Project Report

Experiment: 03

<u>Frequency Shift Keying (FSK) modulation</u>

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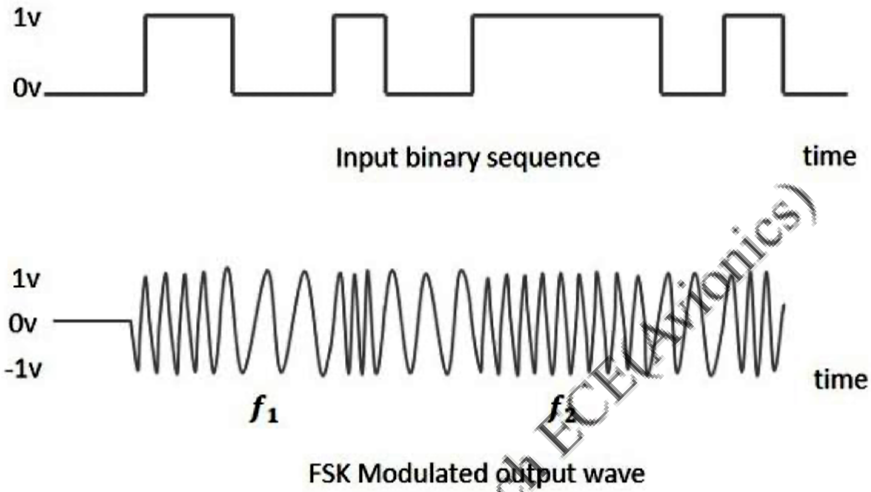
11 April, 2025
Friday

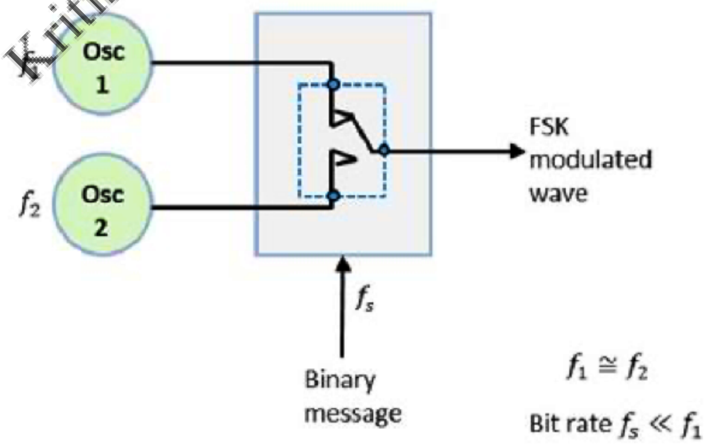
Frequency Shift Keying

Frequency Shift Keying FSK is the digital modulation technique in which the frequency of the carrier signal varies according to the digital signal changes. FSK is a scheme of frequency modulation. The output of a FSK modulated wave is high in frequency for a binary High input and is low in frequency for a binary Low input. The binary 1s and 0s are called Mark and Space frequencies. The following image is the diagrammatic representation of FSK modulated waveform along with its input.



FSK Modulator

The FSK modulator block diagram comprises of two oscillators with a clock and the input binary sequence. Following is its block diagram.



The two oscillators, producing a higher and a lower frequency signals, are connected to a switch along with an internal clock. To avoid the abrupt phase discontinuities of the output waveform during the transmission of the message, a clock is applied to both the oscillators, internally. The binary input sequence is applied to the transmitter so as to choose the frequencies according to the binary input.

Objective:

To understand and implement Frequency Shift Keying (FSK) modulation using simulation in Multisim and practical setup on a breadboard. The modulated signal is observed using a Digital Storage Oscilloscope (DSO).

Theory:

Frequency Shift Keying (FSK) is a digital modulation technique in which the frequency of the carrier signal is changed according to the binary information (0s and 1s) being transmitted.

Principle of FSK:

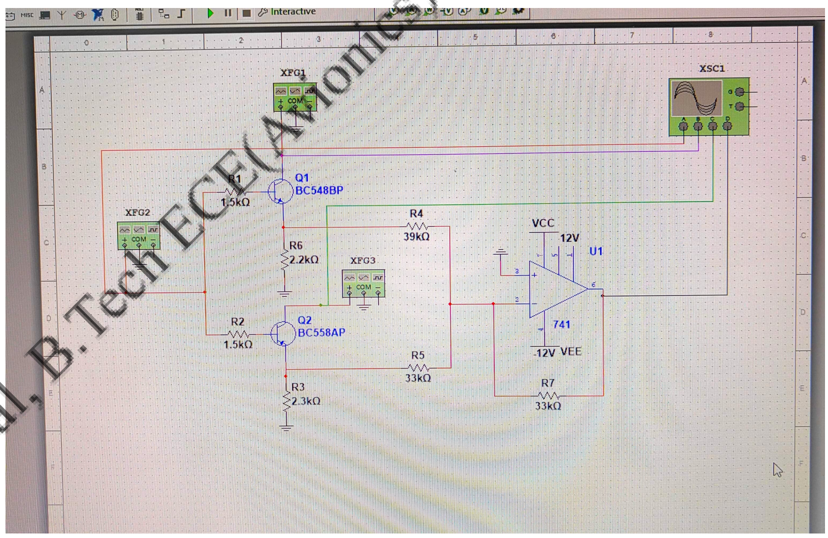
In FSK: *A binary '1' is represented by a **high-frequency carrier** f1
*A binary '0' is represented by a **low-frequency carrier** f0

Mathematical Representation of ASK Modulated wave:

$s(t)=A\cos(2\pi f_c i)\quad 0<t<T \quad i=1,2.$

$\phi(t)= \sqrt{2/T} \times \cos 2\pi f_{ci} t$

Simulation Using the Multisim Software:



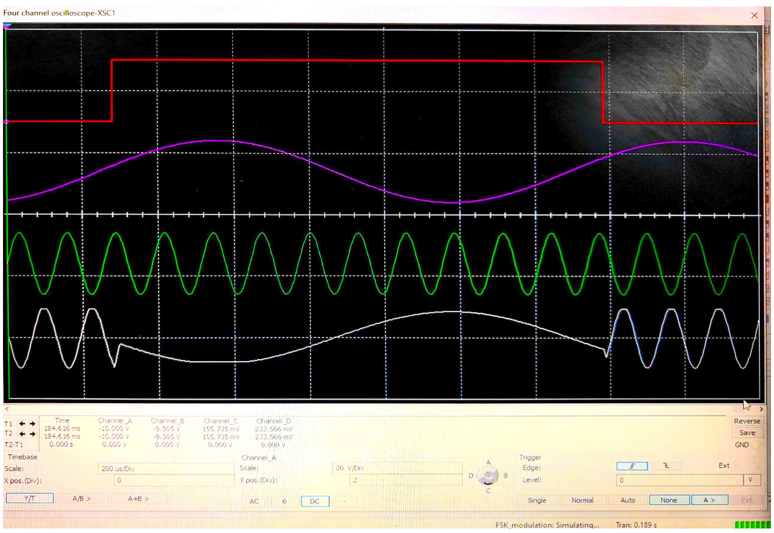
Components Used

- Two Function generator (Sine carrier signals and Data message signal)
- Resistors of 1k, 2k, 40k ohm, 30k ohm BC4434 (PNP), 2N222A (NPN) transistor, 741 op-amp
- Oscilloscope, Power and Ground

Carrier1 Frequency: 7.8kHz. Carrier2 Frequency: 806Hz
Message Frequency: 384 Hz.

Simulation Steps

- **Input Message**: 384 Hz square wave at XPG2
- **Carrier Frequencies**: 7.8kHz and 806 Hz sinusoids at XPG1 and XPG3
- **Output**: Oscilloscope XSC1 shows switching frequencies based on the message input
- **Observation**: Clean FSK signal—frequency transitions match data transitions.

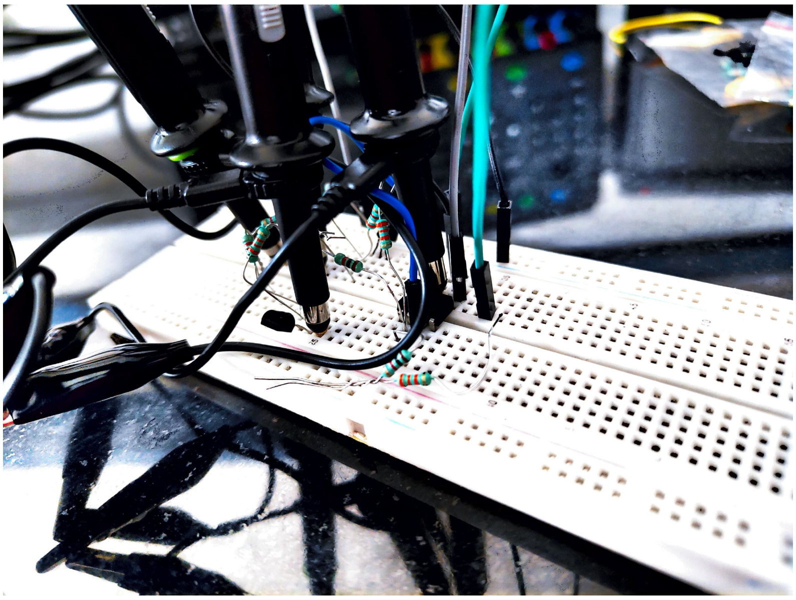


____ : Message signal
____: Carrier1 wave
____: Carrier2 wave
____: ASK modulated wave

Practical Implementation on Breadboard:

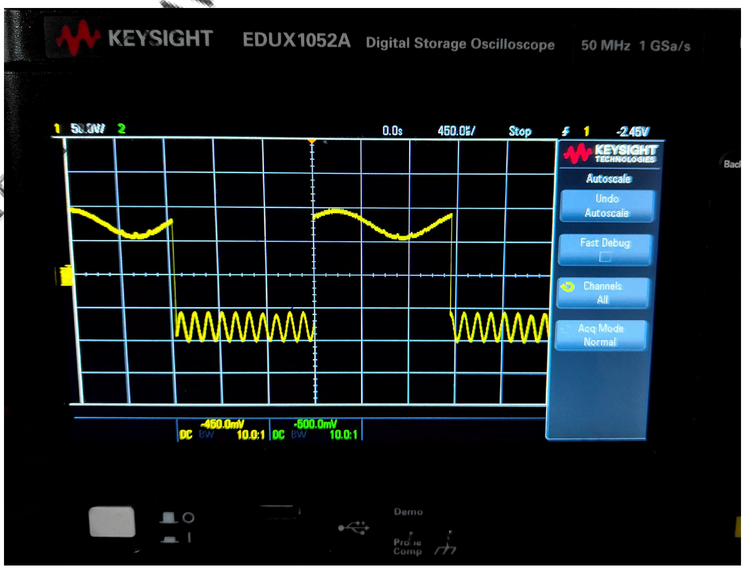
Components Used

- Q1 (2N222A): NPN transistor
- Q2 (BC4434): PNP transistor
- Two waveform generators (carrier signals and message signals)
- Breadboard
- Resistors (1k, 2k, 40k, 30k)
- Power supply (+5V or ±15V)
- Multisim software



Procedure:

- Design and simulate the FSK modulation circuit in Multisim.
- Observe and verify the output waveform (frequency change with bit toggles).
- Assemble the circuit on a breadboard.
- Feed appropriate carrier and data signals using waveform generators.
- Monitor output using DSO.
- Confirm the frequency shift corresponding to binary



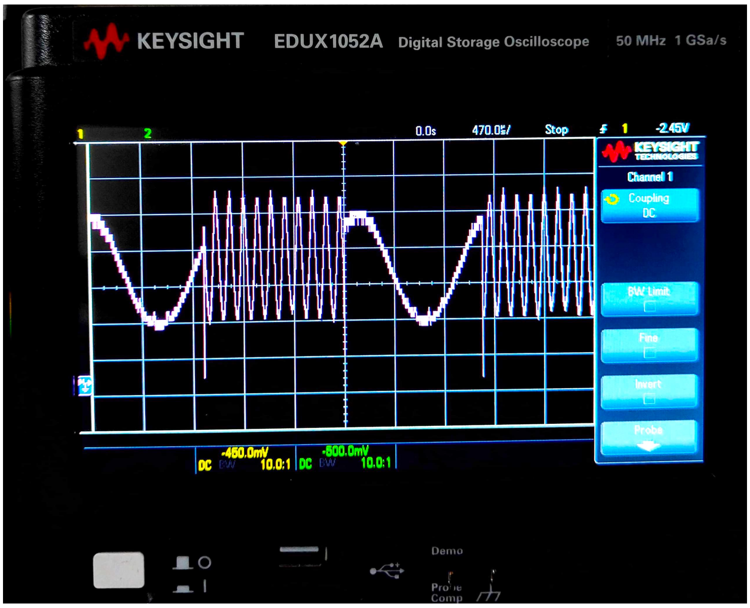
Observations:

When input = HIGH (5V):

- Q1 (NPN - 2N222A) turns ON, passing 806 **Hz sine wave** to the op-amp.
- Output waveform on DSO shows **tightly packed cycles** indicating high frequency.

When input = LOW (0V):

- Q2 (PNP - BC4434) turns ON, passing 7.8 **kHz sine wave** to the op-amp.
- Output waveform shows **more spaced cycles**, indicating lower frequency.



Conclusion:

FSK modulation was effectively realized both in simulation and hardware. The circuit performed well with proper synchronization between the input data and the output waveform. This experiment helped in understanding the core principle of FSK and its real-world implementation.

Applications of FSK

Despite its bandwidth limitations, FSK is still used today in certain situations where high-reliability transport is needed for low-bandwidth applications. Common use cases for FSK or close variants include:

- paging communication systems;
- amateur radio
- emergency broadcast system
- modems
- caller identification; and
- utility metering.

Advantages of FSK Modulation

- It has lower probability of error (Pe).
- It provides high SNR (Signal to Noise Ratio).
- It has higher immunity to noise due to constant envelope. Hence it is robust against variation in attenuation through channel.
- FSK transmitter and FSK receiver implementations are simple for low data rate application.

Disadvantages of FSK Modulation

The following are the disadvantages of FSK:

- It uses larger bandwidth compared to other modulation techniques such as ASK and PSK. Hence, it is not bandwidth efficient.
- The BER (Bit Error Rate) performance in the AWGN (Additive White Gaussian Noise) channel is worse compared to PSK modulation.
- FSK may not be the ideal choice for mobile communication systems due to its potential vulnerability to frequency-selective fading, a common occurrence in wireless channels.
- FSK modulation may exhibit reduced power efficiency compared to some other modulation schemes, especially in scenarios where power consumption is a critical consideration.
- FSK systems may require accurate frequency synchronization between the transmitter and receiver to maintain proper communication. Achieving and maintaining synchronization can be challenging in some environments.