Faculty of Engineering and Technology

Electrical and Computer Engineering Department

COMMUNICATIONS LAB

ENEE4113

Experiment #10:Amplitude Shift Keying (ASK)

PreLab #4

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Section: 2

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Signals Information

Train of pulses:

The Train of pulses used in this pre-Lab has these initial values (They will be changed in the steps):

1. Vss=10 volt, so the amplitude = 5volts

2. Frequency = 1000 Hz, which is equivalent to $2\pi(1000)$ rad/sec with period = $1/f = 1/1000$

3. Duty cycle = 50%, so the pulse width = 50%

Carrier Signal:

The carrier signal used in this pre-Lab is represented as:

$c(t)=\cos(2\pi(20k)t)$

From this representation:

1. Amplitude of the carrier signal (Ac) = 1

2. Frequency of the carrier signal = 20kHz, which is equivalent to $2\pi(20000)$ rad/sec

ASK Modulation

In Amplitude Shift Keying (ASK), the amplitude of the carrier signal is modified according to the binary input message signal. When the binary bit is 1, the carrier is transmitted; when it is 0, the carrier is suppressed. This section visually represents the basic concept of ASK, highlighting how the carrier wave varies with the message.

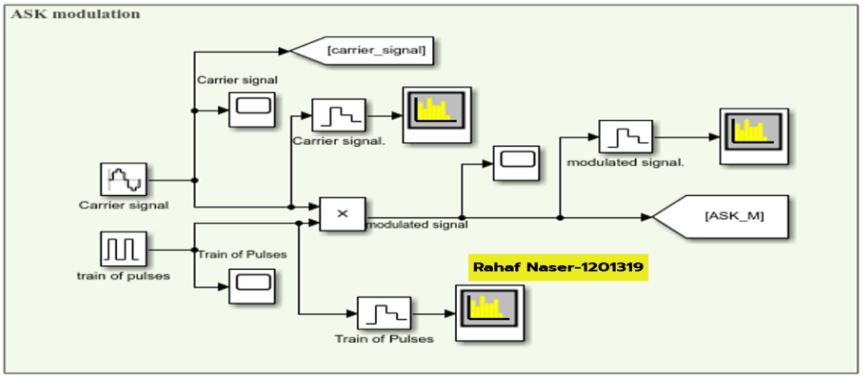

Figure 1:ASK MODUALATION

ASK demodulation 1+2

Two types of demodulation are presented. The first is envelope detection, which is a simple and commonly used method in ASK systems. The second method could involve coherent detection, requiring synchronization between transmitter and receiver. Comparing the two helps understand trade-offs between complexity and performance.

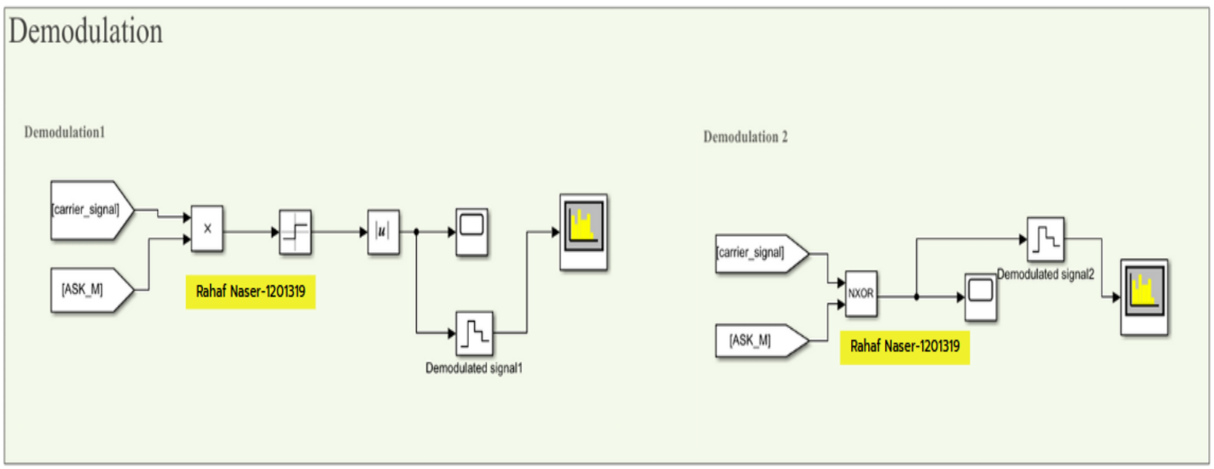

Figure 2:ASK DEMODULATION 1+2

Message signal

Time domain:

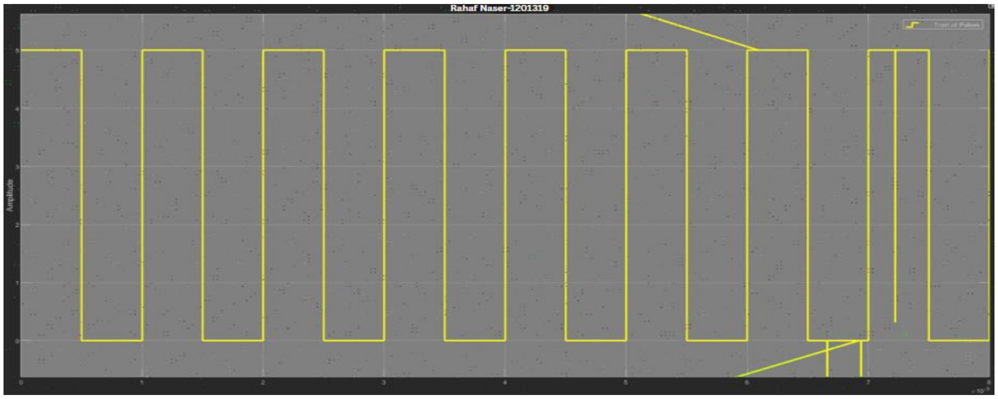

Figure 3:Message signal time domain

Frequency domain:

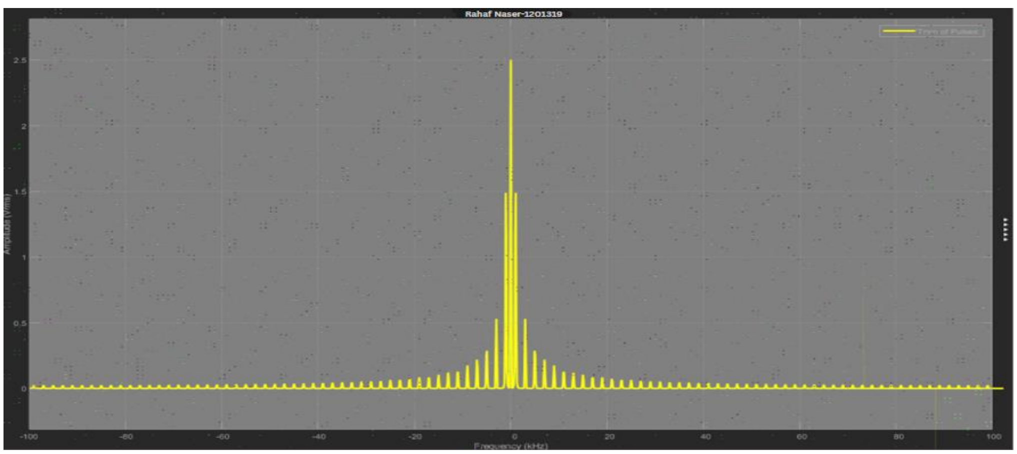

Figure 4:Message signal frequency domain

Message Signal

- **Time Domain**: The message signal consists of a binary waveform, typically a square wave. This represents the original data to be transmitted.
- **Frequency Domain**: The frequency components here show that the message signal contains harmonics, a characteristic of square waves. These harmonics influence the spectral characteristics of the ASK signal.

Carrier Signal

Time domain:

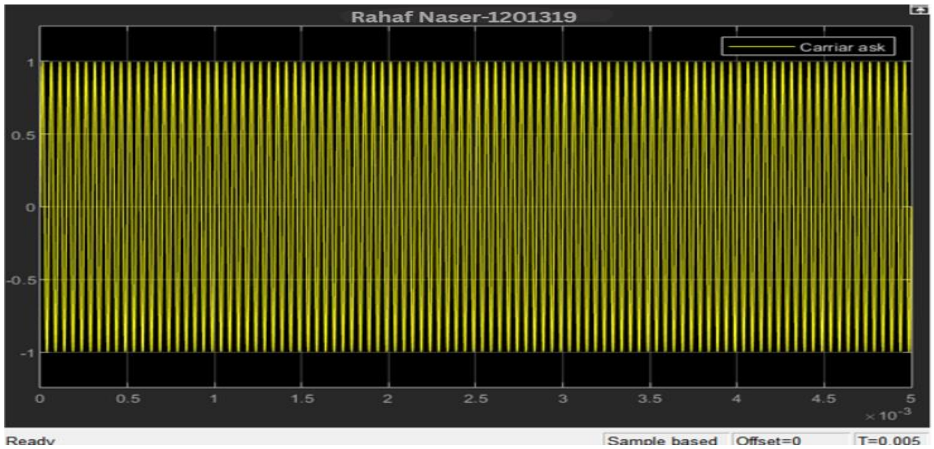

Figure 5:Carrier signal time domain

Frequency domain:

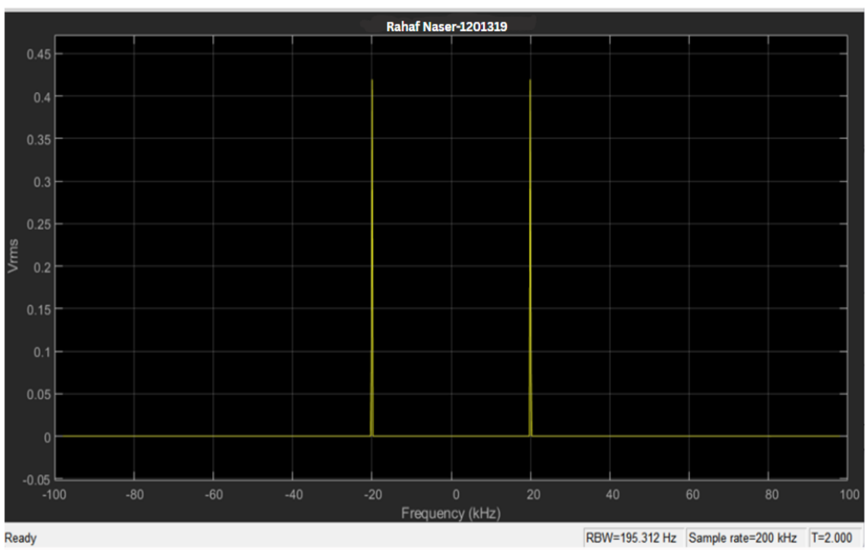

Figure 6:Carrier signal frequency domain

Carrier Signal

- **Time Domain**: A high-frequency sinusoidal signal used for modulation.
- **Frequency Domain**: Displays a sharp peak at the carrier frequency, indicating a pure tone, which serves as the base for modulation.

ASK Modulated signal @ Am=5, D=50% & f=1KHz

Time domain:

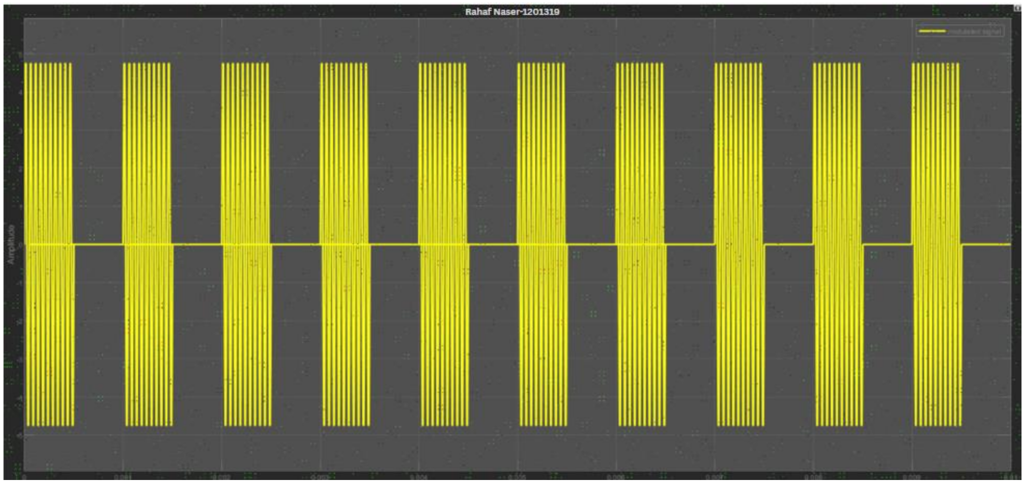

Figure 7:ASK Modulated signal @ Am=5, D=50% & f=1KHz time domain

Frequency domain:

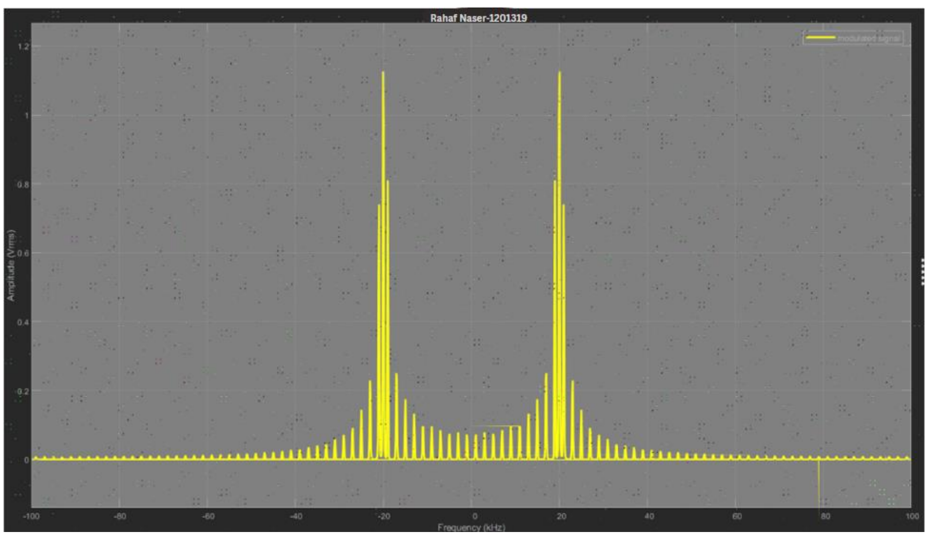

Figure 8:ASK Modulated signal @ Am=5, D=50% & f=1KHz frequency domain

@ Am=5, D=50%, f=1KHz: A typical ASK signal. The amplitude of the carrier switches between high and zero according to the message signal. In the frequency domain, sidebands appear around the carrier.

ASK Modulated signal @ DC signal 0V

Time domain:

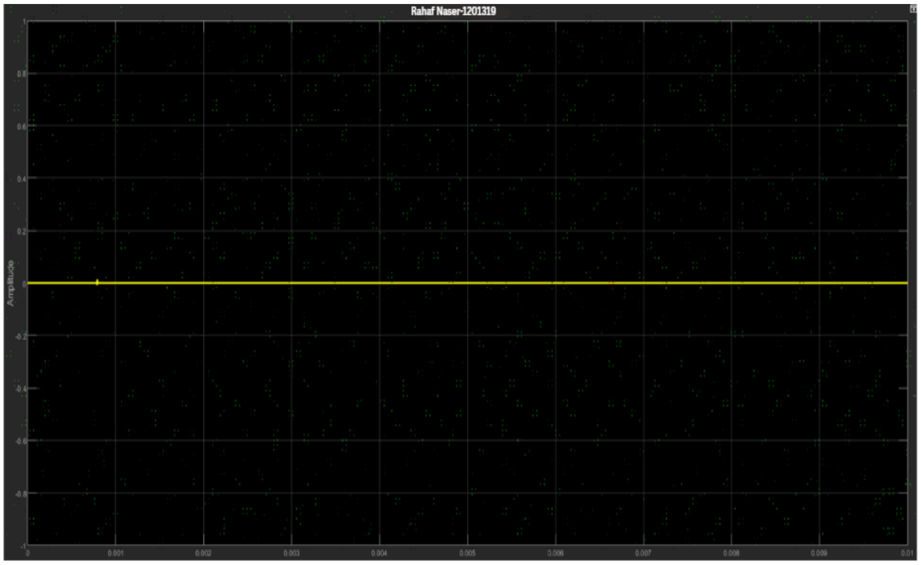

Figure 9:ASK Modulated signal @ DC signal 0V time domain

Frequency domain:

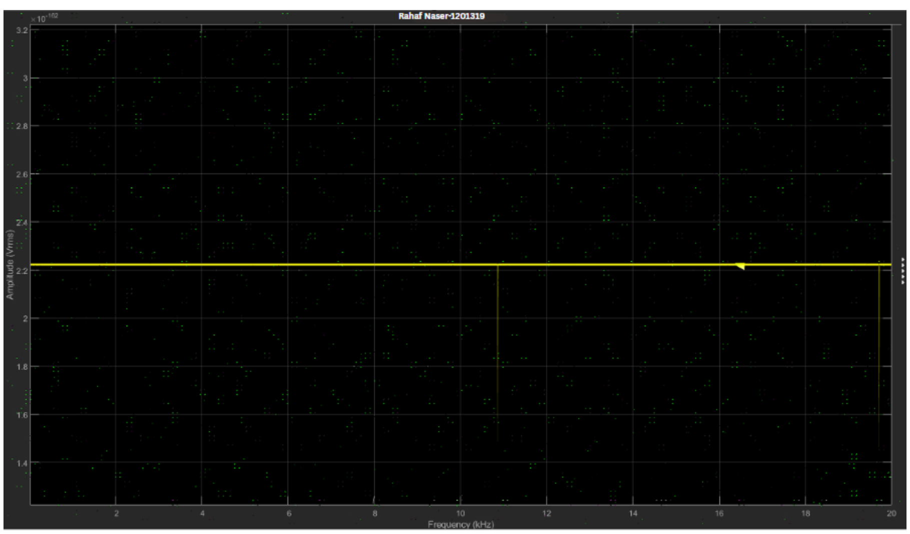

Figure 10:ASK Modulated signal @ DC signal 0V frequency domain

@ DC signal 0V: No modulation occurs as the message signal is always zero. Hence, no carrier is transmitted, which is reflected by an absence of frequency components.

ASK Modulated signal @ DC signal 2.5V

Time domain:

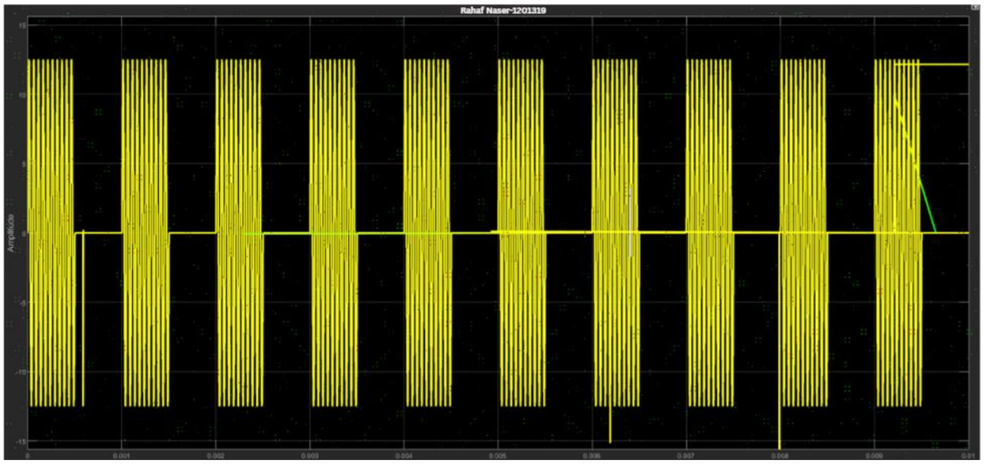

Figure 11:ASK Modulated signal @ DC signal 2.5V time domain

Frequency domain:

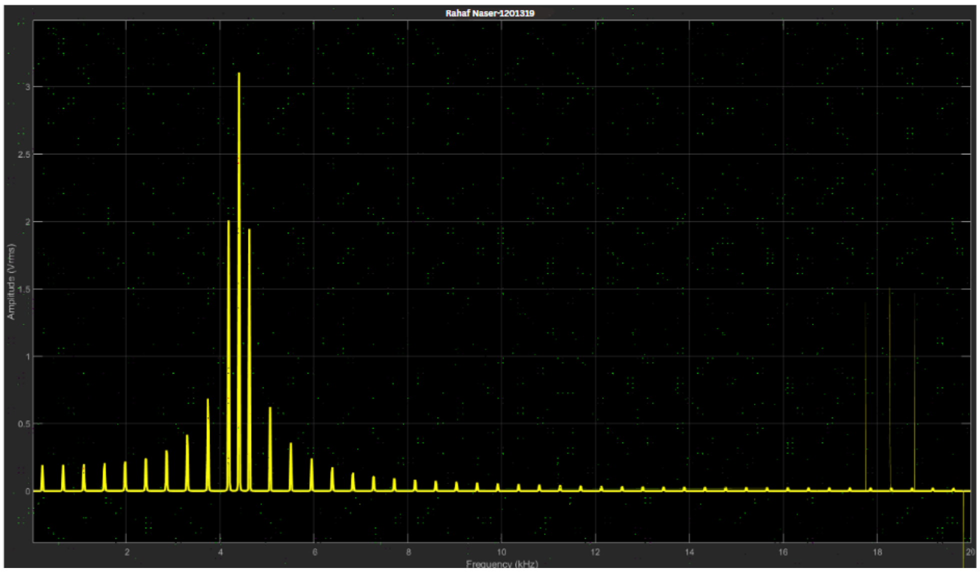

Figure 12:ASK Modulated signal @ DC signal 2.5V frequency domain

@ DC signal 2.5V: The message signal is constantly high, so the carrier is continuously transmitted. The frequency spectrum shows only the carrier without sidebands.

ASK Modulated signal @ Am=1.5, D=50% & f=1KHz

Time domain:

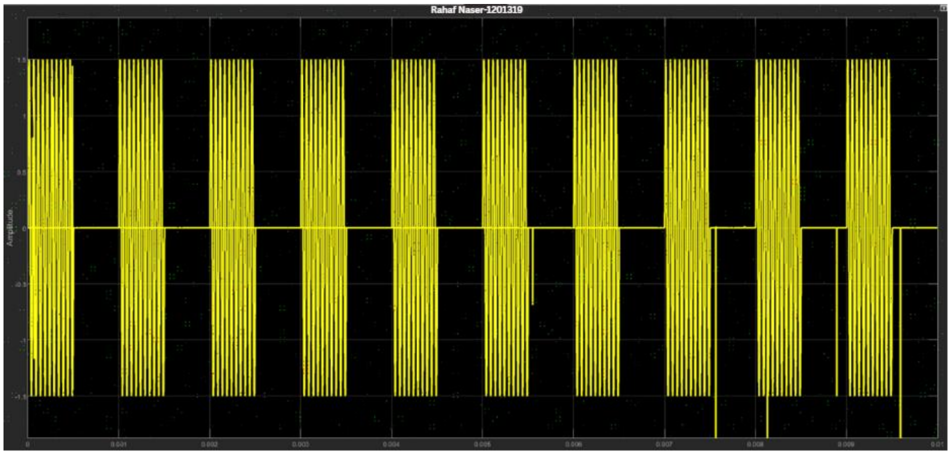

Figure 13:ASK Modulated signal @ Am=1.5, D=50% & f=1KHz time domain

Frequency domain:

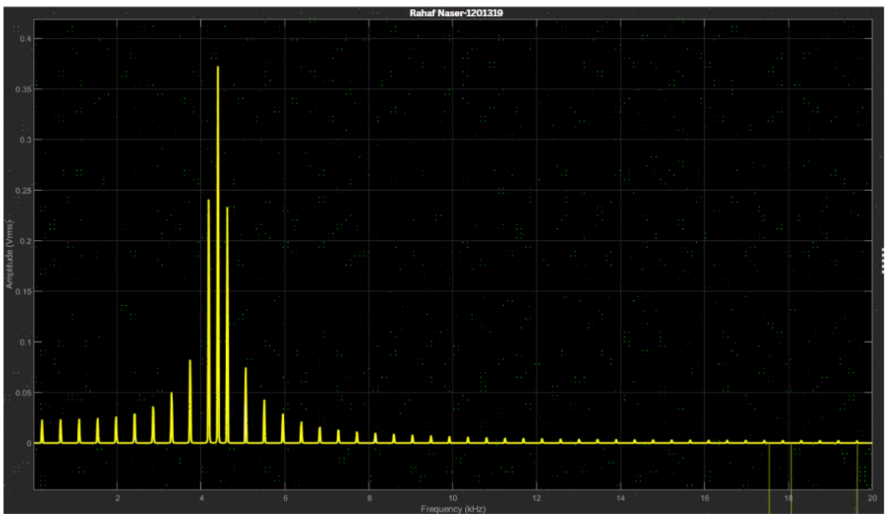

Figure 14:ASK Modulated signal @ Am=1.5, D=50% & f=1KHz frequency domain

@ Am=1.5, D=50%, f=1KHz: Lower modulation amplitude makes the ASK signal less distinguishable, which may increase susceptibility to noise.

ASK Modulated signal @ Am=5, D=50% & f=0.5KHz

Time domain:

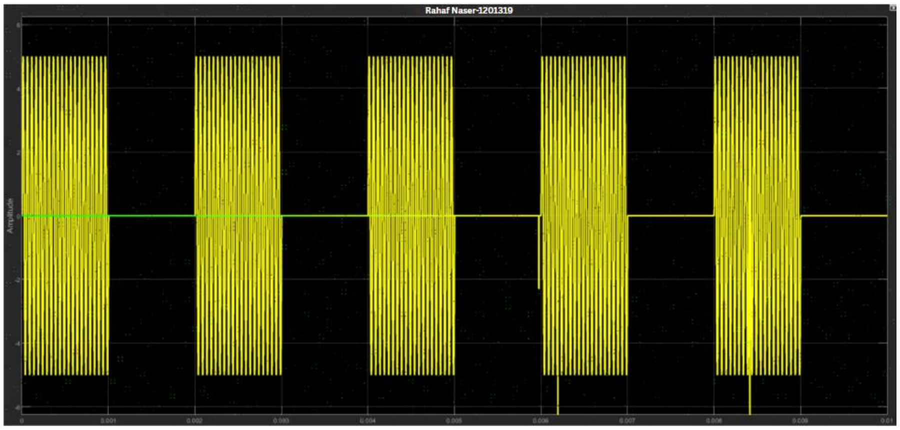

Figure 15:ASK Modulated signal @ Am=5, D=50% & f=0.5KHz time domain

Frequency domain:

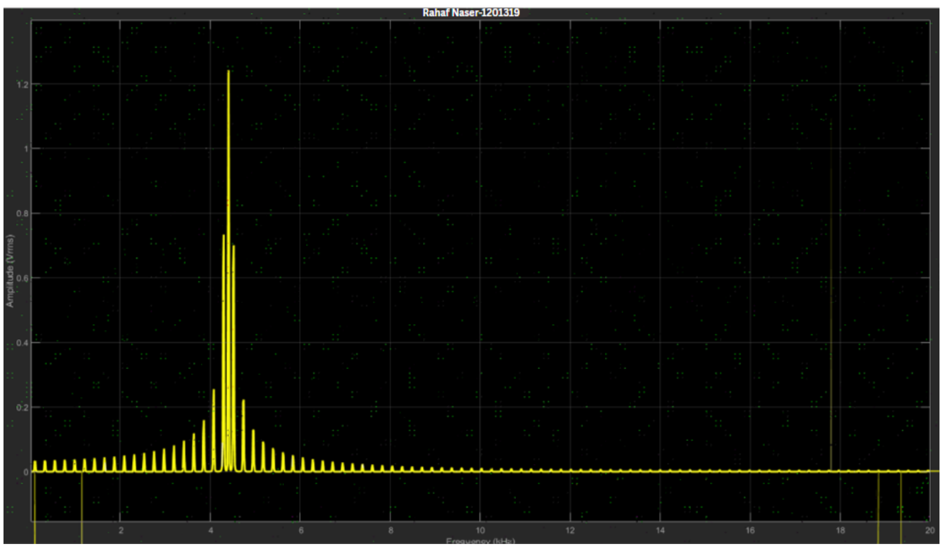

Figure 16:ASK Modulated signal @ Am=5, D=50% & f=0.5KHz frequency domain

@ Am=5, D=50%, f=0.5KHz: Lower message frequency results in a slower change in modulation. In the frequency domain, sidebands are closer to the carrier frequency.

ASK Modulated signal @ Am=5, D=10% & f=1KHz

Time domain:

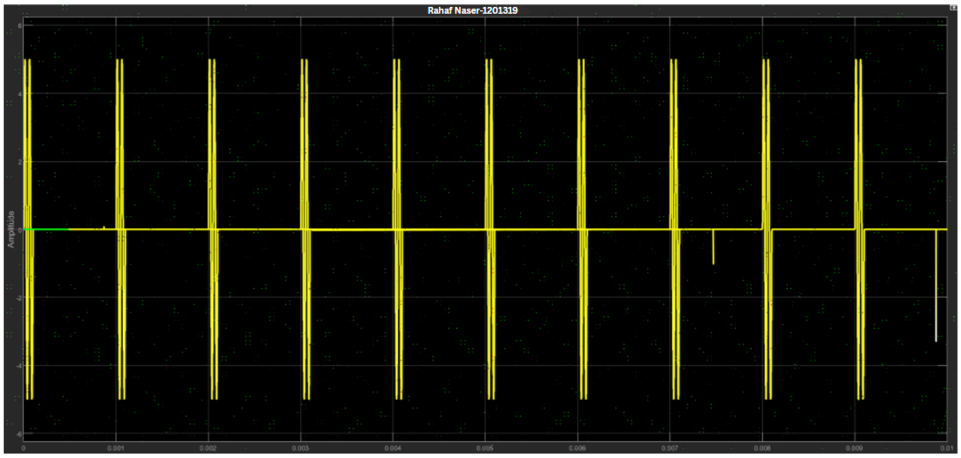

Figure 17:ASK Modulated signal @ Am=5, D=10% & f=1KHz time domain

Frequency domain:

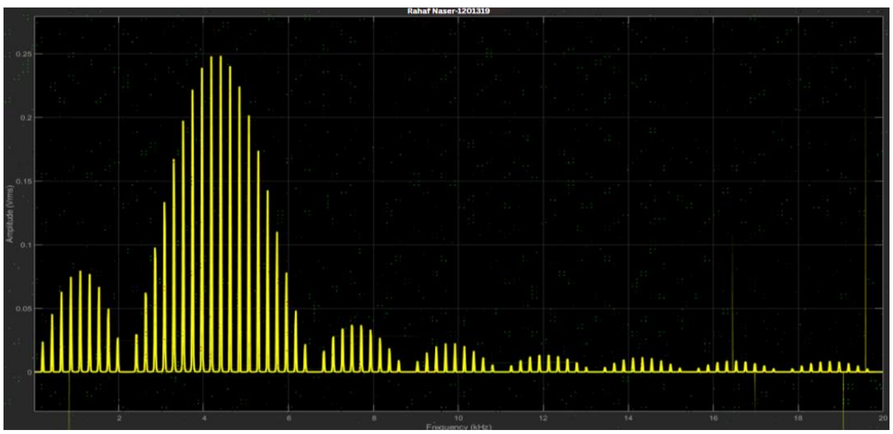

Figure 18:ASK Modulated signal @ Am=5, D=10% & f=1KHz frequency domain

@ Am=5, D=10%, f=1KHz: Lower duty cycle indicates a mostly-zero message signal, so the carrier appears only briefly. In frequency domain, reduced power in sidebands.

De-Modulated (1) signal @ Am=5, D=50% & f=1KHz

Time domain:

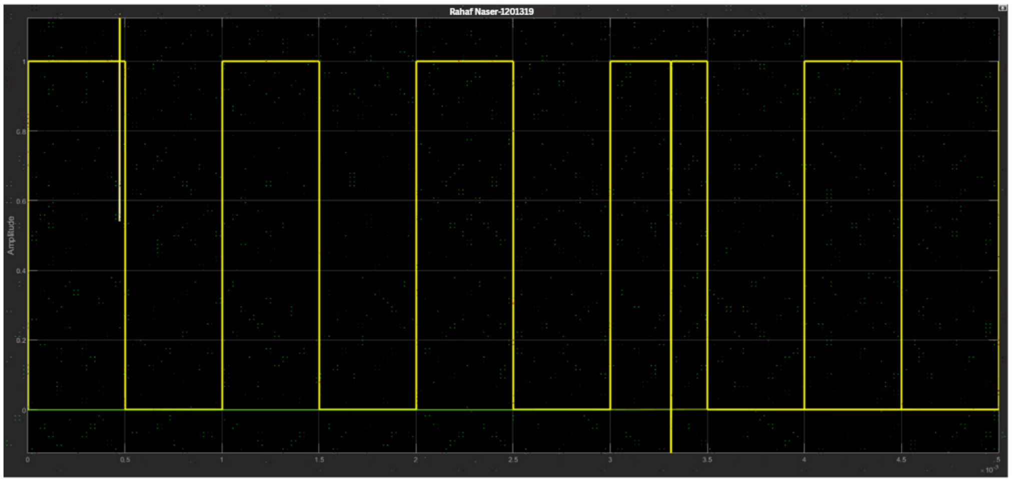

Figure 19:De-Modulated (1) signal @ Am=5, D=50% & f=1KHz time domain

Frequency domain:

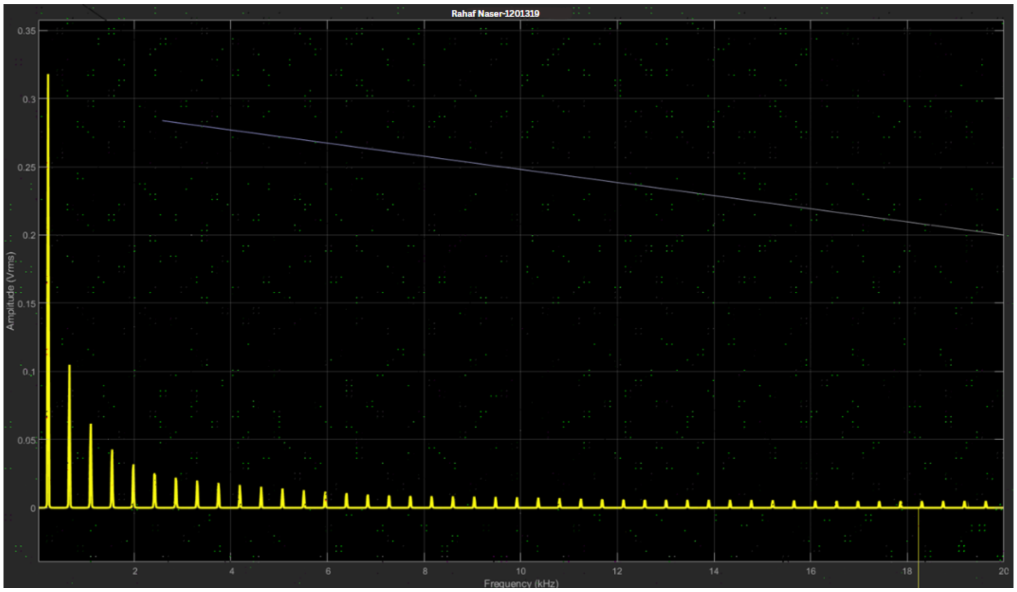

Figure 20:De-Modulated (1) signal @ Am=5, D=50% & f=1KHz frequency domain

De-Modulated (2) signal @ Am=5, D=50% & f=1KHz

Time domain:

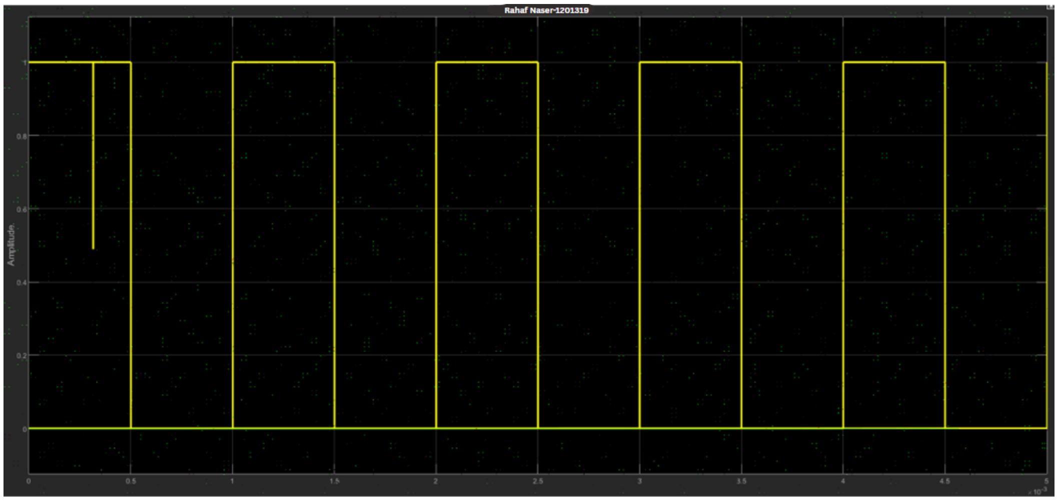

Figure 21:De-Modulated (2) signal @ Am=5, D=50% & f=1KHz time domain

Frequency domain:

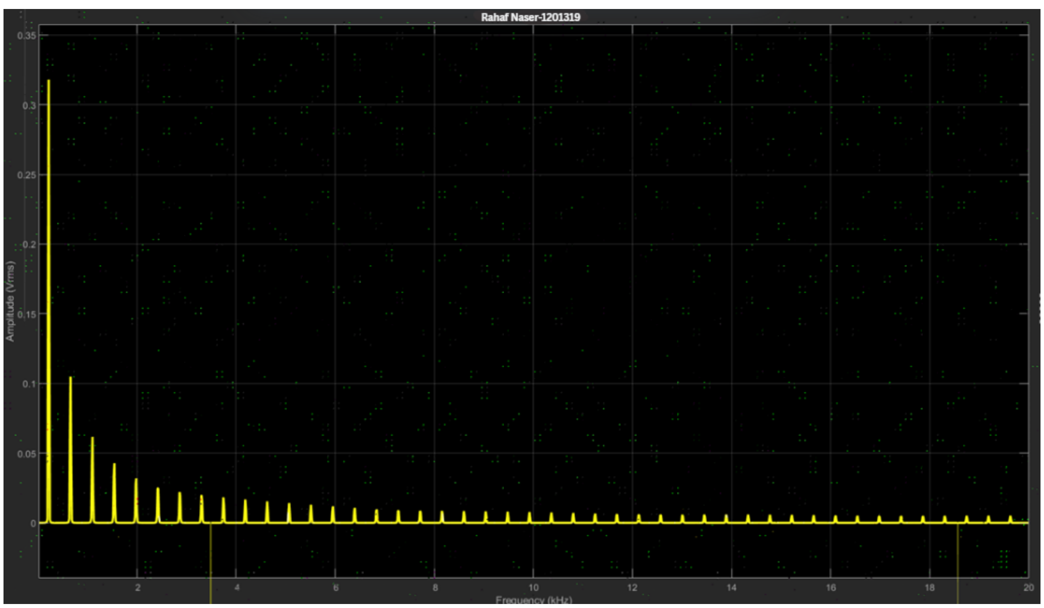

Figure 22:De-Modulated (2) signal @ Am=5, D=50% & f=1KHz frequency domain

Am=5, D=50%, f=1KHz (method1 & 2): Both demodulators successfully recover the original signal, though the clarity may differ depending on noise filtering and accuracy.

De-Modulated (1) signal @ Am=1.5, D=50% & f=1KHz

Time domain:

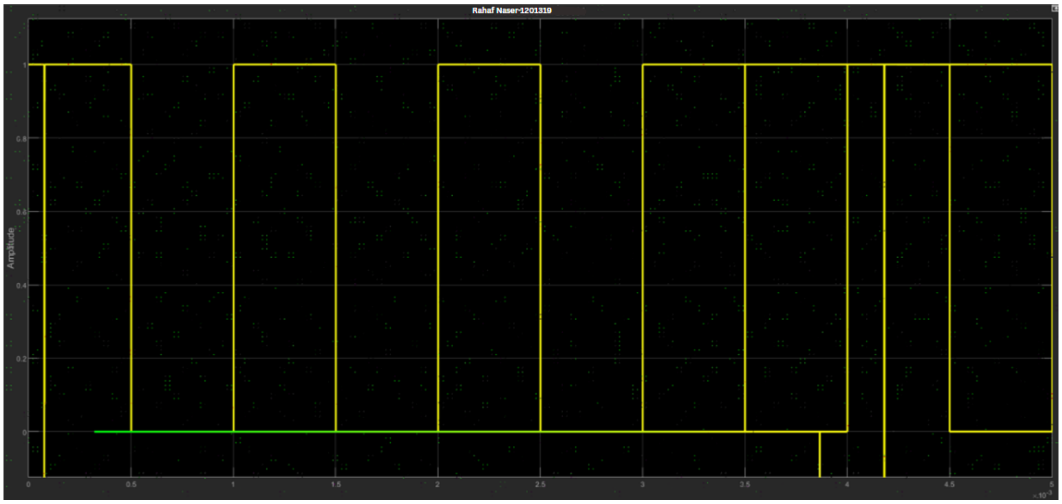

Figure 23:De-Modulated (1) signal @ Am=1.5, D=50% & f=1KHz time domain

Frequency domain:

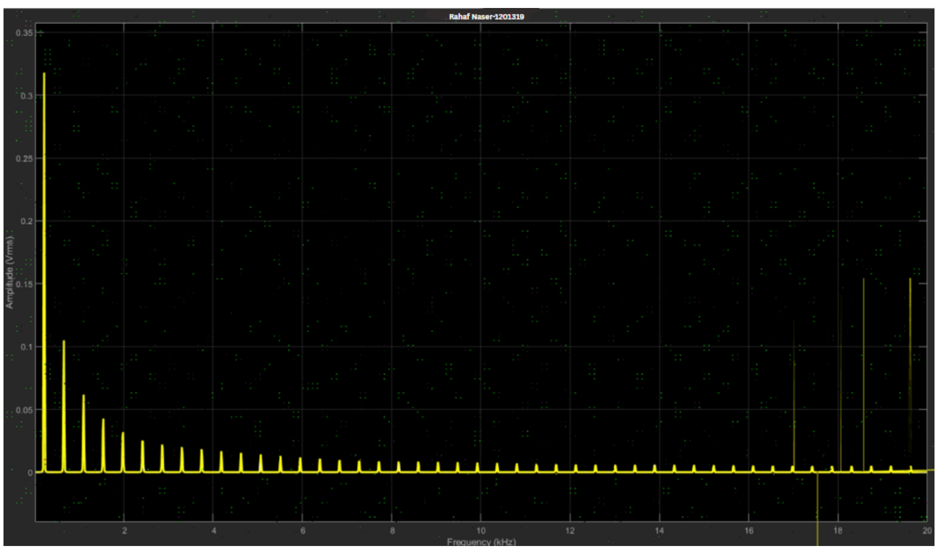

Figure 24:De-Modulated (1) signal @ Am=1.5, D=50% & f=1KHz frequency domain

De-Modulated (2) signal @ Am=1.5, D=50% & f=1KHz

Time domain:

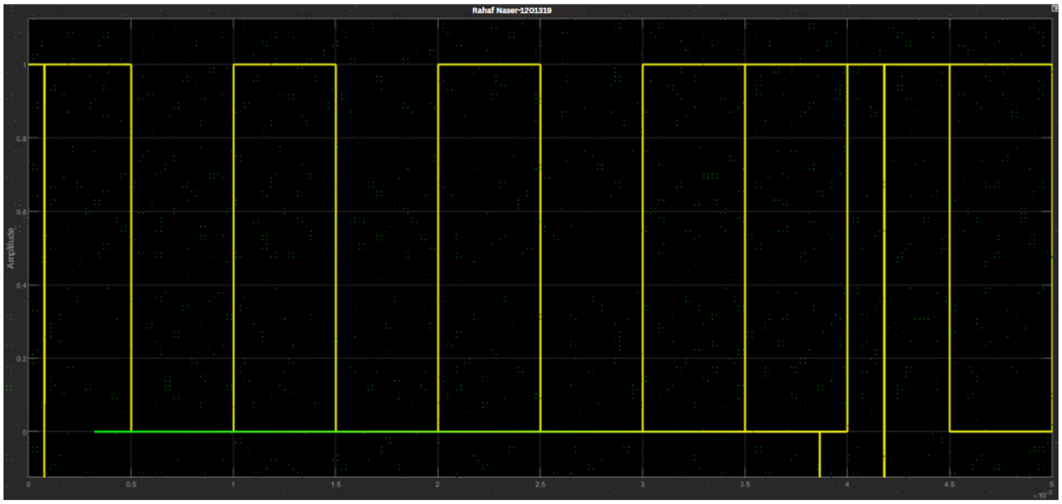

Figure 25:De-Modulated (2) signal @ Am=1.5, D=50% & f=1KHz time domain

Frequency domain:

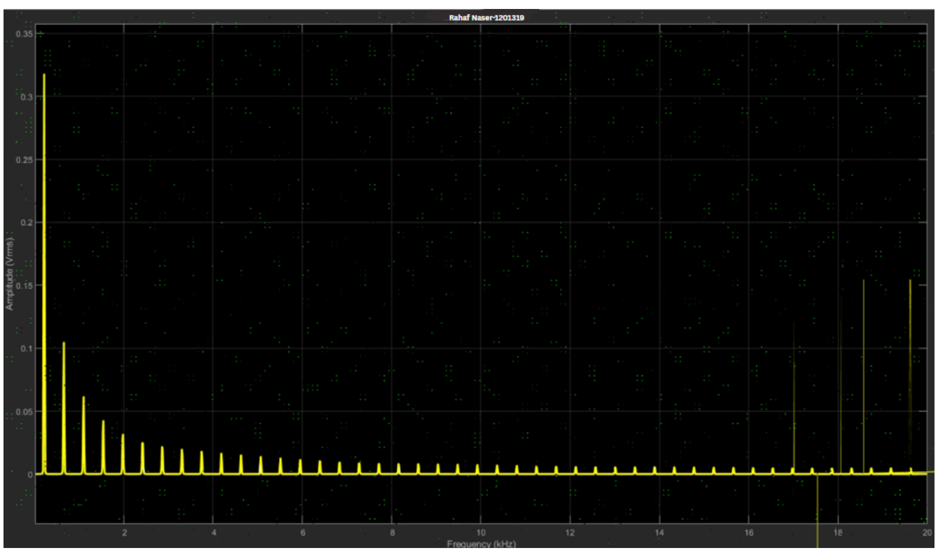

Figure 26:De-Modulated (2) signal @ Am=1.5, D=50% & f=1KHz frequency domain

Am=1.5, D=50%, f=1KHz (method 1 & 2): Lower amplitude affects demodulation accuracy, possibly resulting in weaker signal recovery or distortion.

De-Modulated (1) signal @ Am=5, D=50% & f=0.5KHz

Time domain:

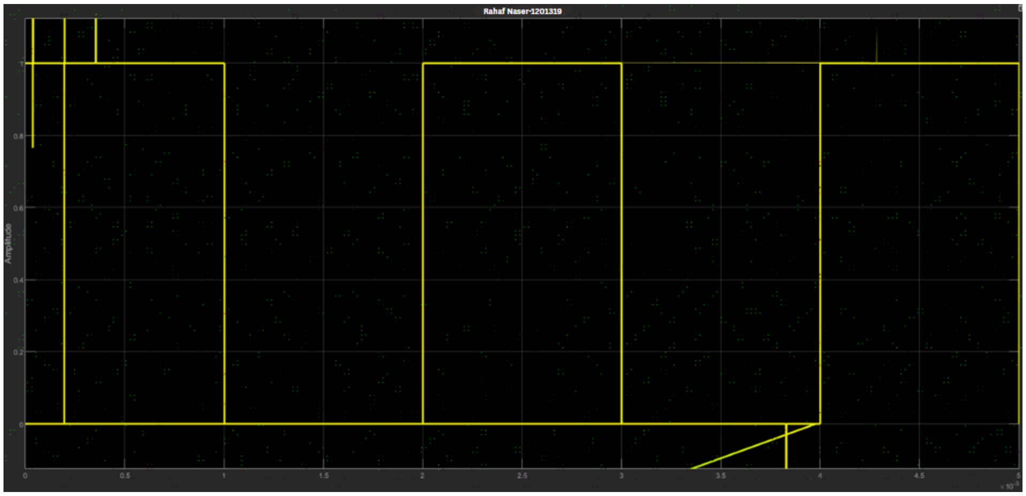

Figure 27:De-Modulated (1) signal @ Am=5, D=50% & f=0.5KHz time domain

Frequency domain:

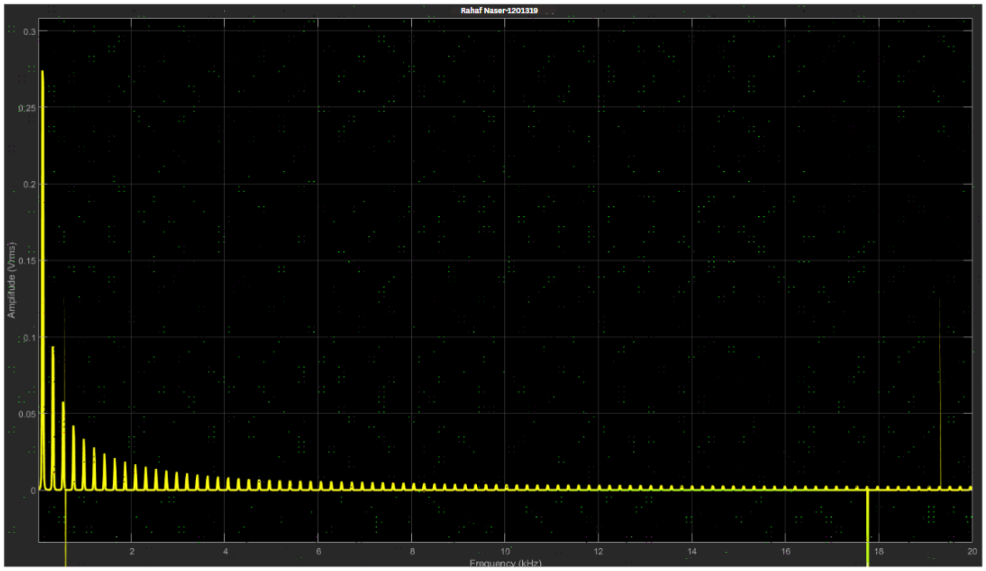

Figure 28:De-Modulated (1) signal @ Am=5, D=50% & f=0.5KHz frequency domain

De-Modulated (2) signal @ Am=5, D=50% & f=0.5KHz

Time domain:

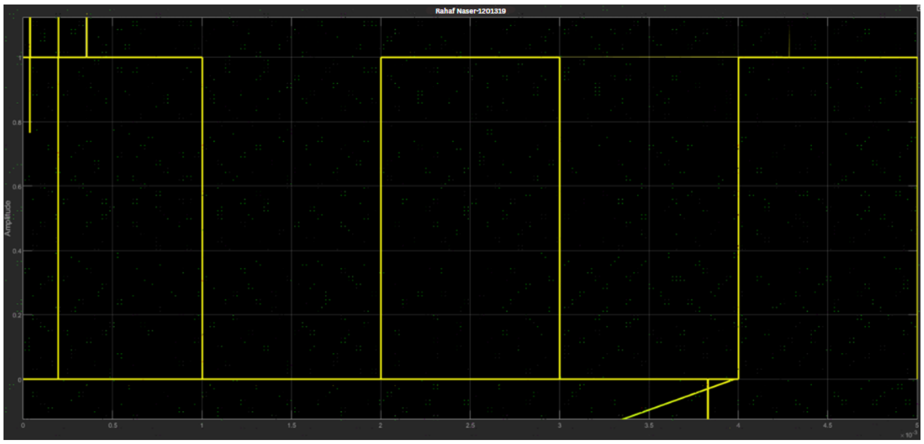

Figure 29:De-Modulated (2) signal @ Am=5, D=50% & f=0.5KHz time domain

Frequency domain:

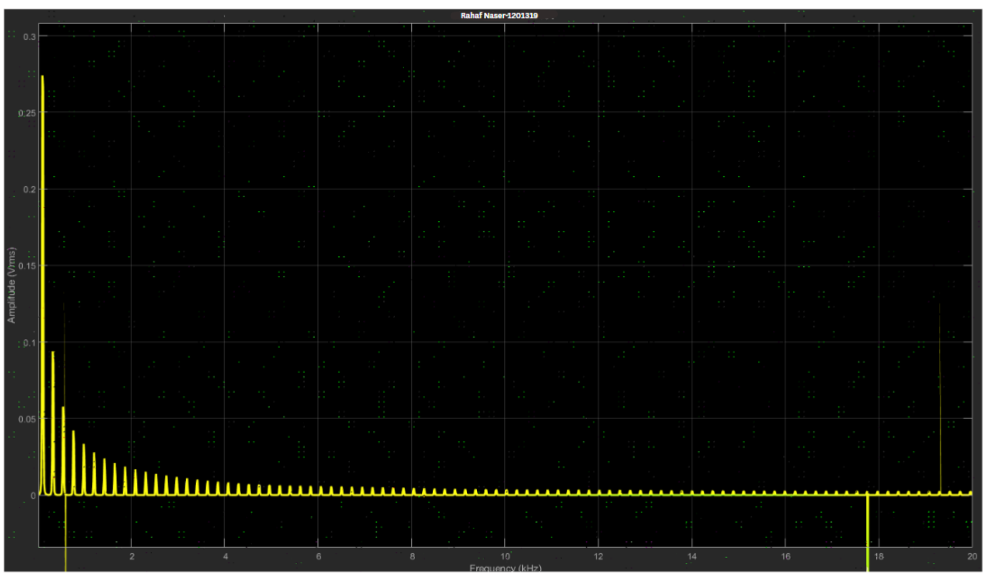

Figure 30:De-Modulated (2) signal @ Am=5, D=50% & f=0.5KHz frequency domain

Am=5, D=50%, f=0.5KHz (method 1 & 2): The demodulated output follows the slower message signal accurately. The performance of both methods can be compared in terms of smoothness and delay.

De-Modulated (1) signal @ Am=5, D=10% & f=1KHz

Time domain:

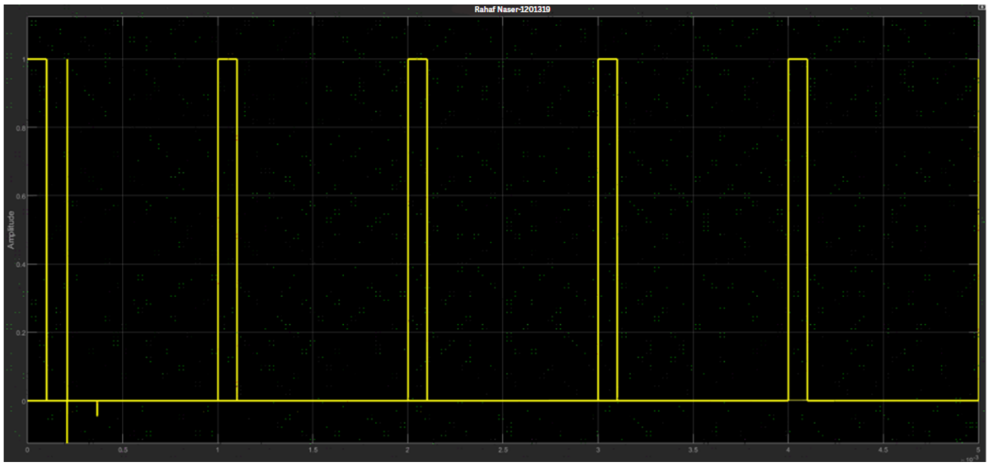

Figure 31:De-Modulated (1) signal @ Am=5, D=10% & f=1KHz time domain

Frequency domain:

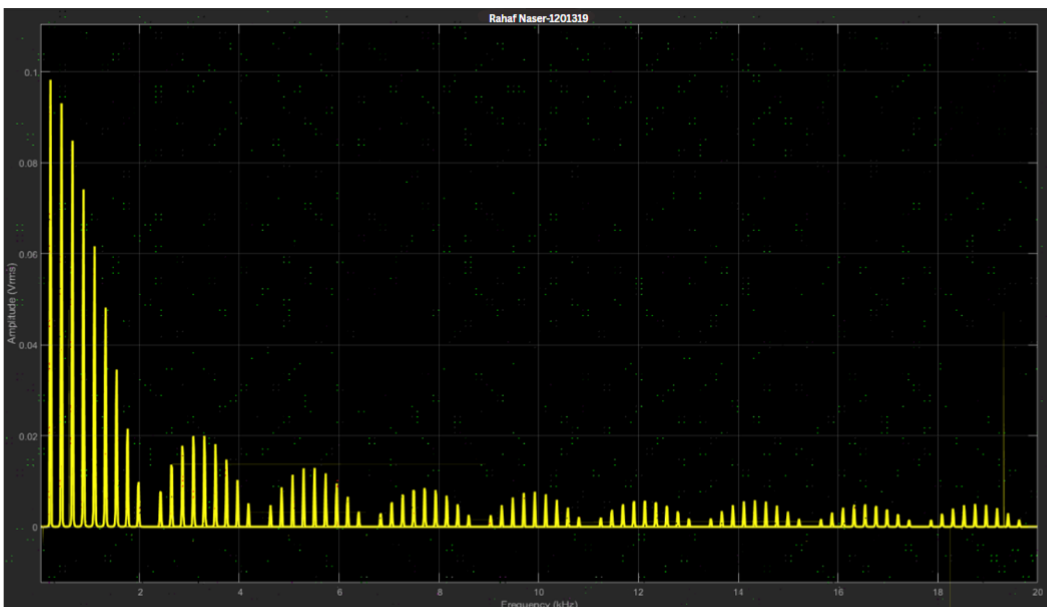

Figure 32:De-Modulated (1) signal @ Am=5, D=10% & f=1KHz frequency domain

De-Modulated (2) signal @ Am=5, D=10% & f=1KHz

Time domain:

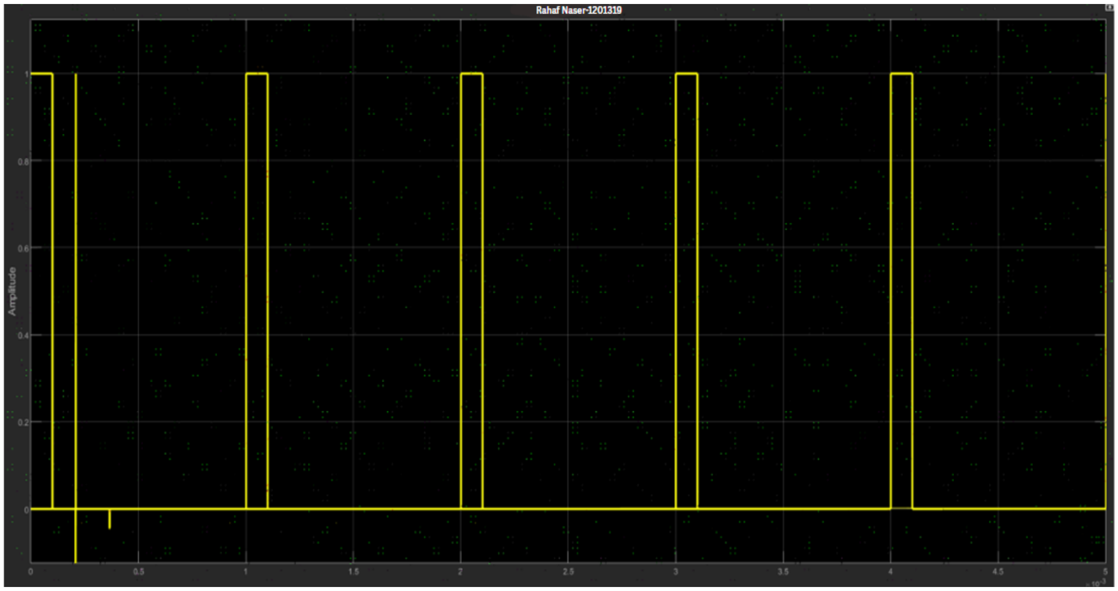

Figure 33:De-Modulated (2) signal @ Am=5, D=10% & f=1KHz time domain

Frequency domain:

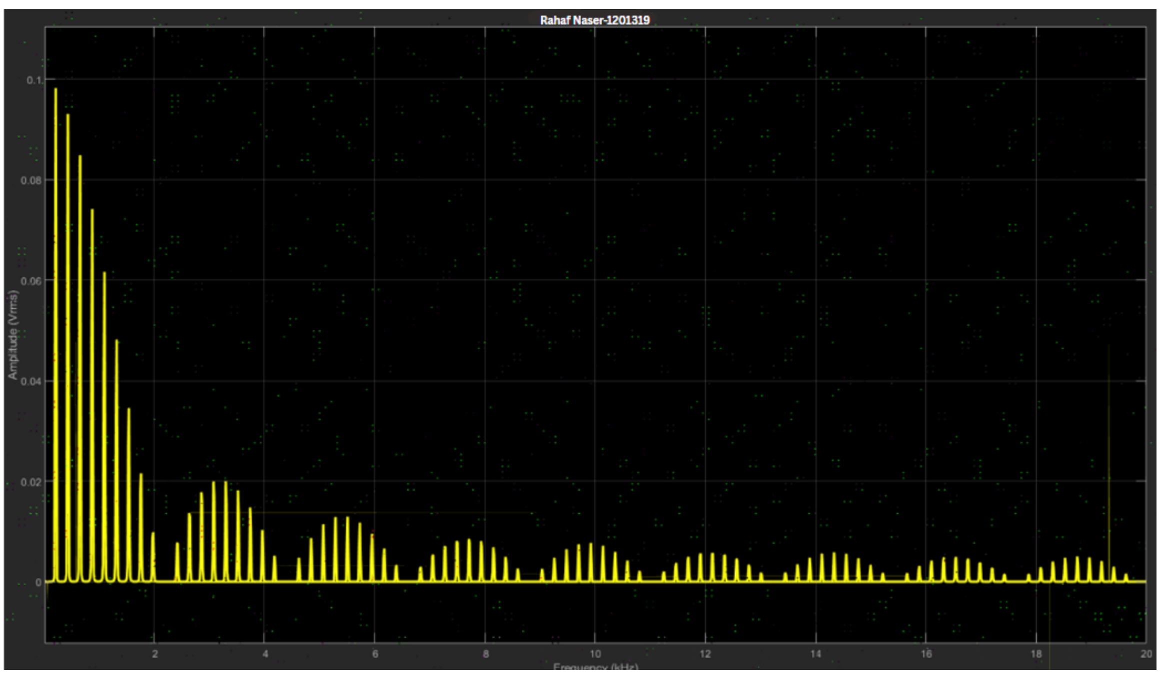

Figure 34:De-Modulated (2) signal @ Am=5, D=10% & f=1KHz frequency domain

Am=5, D=10%, f=1KHz (method 1 & 2): The sparse message signal might lead to poor recovery especially if the demodulator is not sensitive enough to detect short bursts of the carrier.