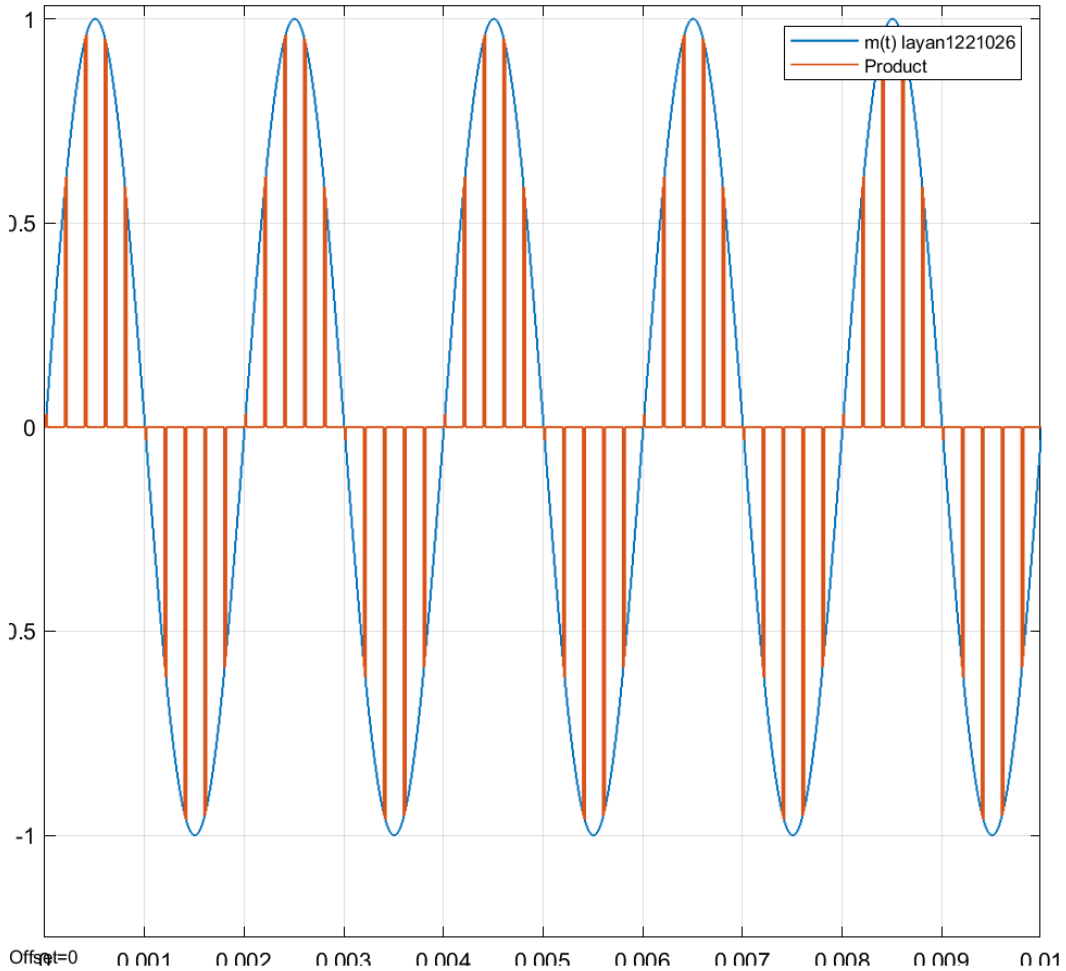
That can be generated by multiplying the message signal by a sequency of pulse, generated from the pulse generator.

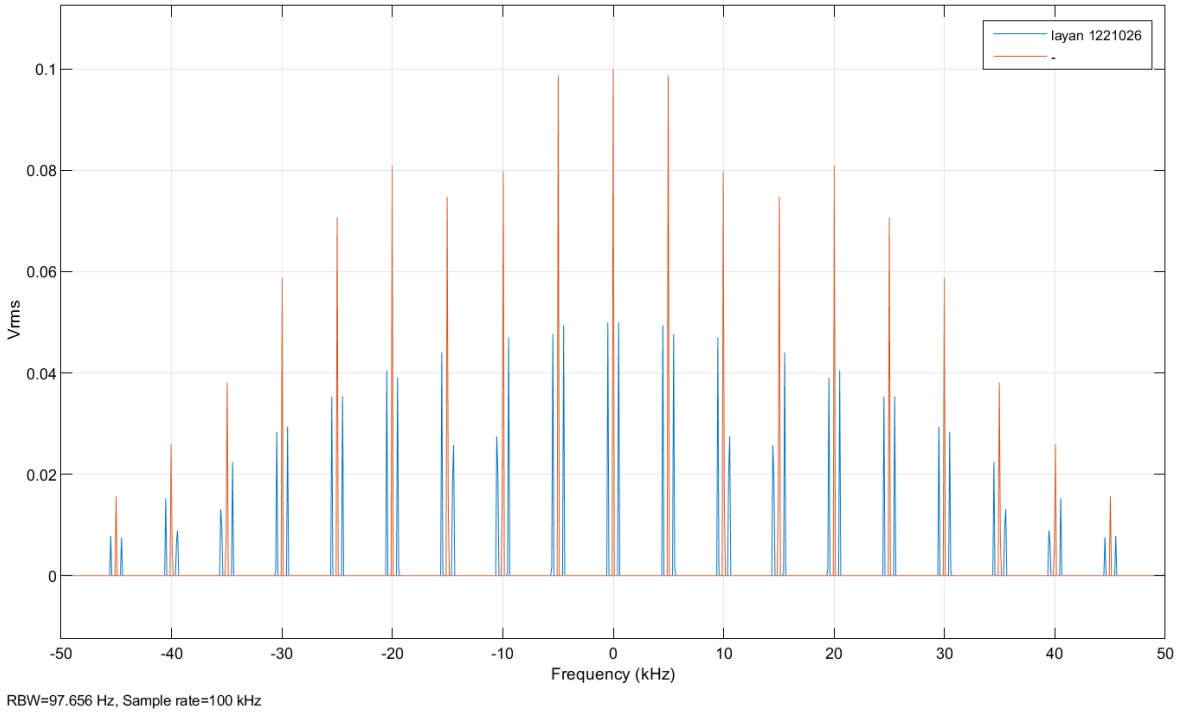


Displaying the Natural Modulated Signal :

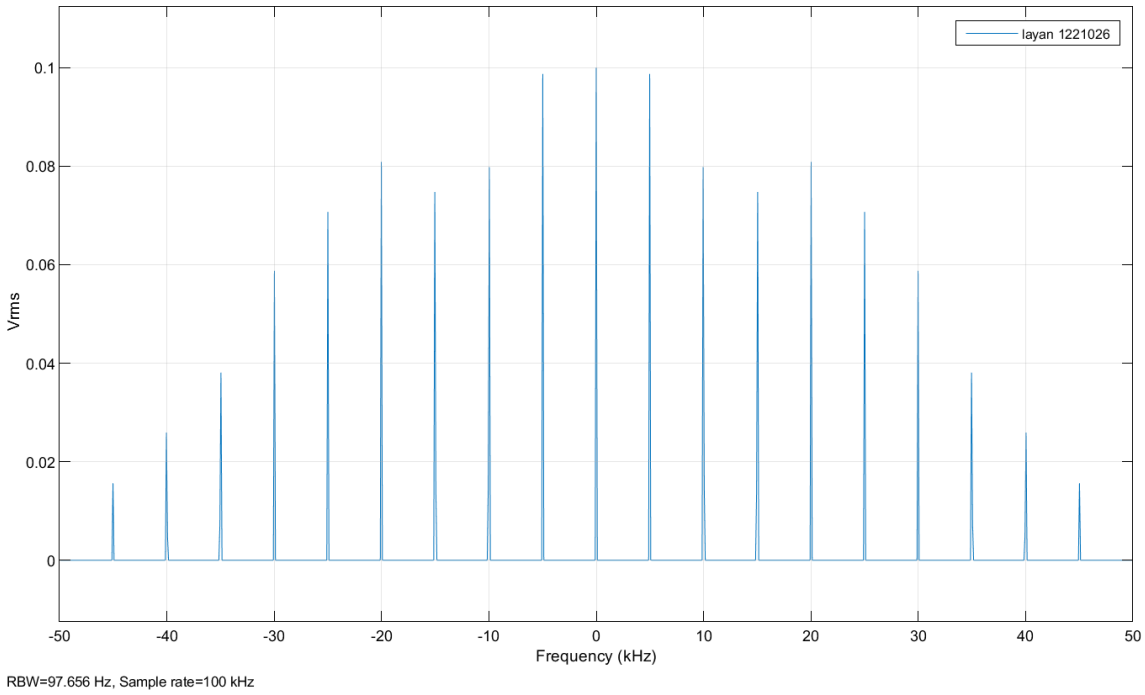
• Taking fm=500 and changing the duty cycle :

→At 10% duty cycle

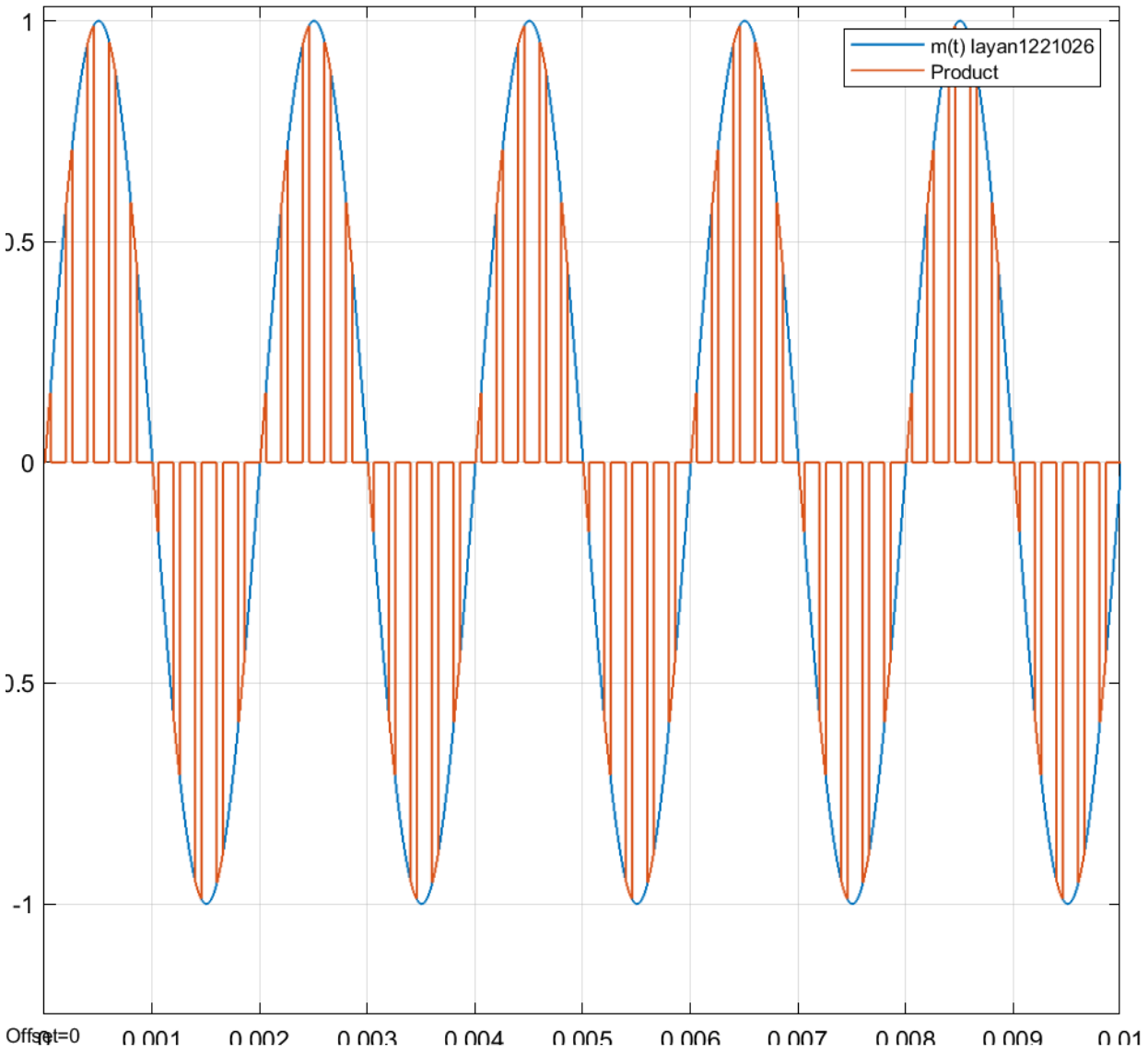


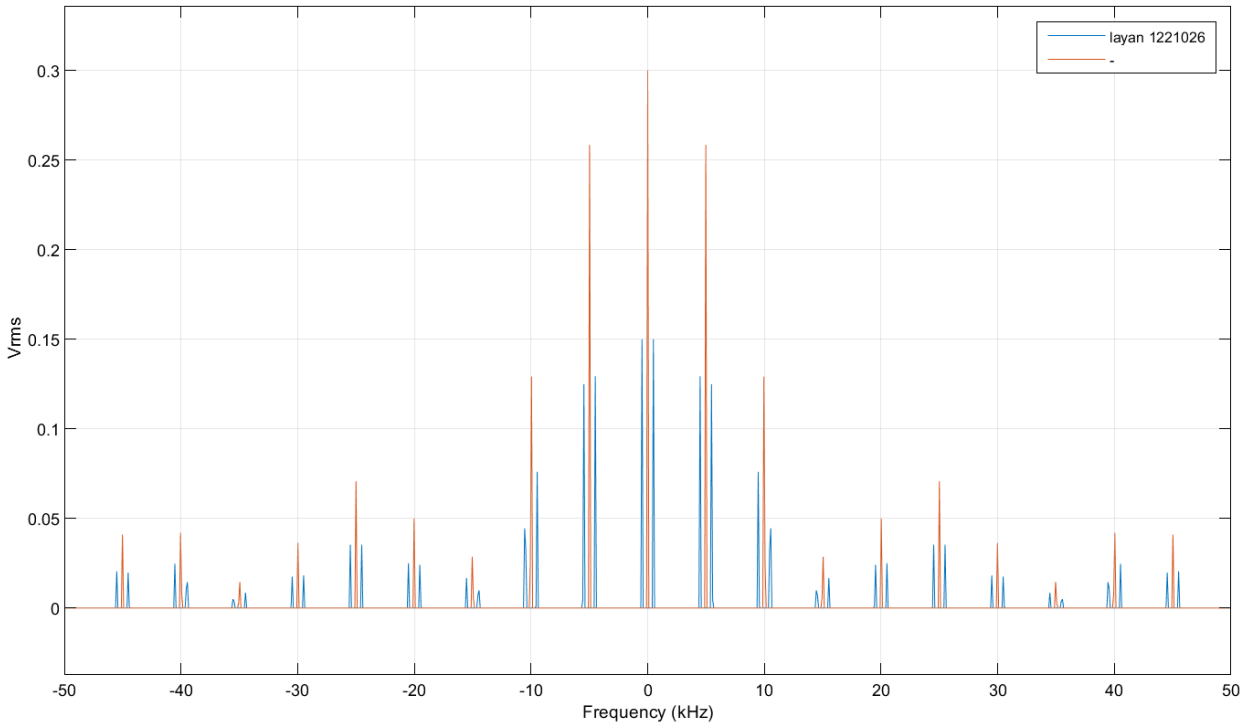


RBW=97.656 Hz, Sample rate=100 kHz

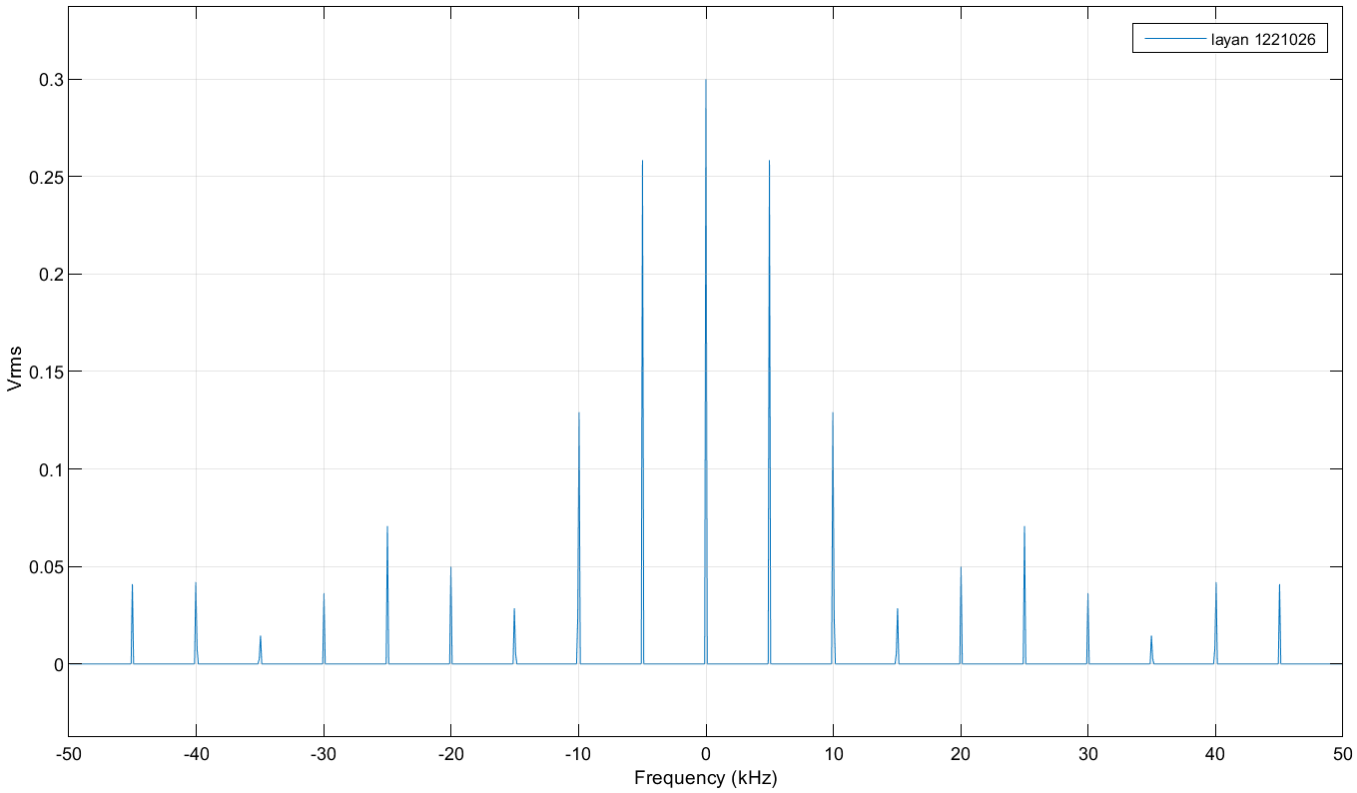


→At 30% duty cycle



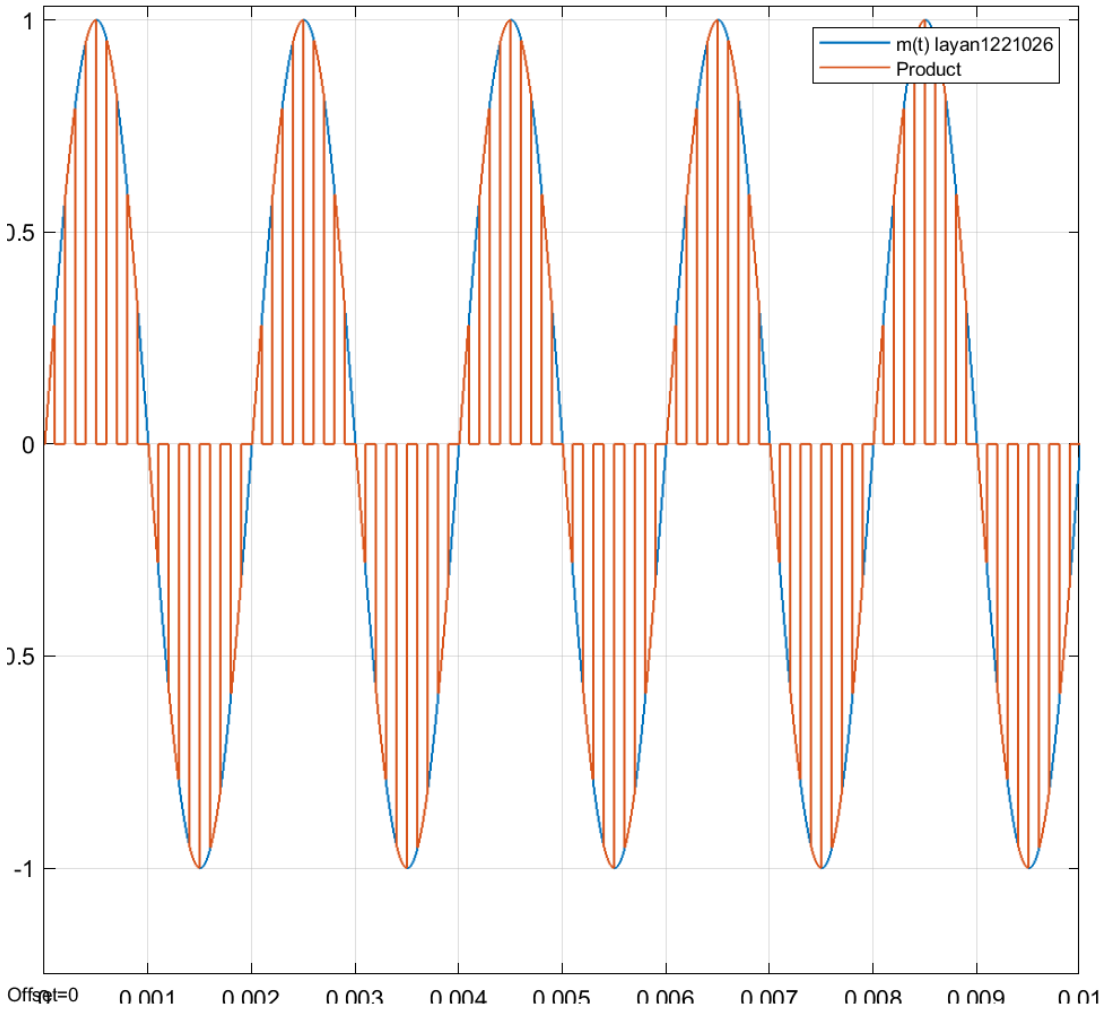


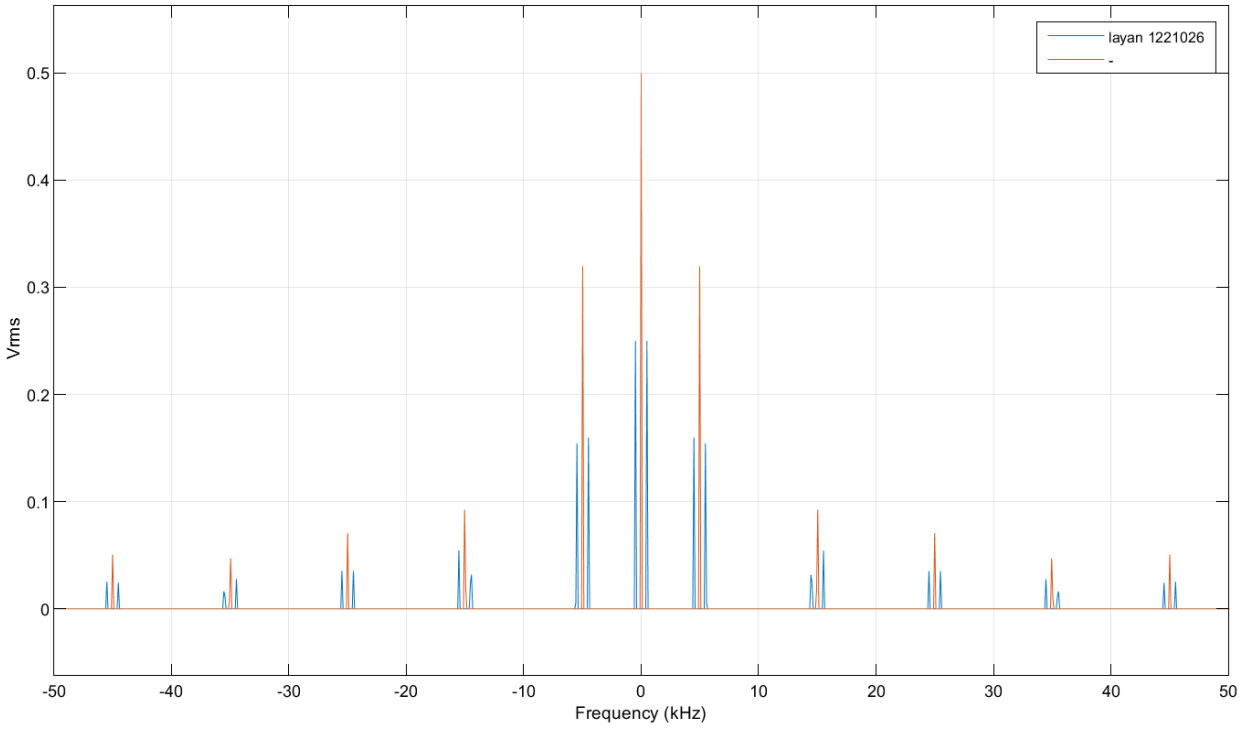
RBW=97.656 Hz, Sample rate=100 kHz



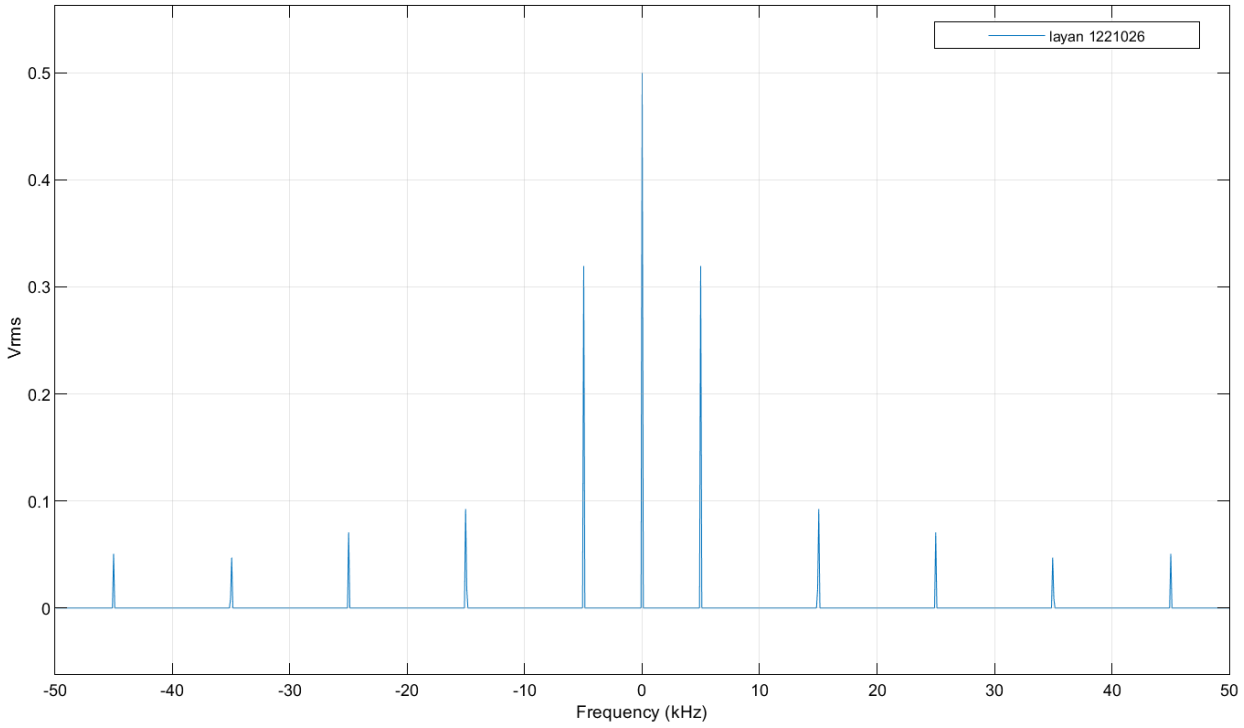
RBW=97.656 Hz, Sample rate=100 kHz

At 50% duty cycle



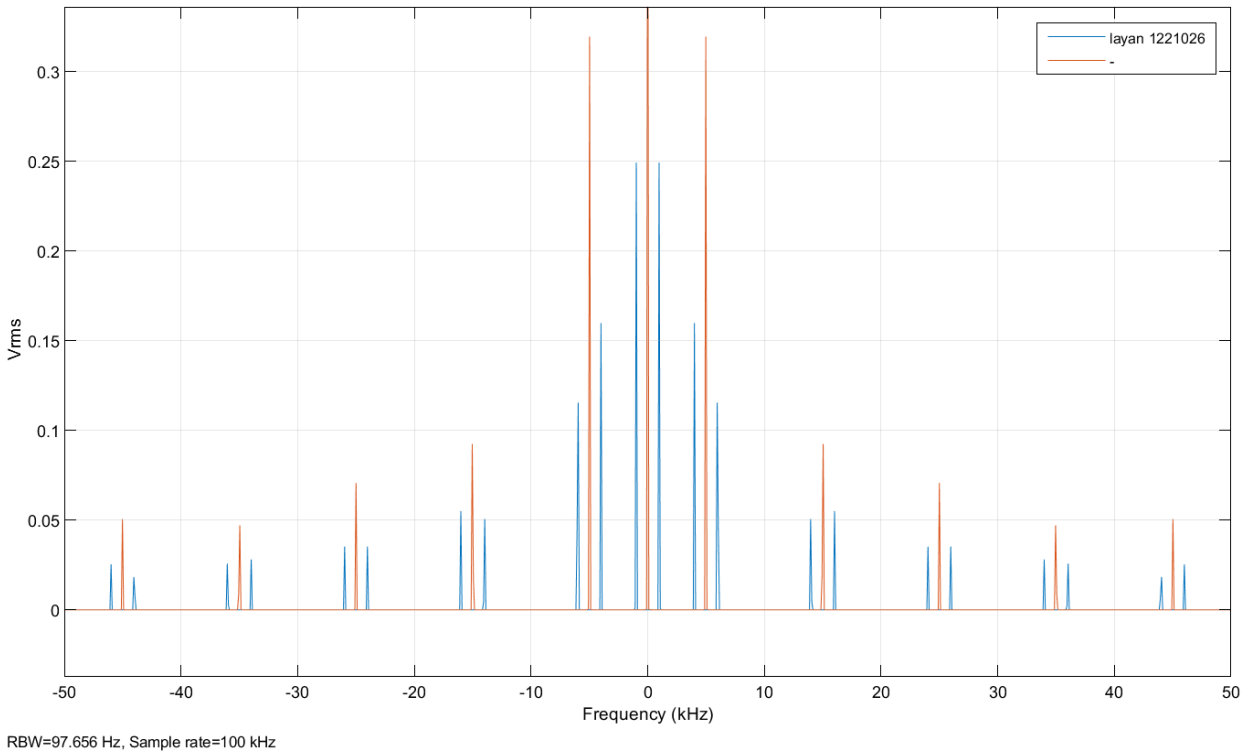


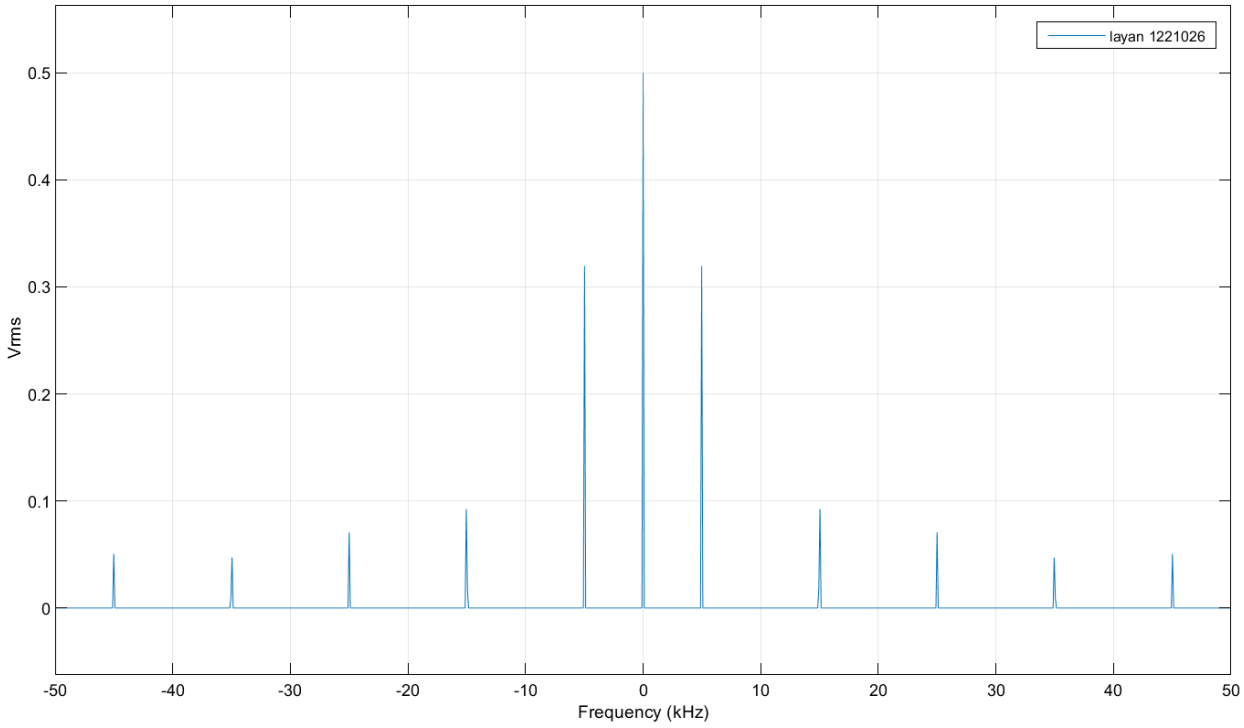
RBW=97.656 Hz, Sample rate=100 kHz



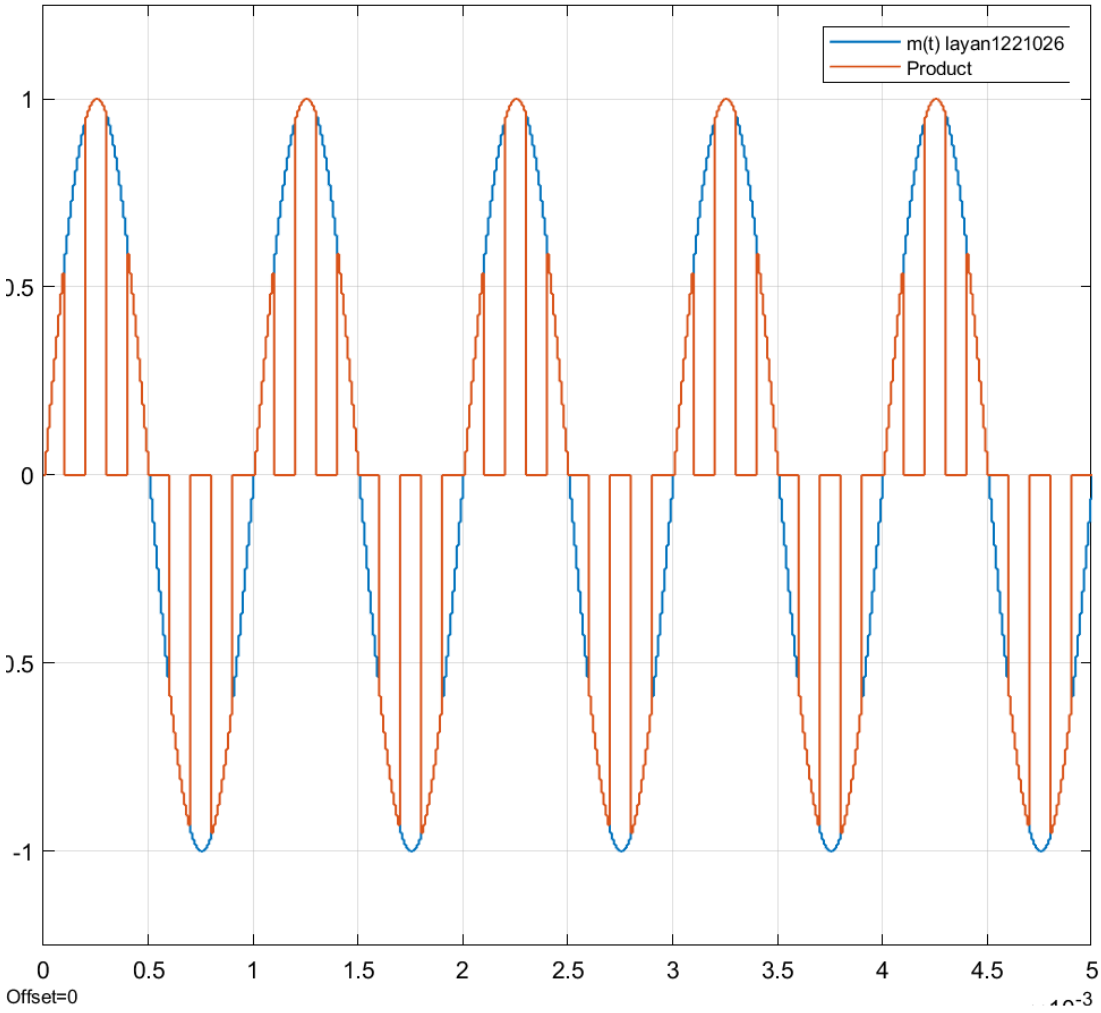
Taking duty cycle = 50% and changing the frequency of the message (fm):

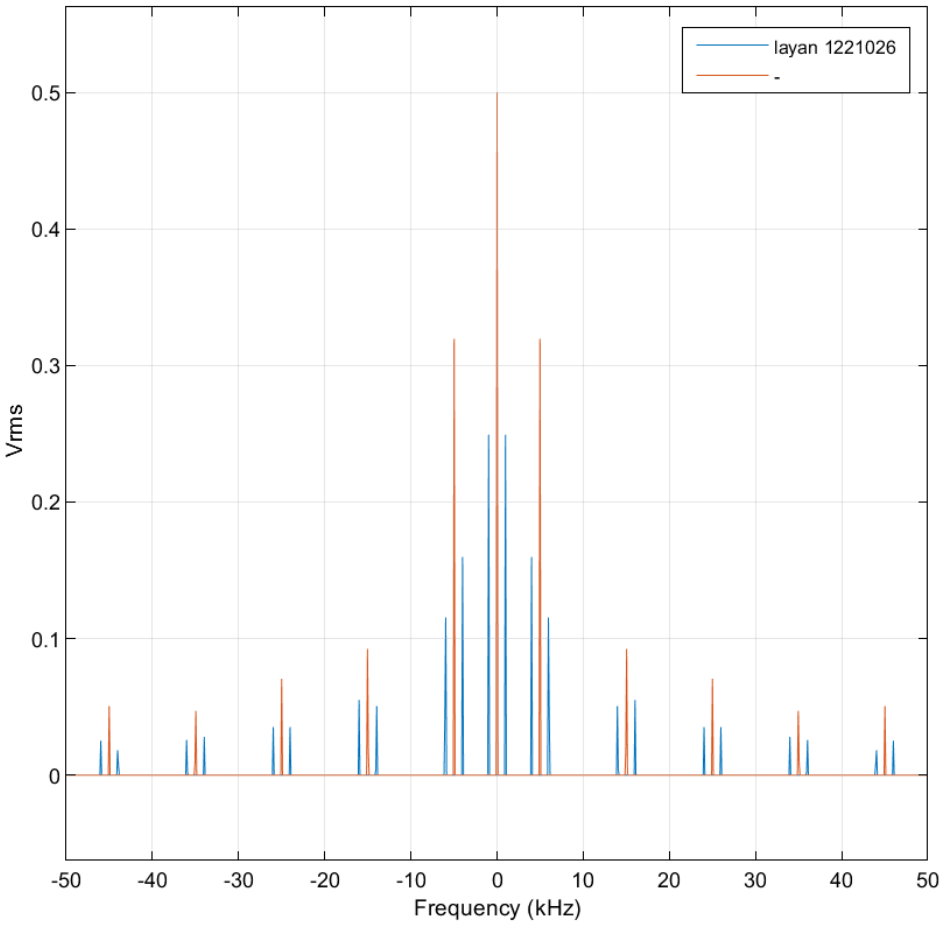
→At fm =1000



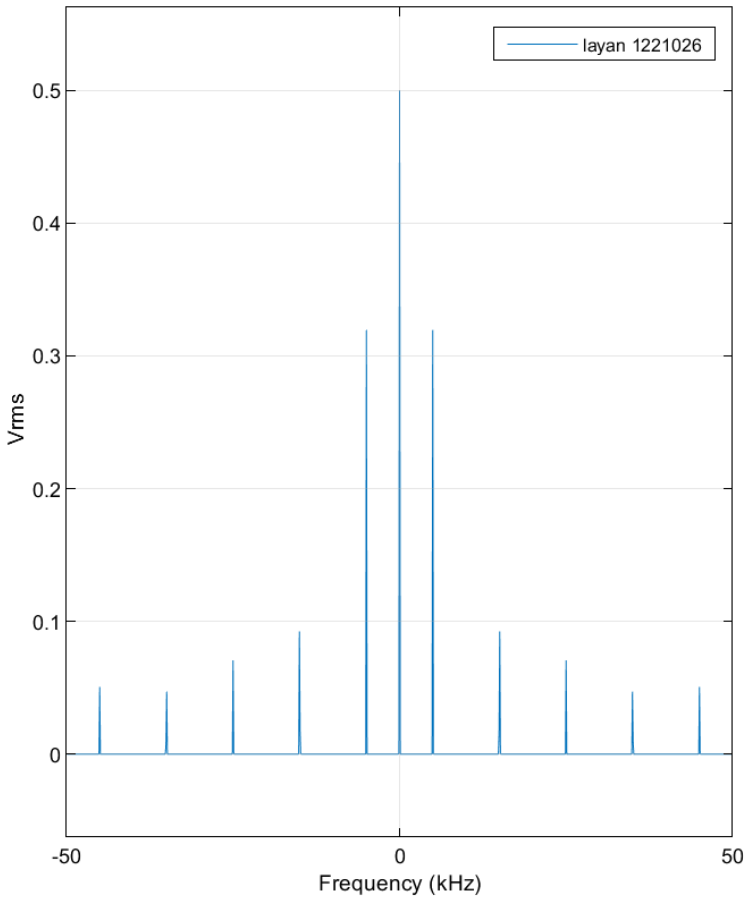

layan 1221026
Vrms
Frequency (kHz)
RBW=97.656 Hz, Sample rate=100 kHz

→At fm=2000


m(t) layan1221026
Product
Offset=0



RBW=97.656 Hz, Sample rate=100 kHz

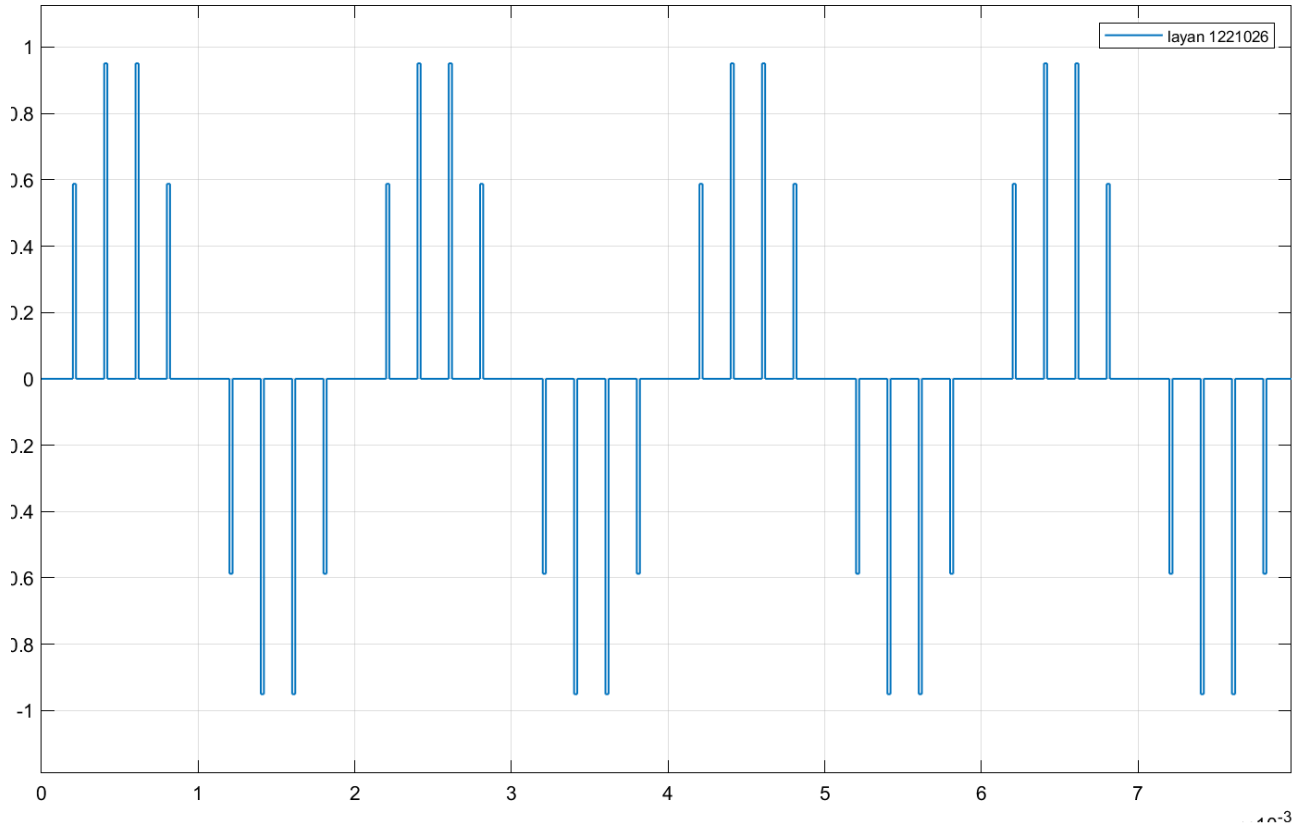


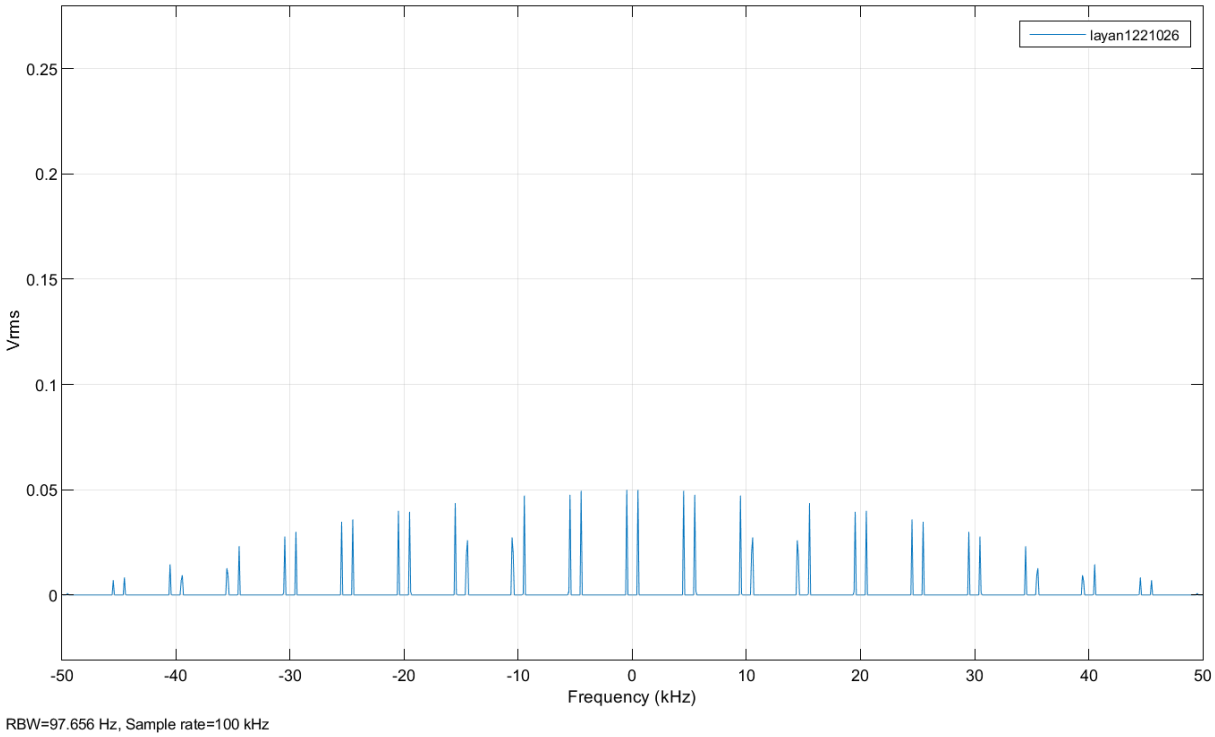
RBW=97.656 Hz, Sample rate=100 kHz

Displaying the Flat-Topped Modulated Signal :

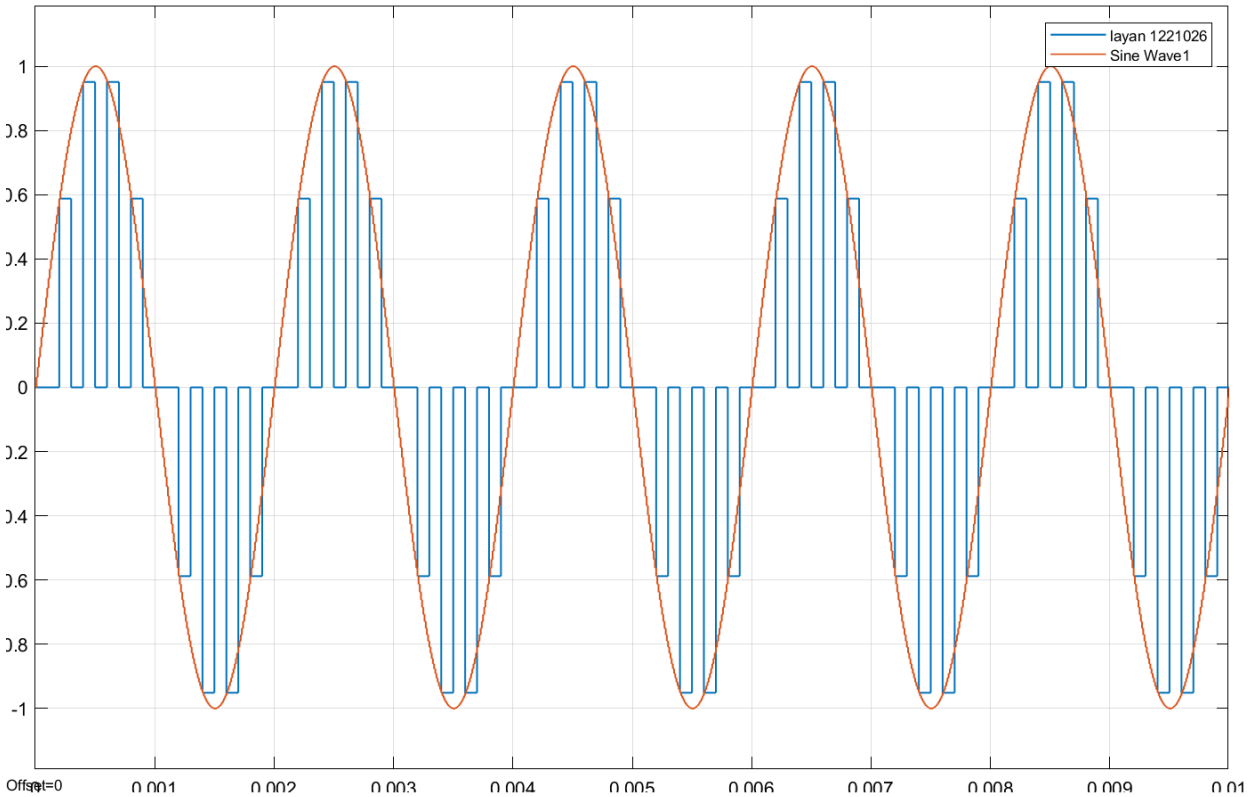
- **Taking fm=500 and changing the duty cycle :**

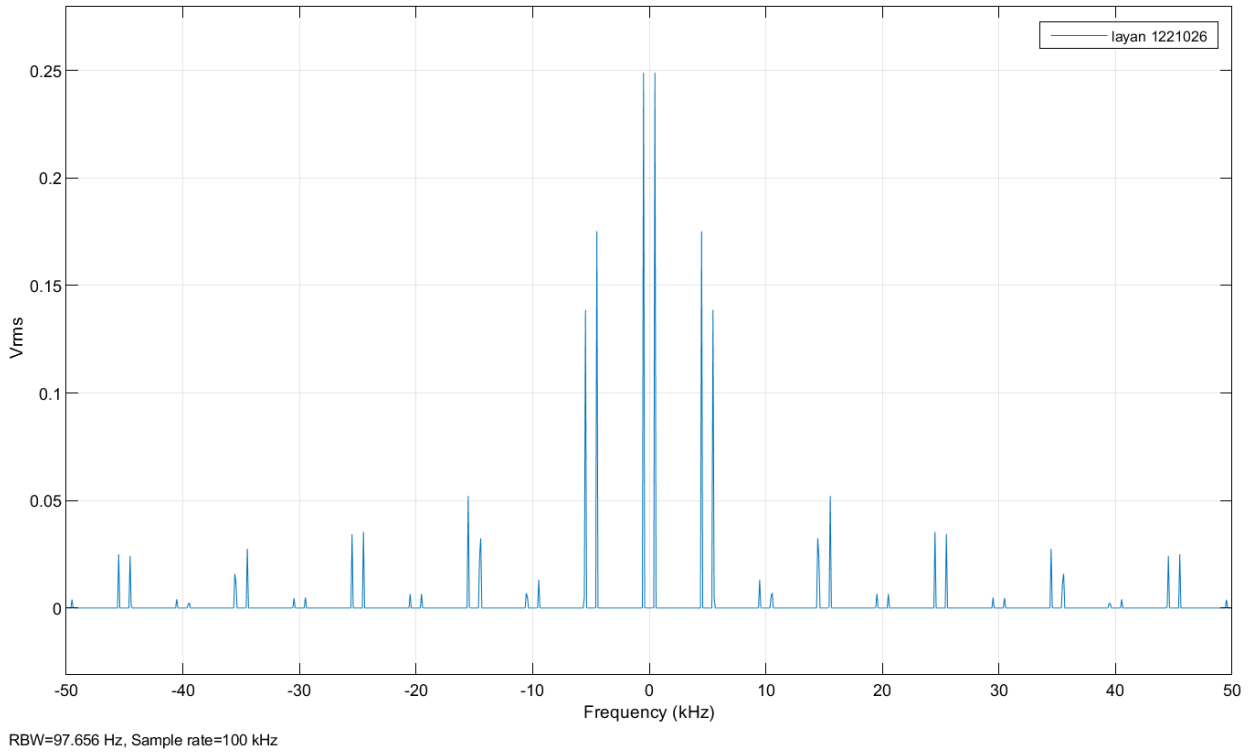
→At 10%





→At 50%

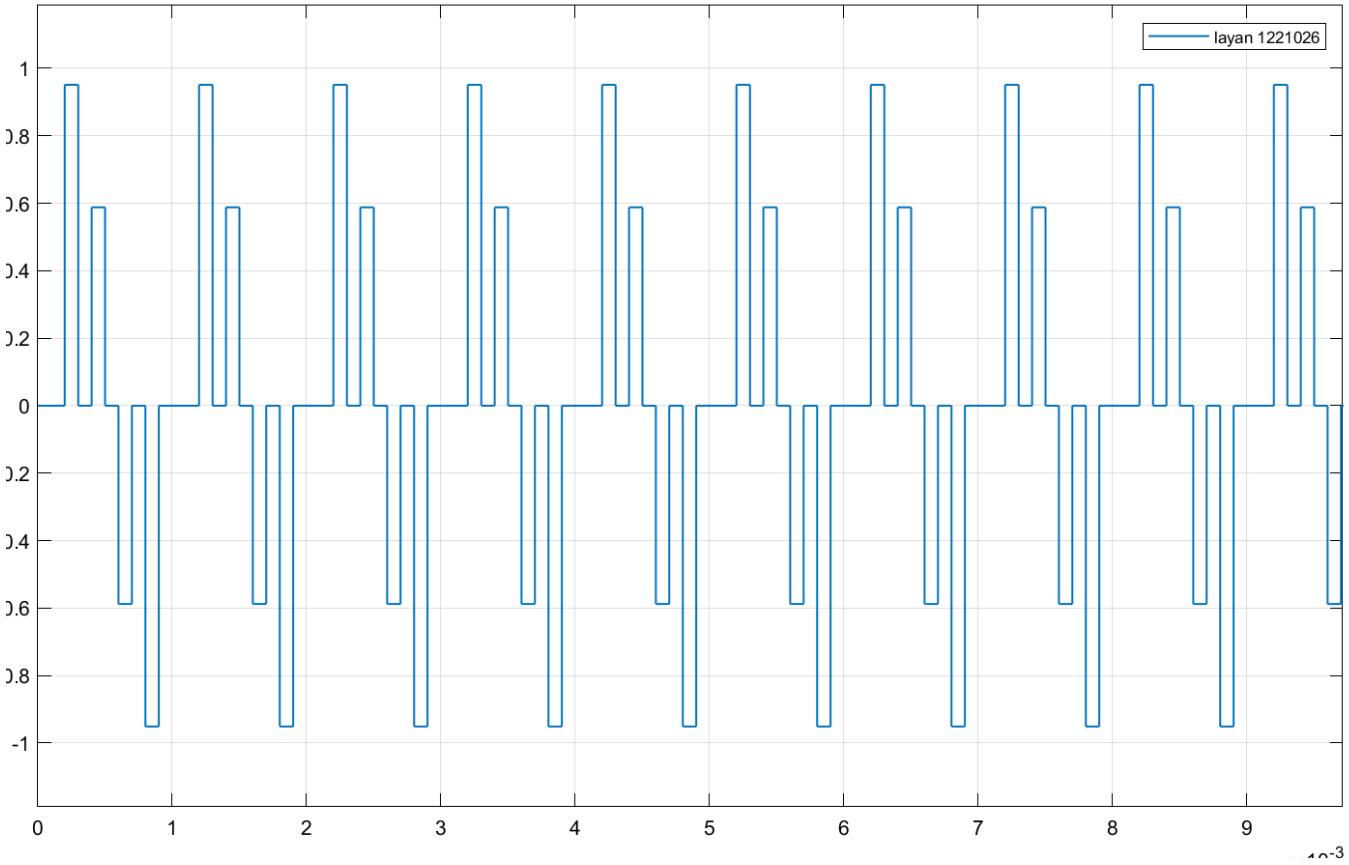


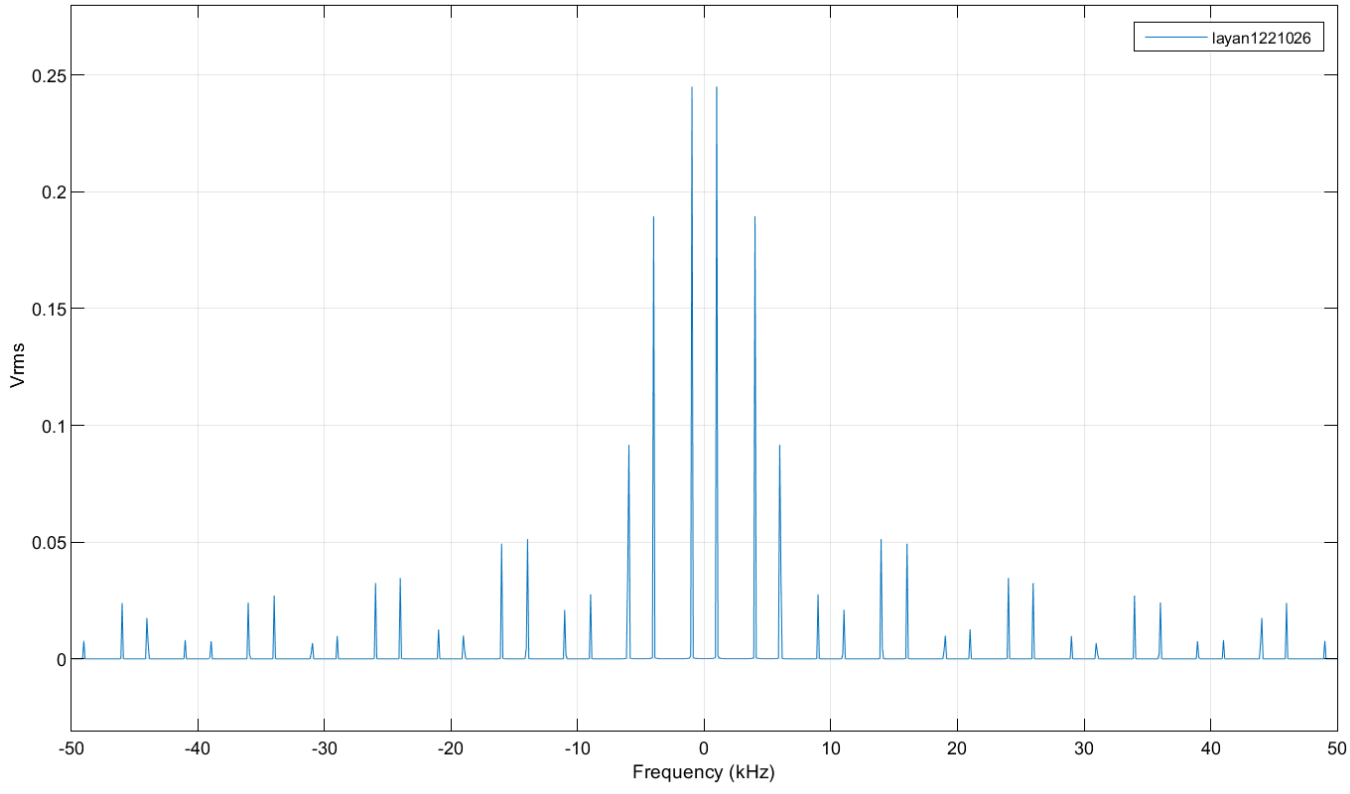


RBW=97.656 Hz, Sample rate=100 kHz

• Taking duty cycle = 50% and changing the frequency of the message (fm):

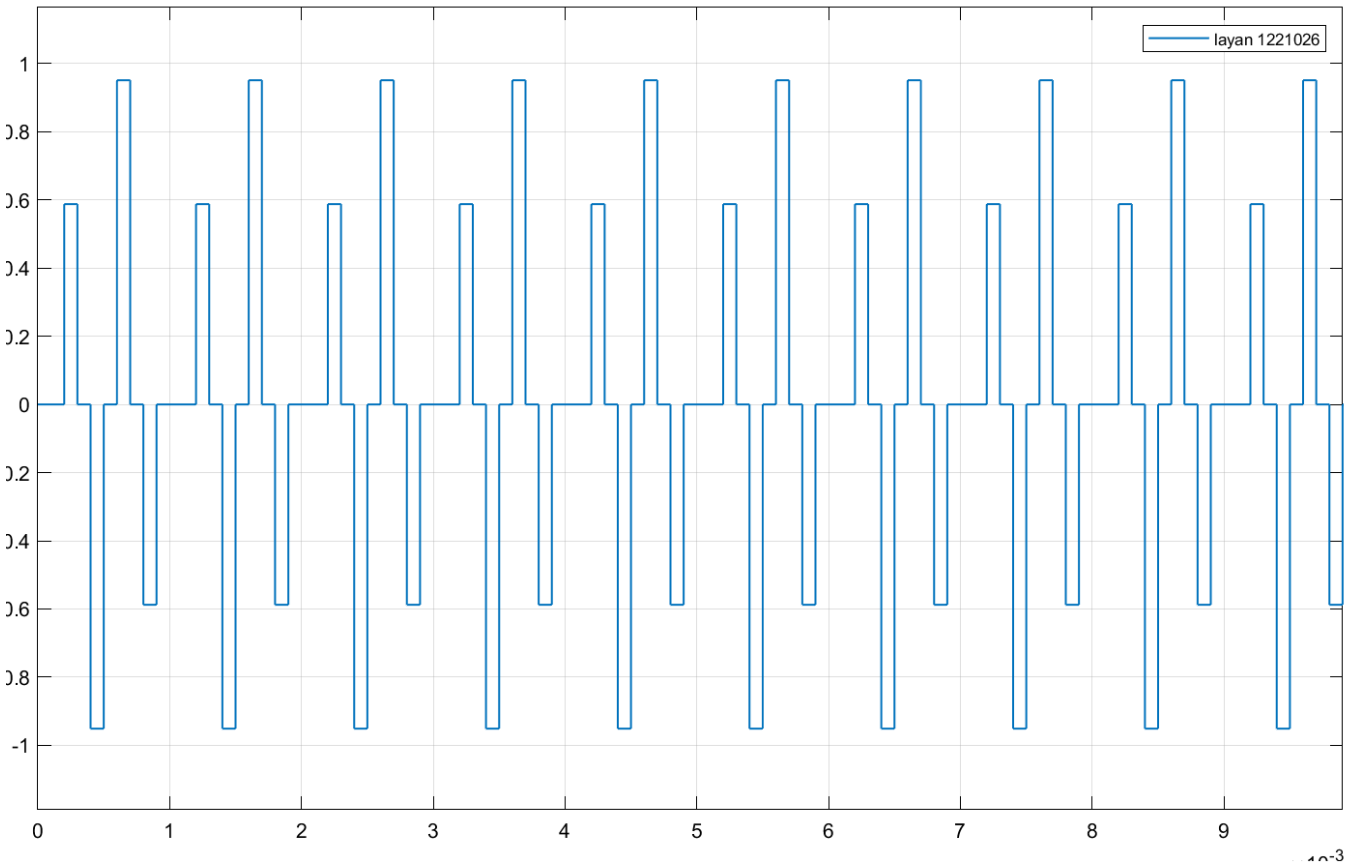
→At fm 1000

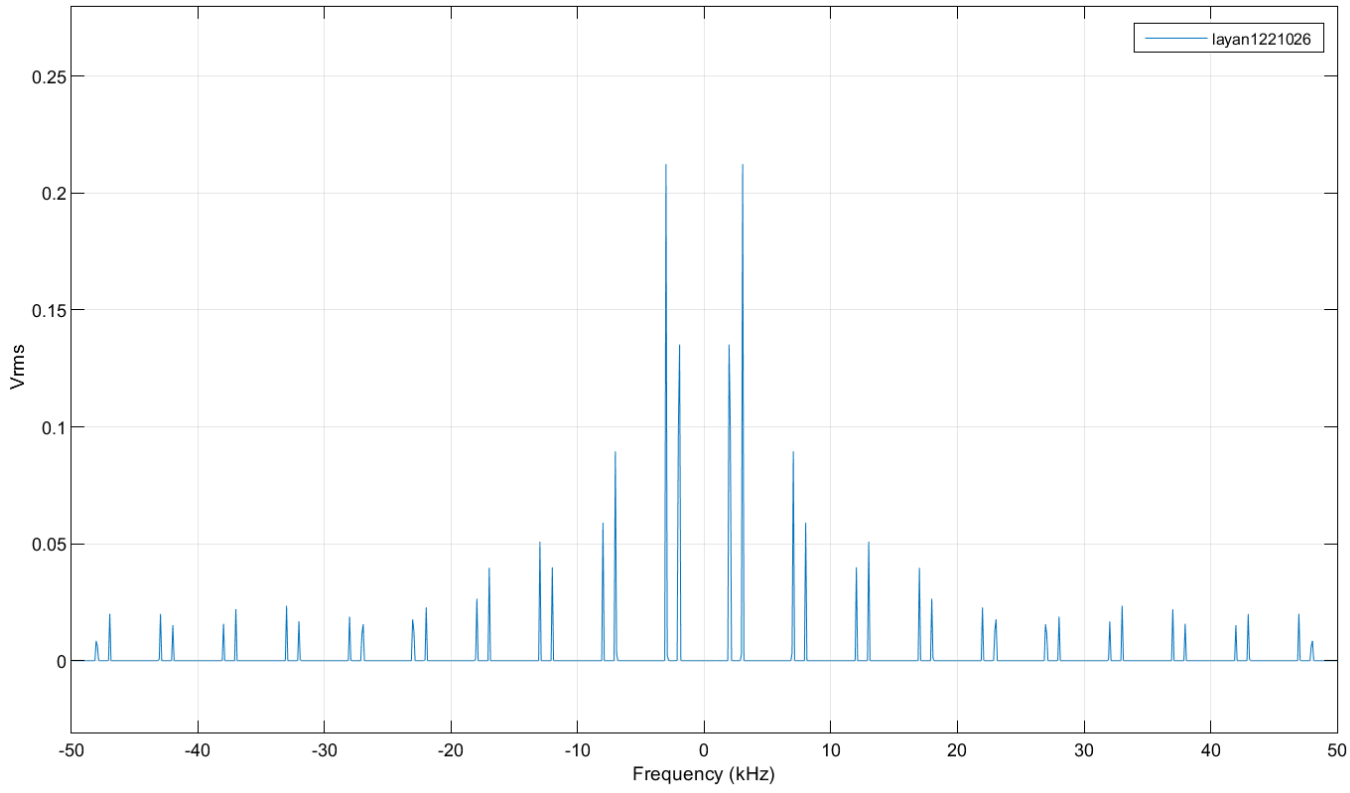




RBW=97.656 Hz, Sample rate=100 kHz

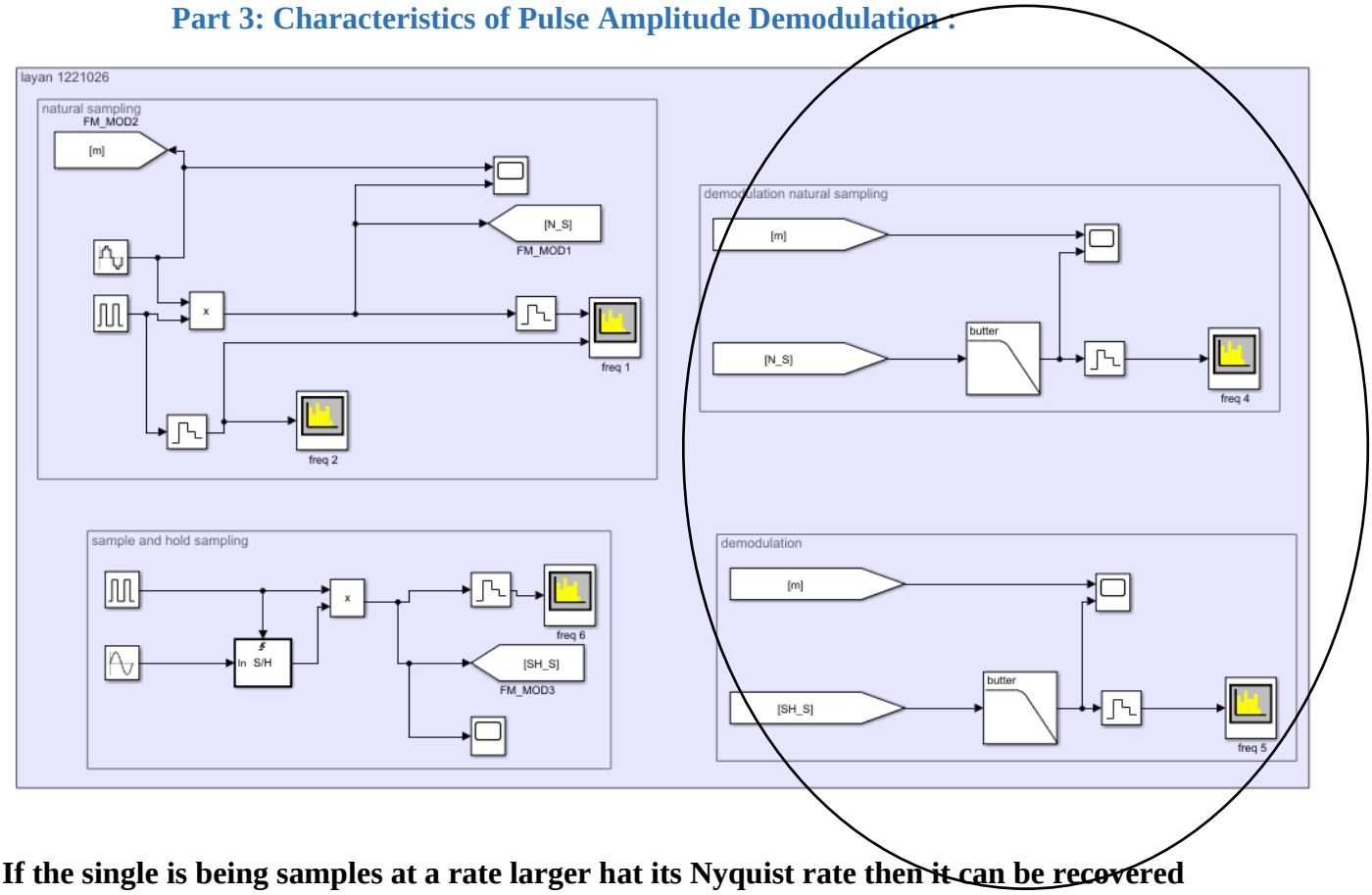
→At fm 2000





RBW=97.656 Hz, Sample rate=100 kHz

Part 3: Characteristics of Pulse Amplitude Demodulation :



If the single is being samples at a rate larger hat its Nyquist rate then it can be recovered from its samples by applying it to a low pass fitter, with cut-off frequency equal to the original bandwidth of the signal.

For a band-limited signal with bandwidth (W) , Nyquist rate is equal to (2W).

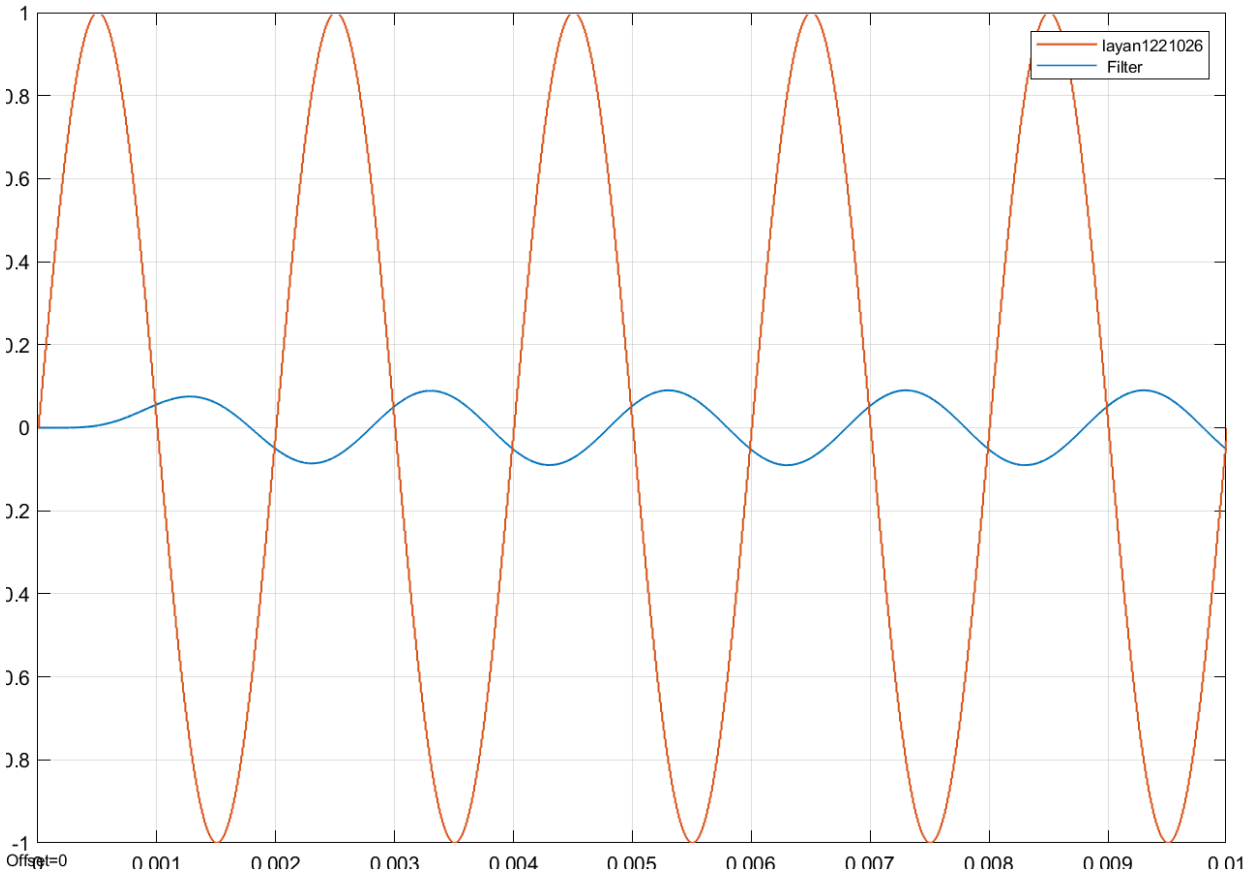
So if fs ≥ 2W (fs ≥ 2fm) then signal can be correctly recovered.

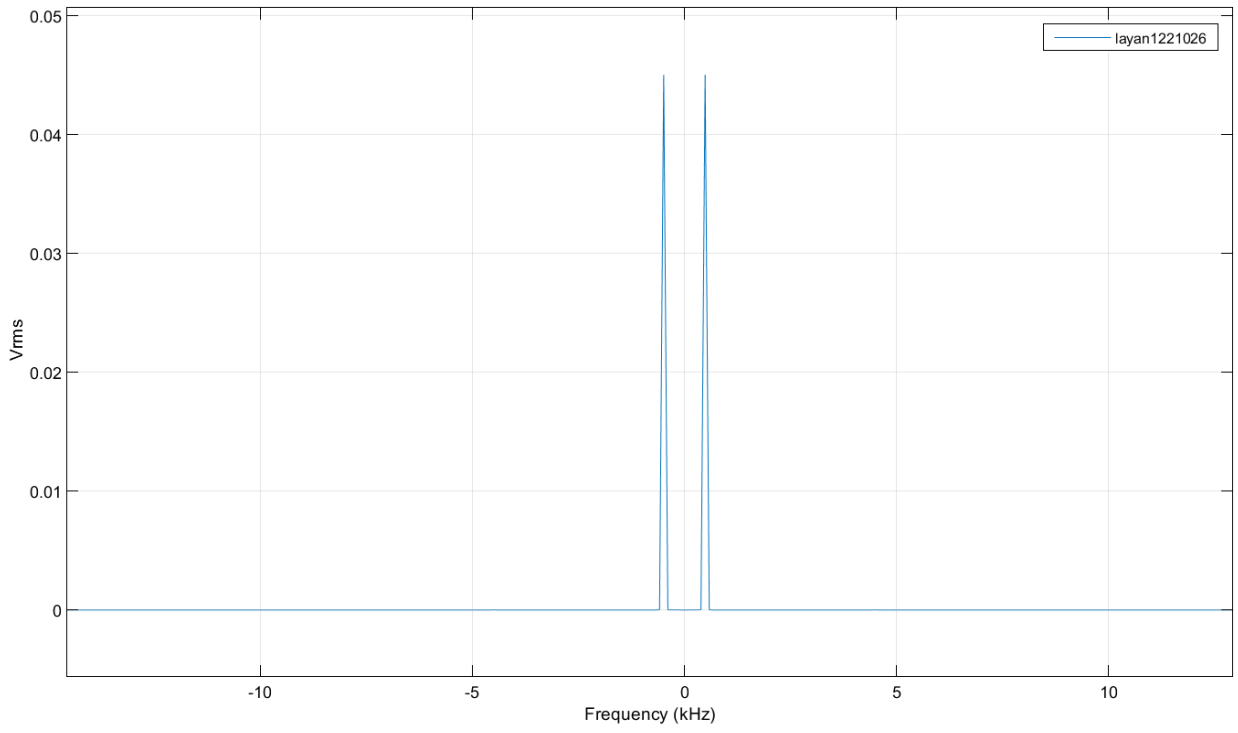
Note: that the demodulation process for the natural or flat-topped PAM is the same.

Displaying the Natural Demodulated Signal :

Note: filter used here is a low pass filter with cut-off frequency = 500Hz, which is equal to the bandwidth of the message.

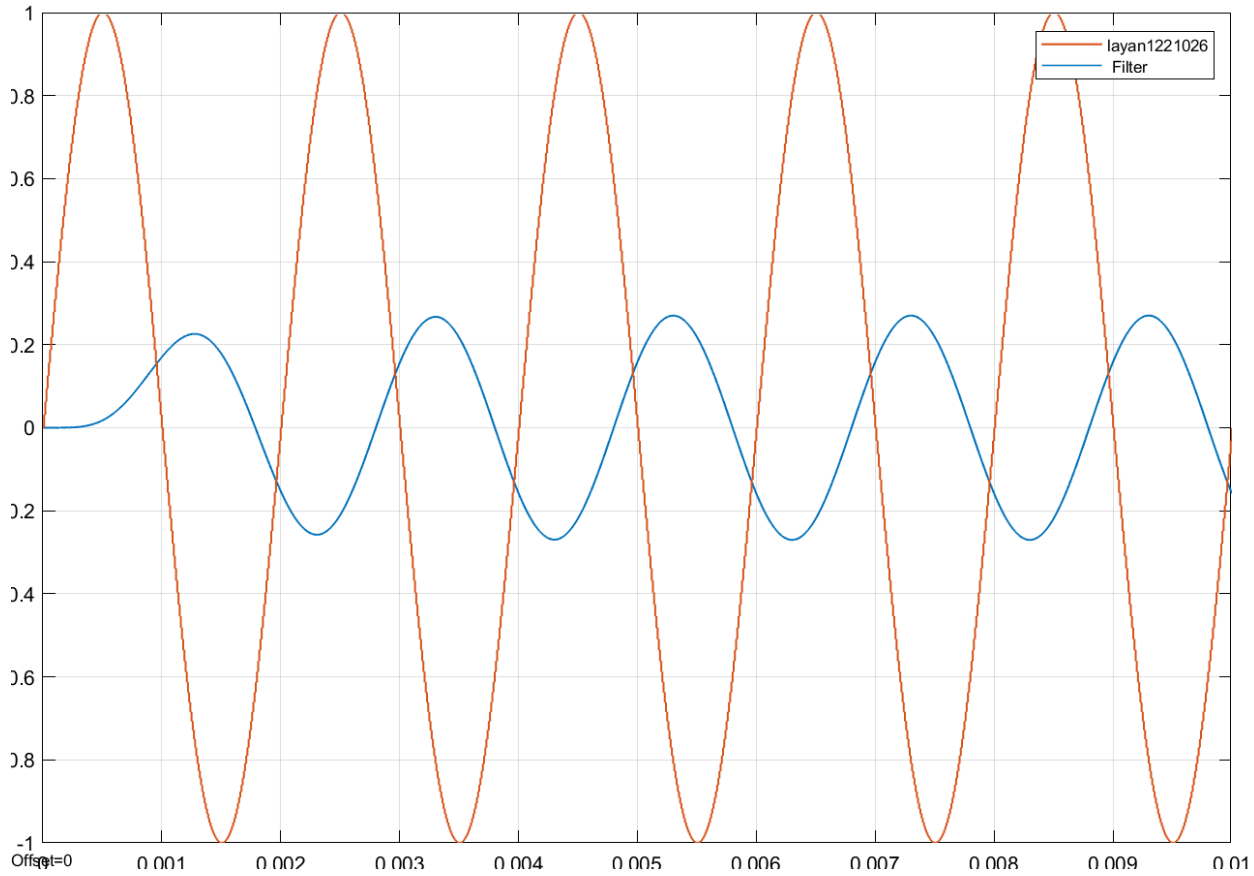
→At 10%

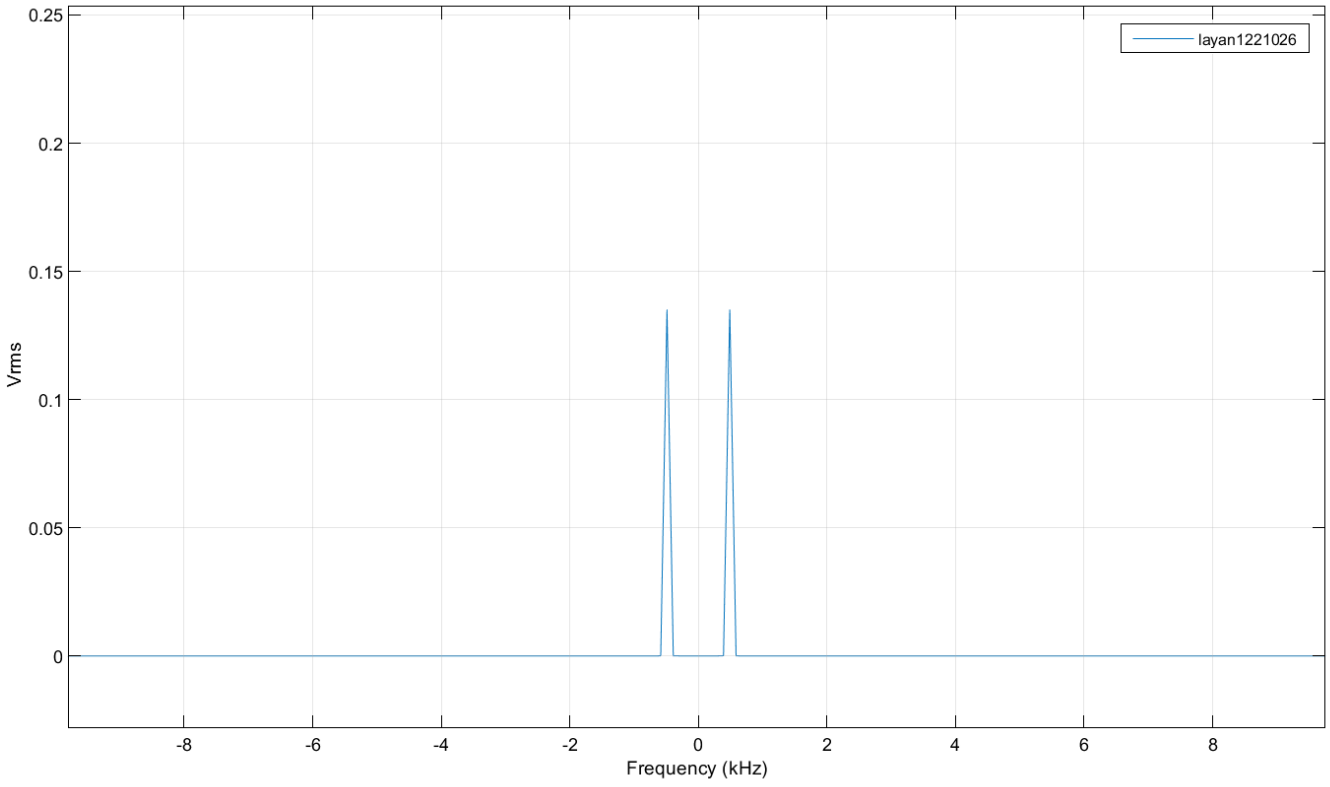




RBW=97.656 Hz, Sample rate=100 kHz

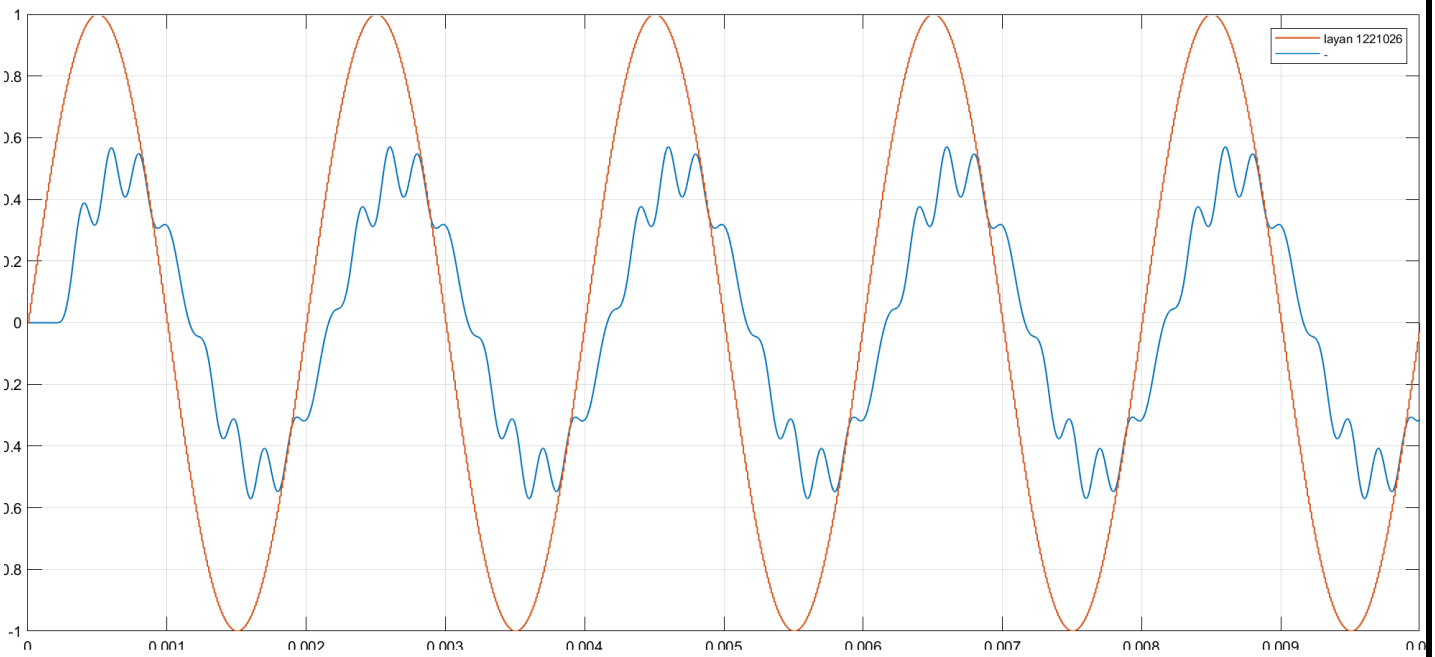
→At 50%

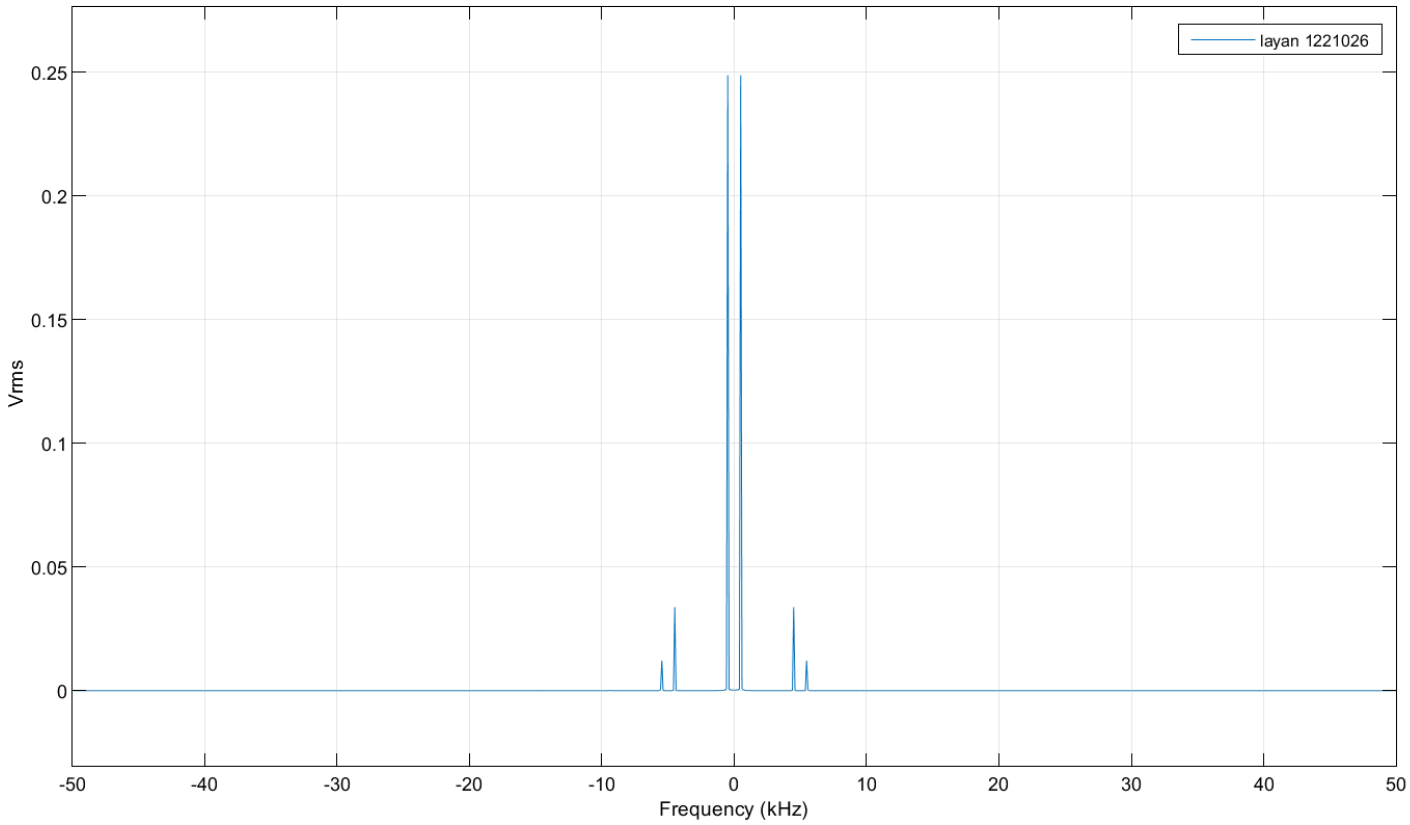




RBW=97.656 Hz, Sample rate=100 kHz

Displaying the Flat-Topped Demodulated Signal :





RBW=97.656 Hz, Sample rate=100 kHz

Part 4: Aliasing in Time and Frequency domains:

Aliasing happens when the rate of sampling is less than the Nyquist rate.

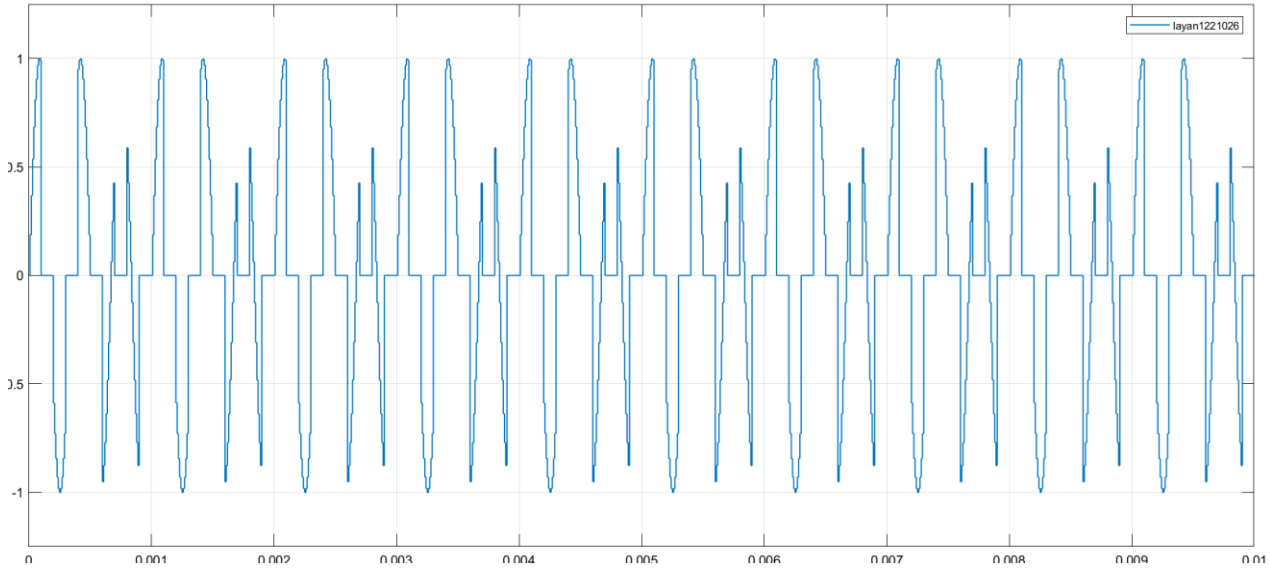
In our case fs= 5000Hz , and fm =3000Hz.

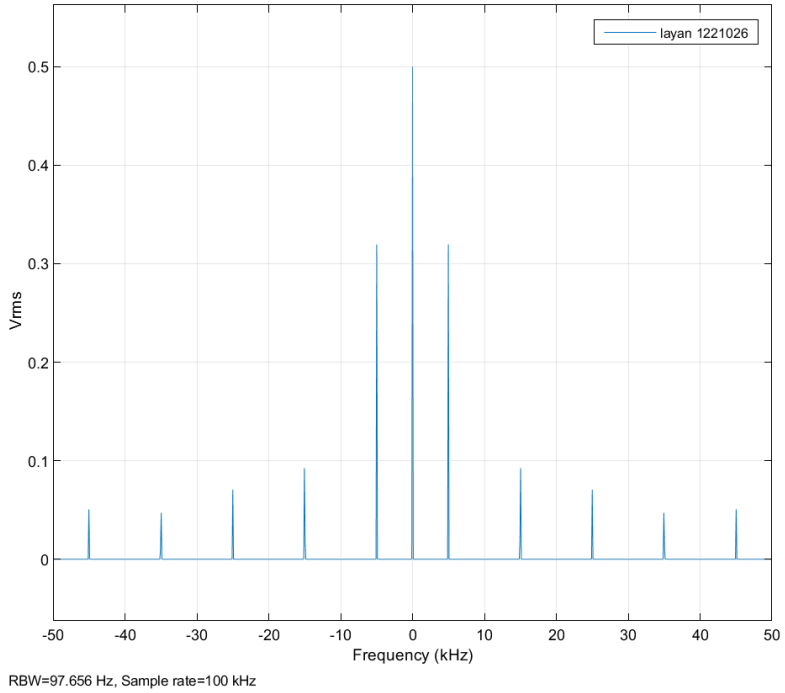
fs $\not\geq$ 2fm

This would case the samples to overlap in frequency domain and so the signal cannot be properly reconstructed.

Note: The filter used in the demodulation process here is a low pass filter with cut-off frequency = 3000Hz, which is equal to the bandwidth of the message**.**

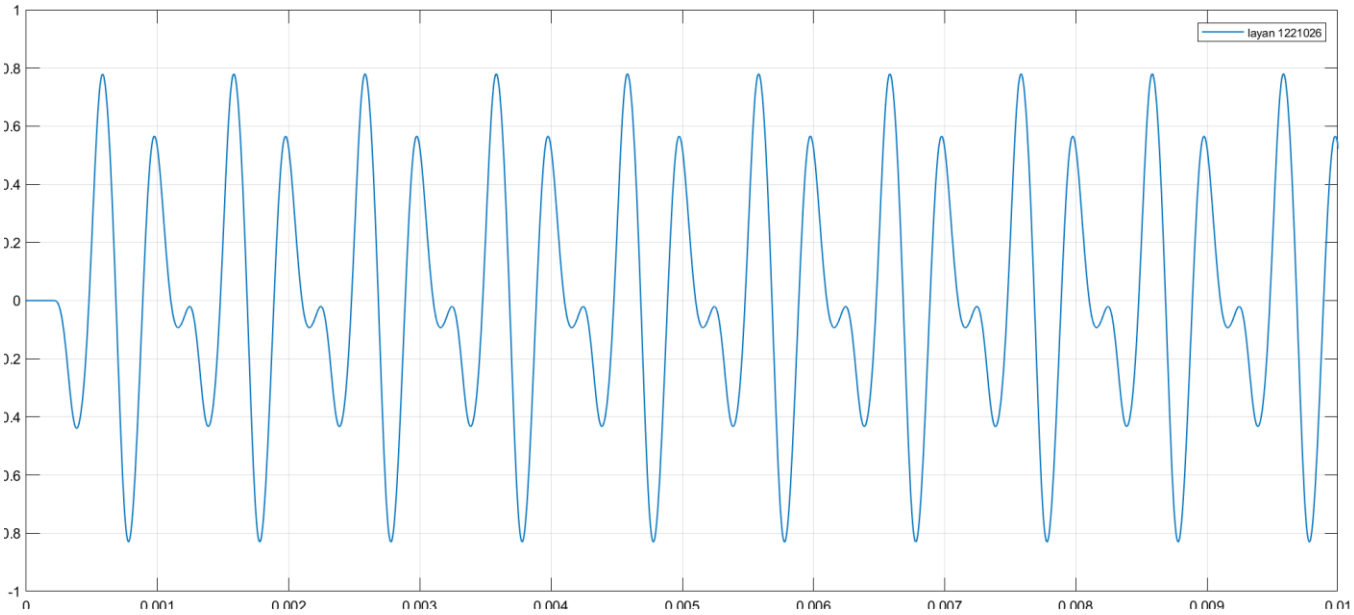
Displaying the Natural Modulated Signal (fm=3000Hz):

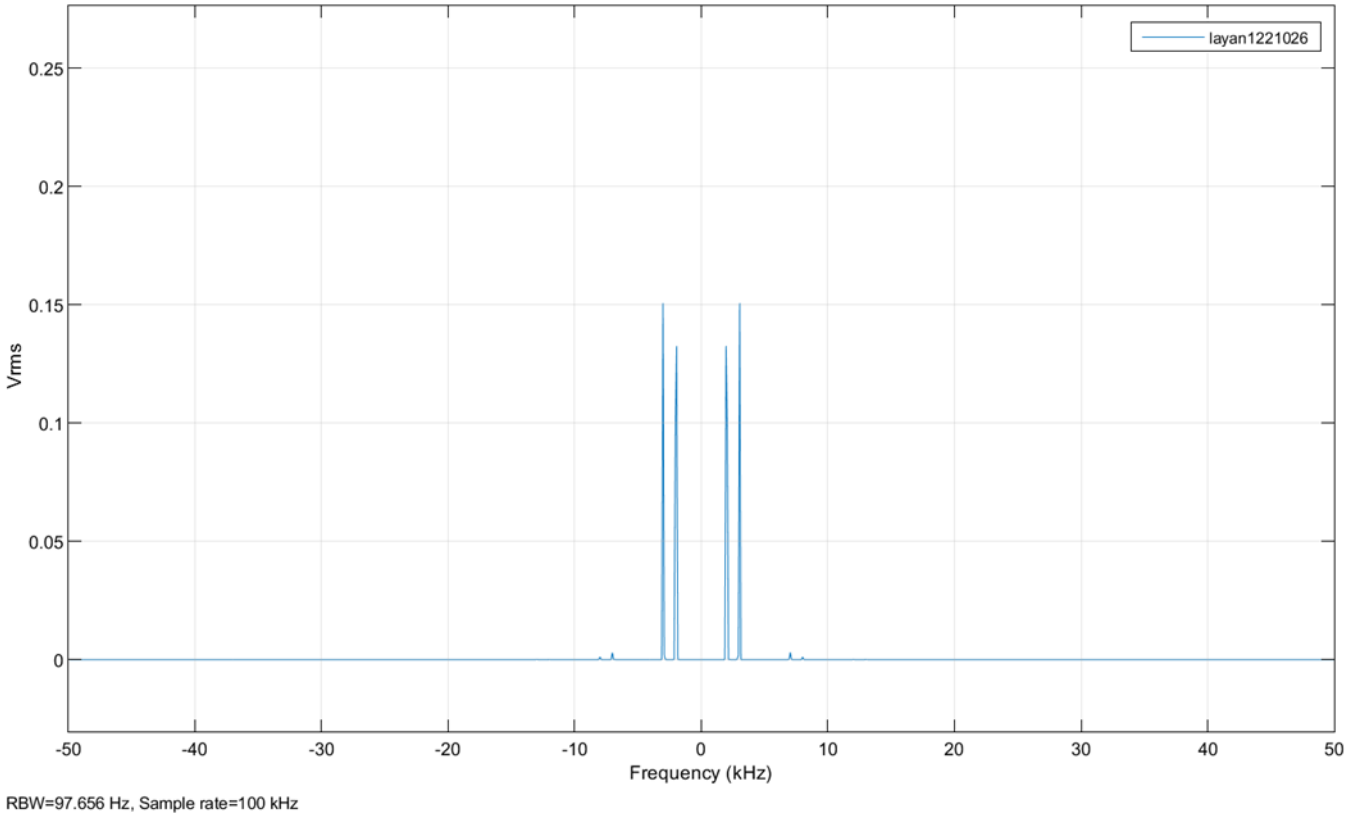




RBW=97.656 Hz, Sample rate=100 kHz

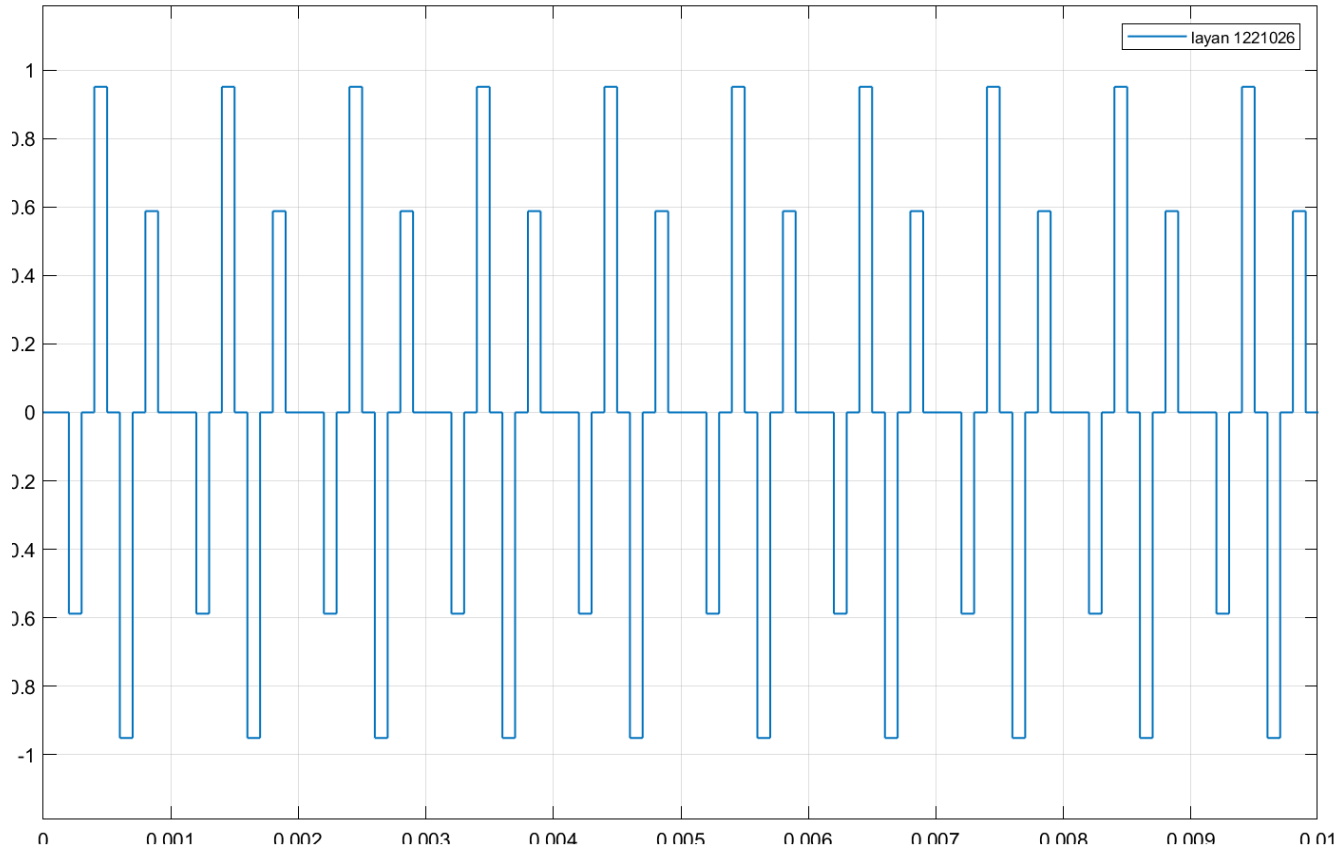
Displaying the Natural Demodulated Signal (fm=3000Hz):

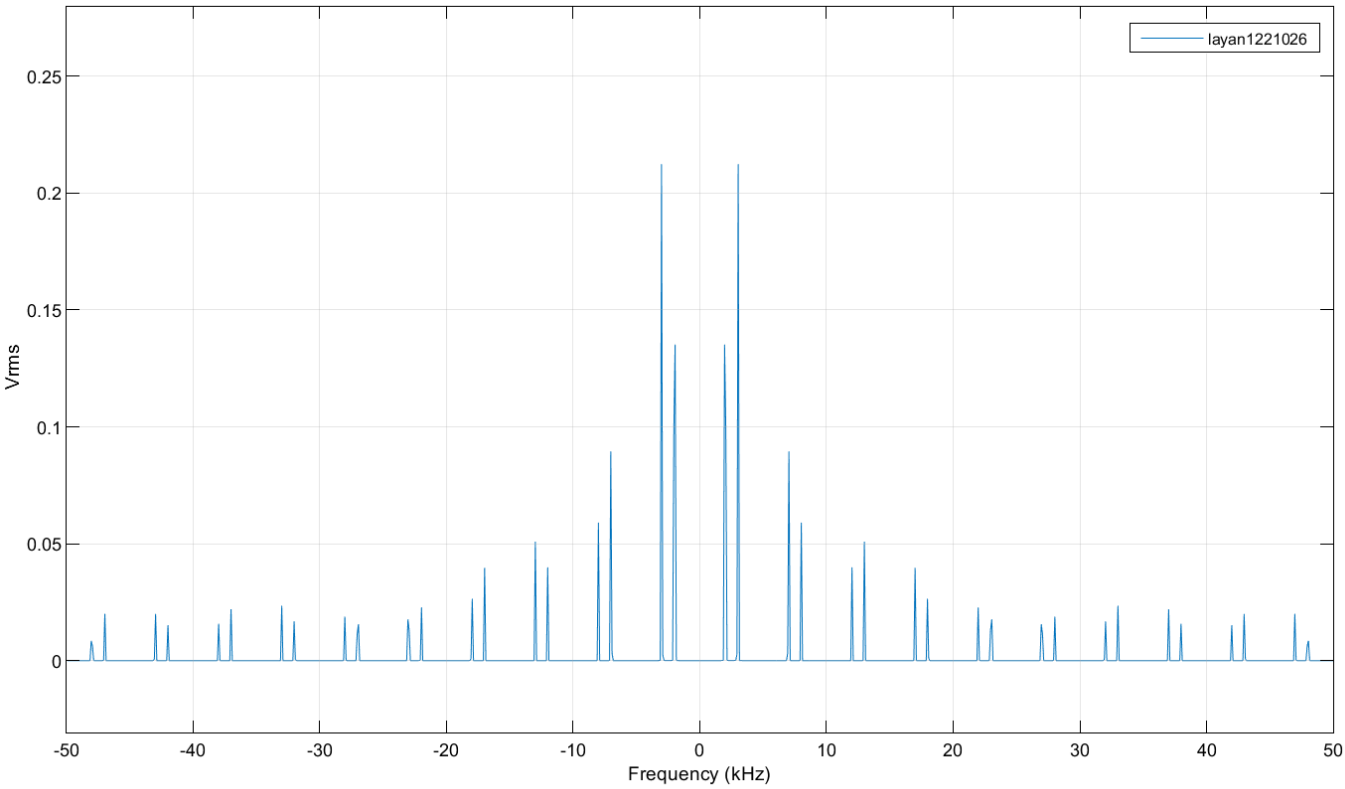




RBW=97.656 Hz, Sample rate=100 kHz

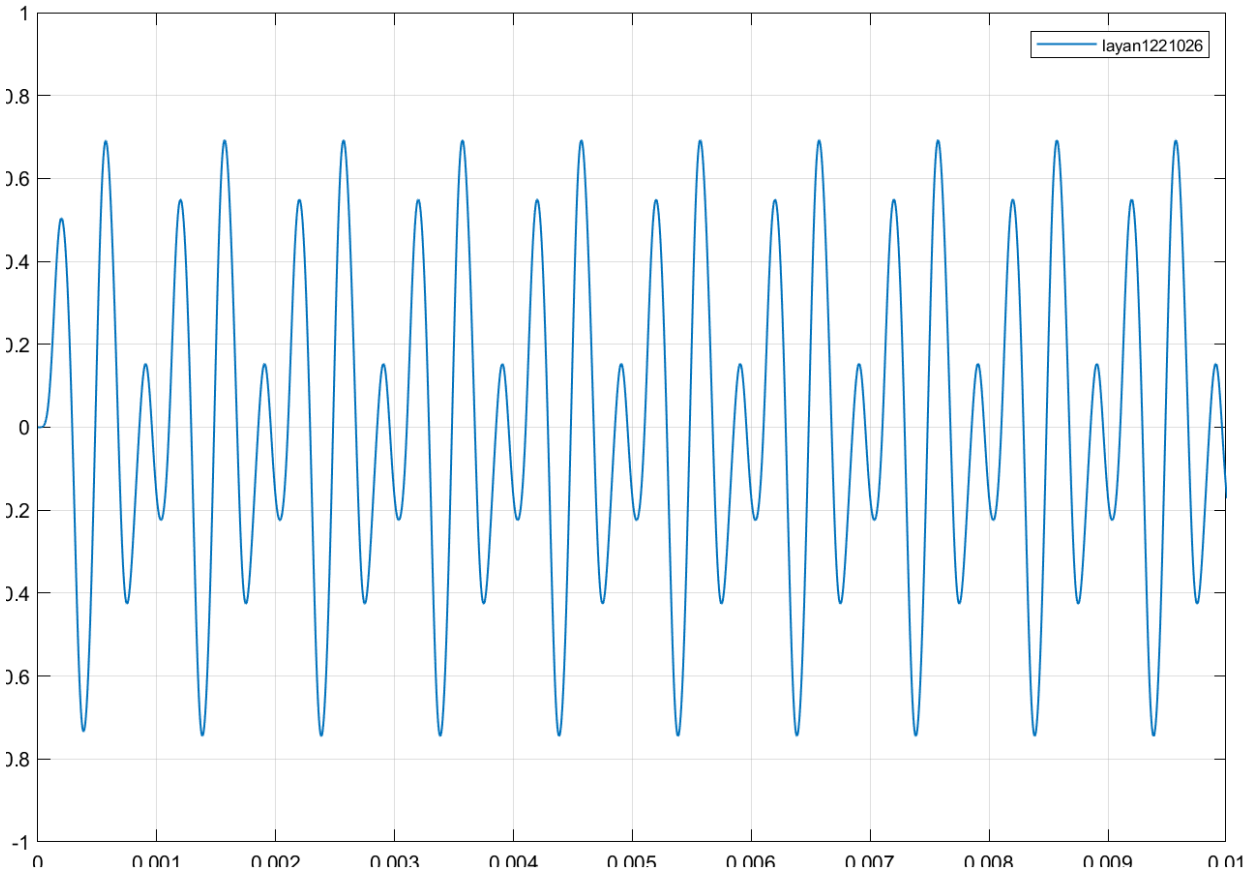
Displaying the Flat-Topped Modulated Signal (fm=3000Hz):

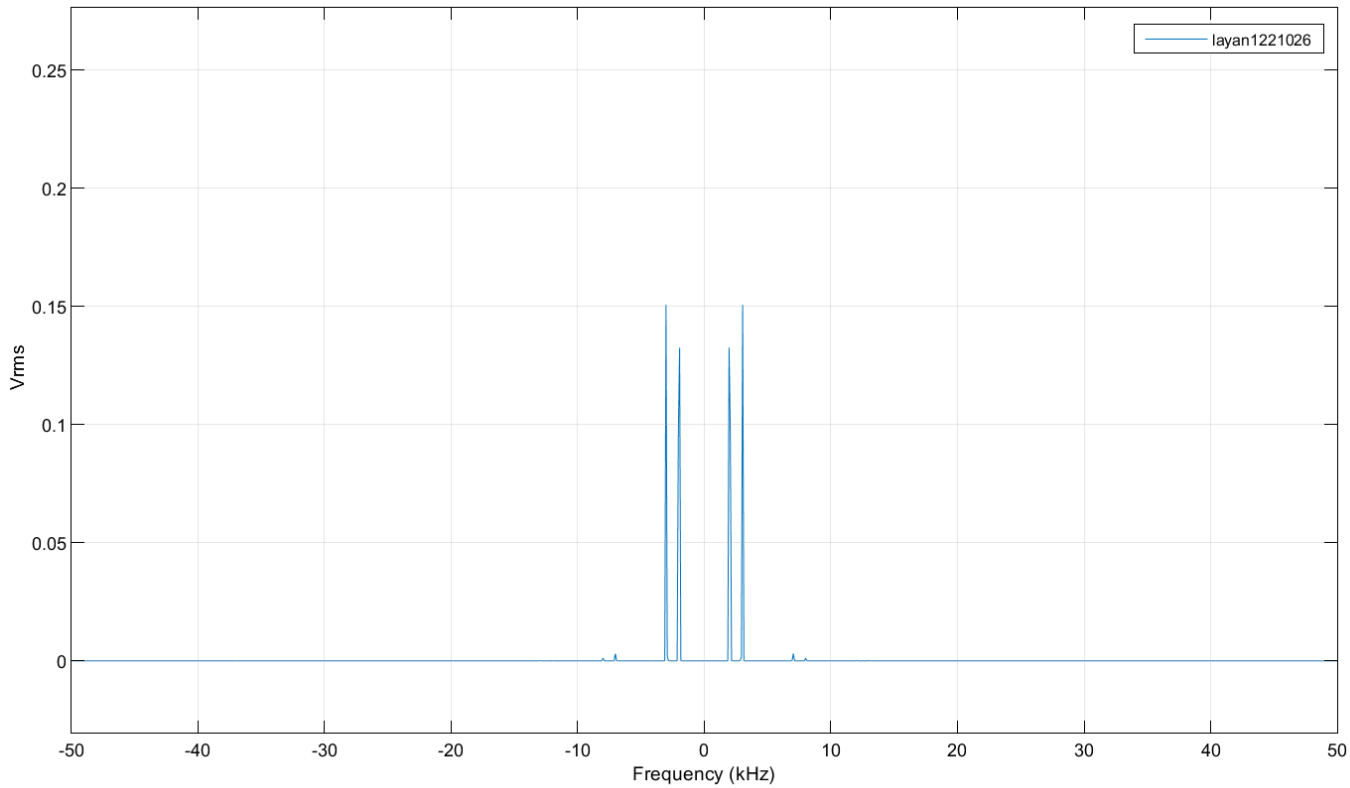




RBW=97.656 Hz, Sample rate=100 kHz

Displaying the Flat-Topped demodulated Signal (fm=3000Hz):





RBW=97.656 Hz, Sample rate=100 kHz