Project Report

Experiment: 01

<u>Binary Phase Shift Keying (BPSK) modulation</u>

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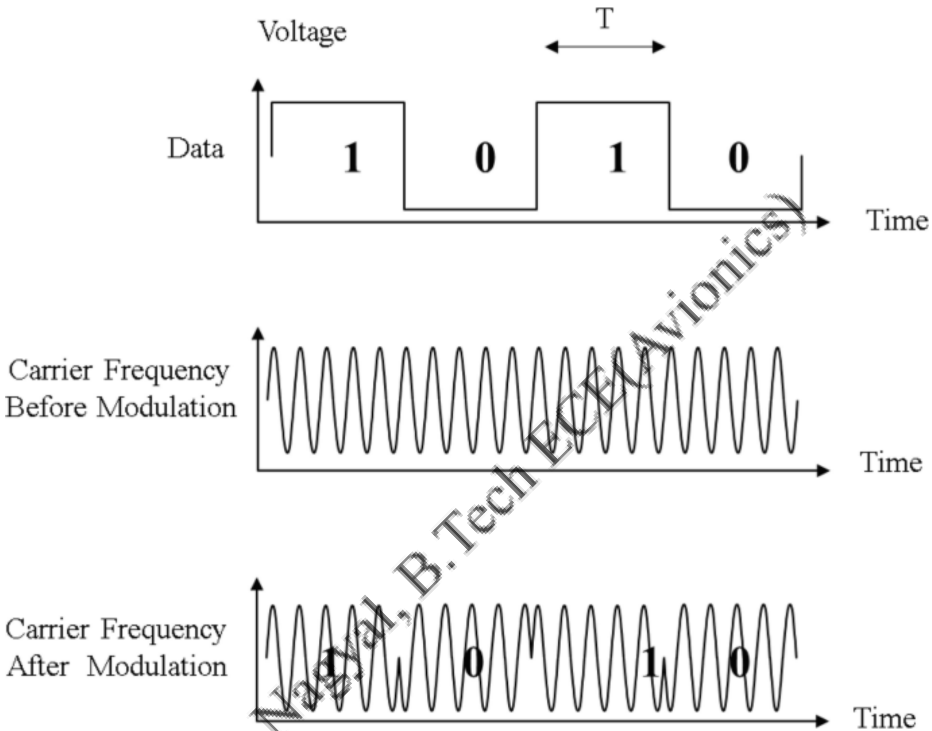
14 March, 2025
Friday

Binary Phase Shift Keying

The BPSK (Binary Phase Shift Keying) is one of the three basic binary modulation techniques. It has as a result only two phases of the carrier, at the same frequency, but separated by 180o. The general form for the BPSK signals are according to (1), where f_c is the frequency of the carrier. The coded signal (1 or 0) enters to a multiplexer that commutes the phase of the carrier signal. Depending on the logical condition of the digital input, the carrier is transferred to the output, either in phase or at 180° outside of phase, with the reference carrier



BPSK Modulator :

BPSK modulation is the process by which the phase of the carrier is varied in accordance with the modulating signal. Fig.1.1 shows a simplified block diagram of a BPSK modulator.

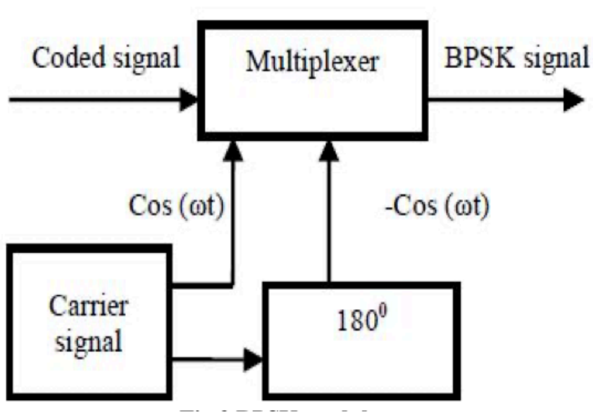


Fig 1.1

In phase modulation BPSK technique has some fine properties which make them an excellent candidate for radar applications. BPSK is chosen as modulation technique because of its advantages like accuracy of ranging, sensitivity, target separation, interference suppression

Objective:

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

Theory:

In BPSK, each bit of the binary data is represented by a phase of the carrier wave. A binary '1' may be represented by a carrier with 0° phase, and a binary '0' by a 180° phase shift.

Principle of ASK:

In BPSK: *A binary '1' is transmitted by keeping the phase of the carrier unchanged (0°).
*A binary '0' is transmitted by **shifting the phase of the carrier by 180°**.

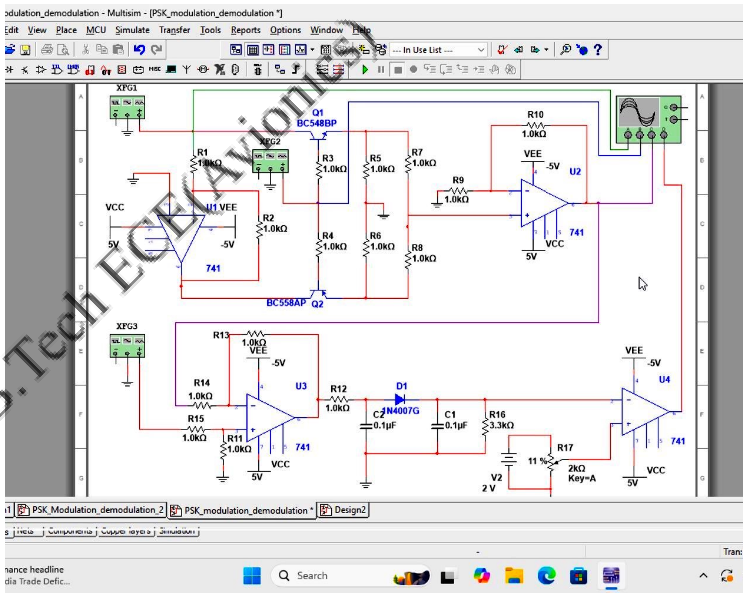
Mathematical Representation of ASK Modulated wave:

$s(t)=A\cos(2\pi f_c\, t+\pi b(t)) \quad 0<t<T$

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

A = Amplitude of the carrier, fc = Carrier frequency, b(t) = Binary data (0 or 1)

Simulation Using the Multisim Software:



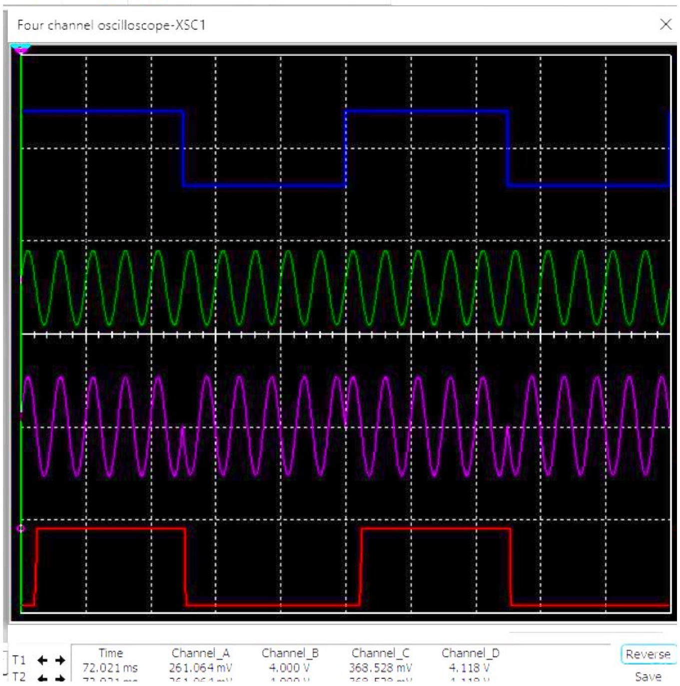
Carrier Frequency: 1kHz. Message Frequency: 200 Hz.

Components Used

- Function generator (Sine carrier signal and Data message signal)
- Resistors of 1k ohm, 10k ohm BC4434 (PNP), 2N222A (NPN) transistor
- Oscilloscope, Power and Ground

Simulation Steps

- **Draw the schematic** of the BPSK modulator in NI Multisim using 2N222A (NPN), BC 4434 (PNP), and 741 Op-Amp.
- Apply a **2Vpp, 1kHz sine wave** as the **carrier signal**.
- Apply a **10Vpp, 200Hz square wave** as the **message (binary data)** signal.
- Run the simulation and observe the **BPSK output waveform**.
- Verify that the carrier's phase flips with respect to the binary input

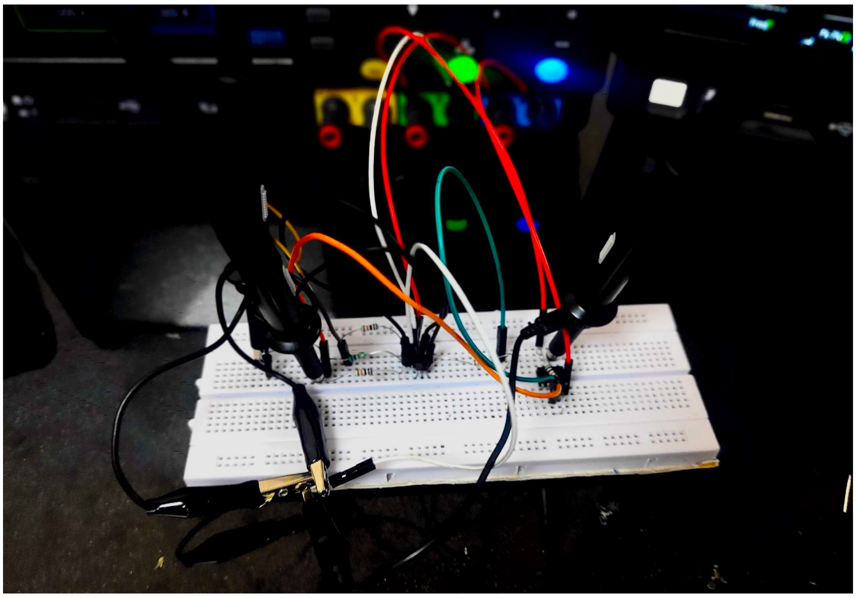


_____ : Message signal
_____: Carrier wave
_____: ASK modulated wave

Practical Implementation on Breadboard:

Components Used

- NPN Transistor 2N222A
- PNP Transistor BC4434
- Operational Amplifier (IC 741)
- Resistors: 1kΩ, 10kΩ
- Dual DC Power Supply (±15V)
- Breadboard and connecting wires
- Digital Storage Oscilloscope (DSO)
- Function Generator

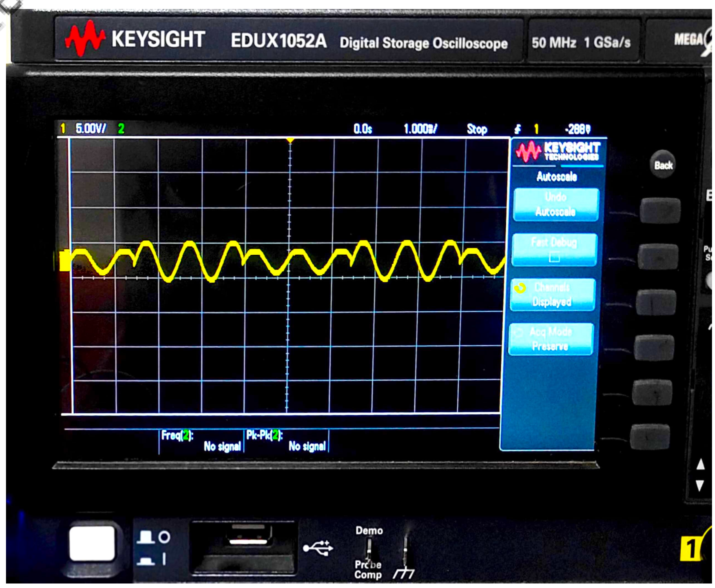


Procedure:

- Test all the components and probes.
- Set up the circuit on the **breadboard** as shown in the **figure**.
- Feed **2Vpp, 1kHz sine wave** as the **carrier input** and **10Vpp, 200Hz square wave** as the **message input**.
- Observe the **BPSK output** on the **CRO** and plot the waveforms.
- Feed this **BPSK modulated signal** to the **inverting input** of the **demodulator**. Also, feed the **unmodulated carrier signal** (2Vpp, 1kHz) to the **non-inverting input**.
- Observe the waveforms on the CRO. Adjust the **potentiometer** to obtain the correct output (if needed).

Observations:

- The output waveform on the DSO confirmed the expected behavior of BPSK modulation.
- Phase of the carrier flipped by 180° when the input data signal switched from high i.e. 1 to low i.e. 0
- The transition points were clearly visible, indicating effective modulation.
- Adjust the resistors or signal levels if necessary to fine-tune the output



Conclusion:

BPSK is a robust modulation scheme that offers effective data transmission with minimal bandwidth usage. This experiment enhanced the understanding of digital modulation techniques and provided hands-on experience with both simulation and hardware realization of a communication circuit

Advantages of BPSK

There are multiple advantages of Binary Phase Shift Keying process including all signals form, such as:

- Simplicity: BPSK, which stands for Binary Phase Shift Keying is a modulation scheme. It simplifies implementation, in hardware and software by utilizing two phase states; 0 degrees and 180 degrees.
- Effective Operation with Reliability: It has ability to operate effectively in the presence of noise or interference from signals ensuring reliable performance.
- Less Power Consumption: BPSK consumes power compared to alternative methods making it advantageous for battery powered devices.
- Easy Detection: Receivers find it easy to comprehend BPSK accurately determining the frequency and phase of the transmitted signal.
- Compatible: BPSK serves as a building block for complex modulation schemes like QPSK (Quadrature Phase Shift Keying) and higher order Quadrature Amplitude Modulation (QAM).

Applications of BPSK

BPSK finds use in numerous applications, including:

- Satellite Communication: BPSK is utilized for both uplink and downlink communication with satellites, owing to its robustness in noisy environments and its ability to maintain signal integrity over long distances.
- Wireless Communication: Early wireless communication systems, such as the original 802.11 Wi-Fi standard, employed BPSK for its simplicity and reliable performance even when the signal-to-noise ratio (SNR) is low.
- Deep Space Communication: Space agencies like NASA rely on BPSK for communicating with spacecraft and probes because of its high reliability in the face of extreme noise and signal attenuation over vast distances.
- RFID Systems: Some Radio-Frequency Identification (RFID) systems use BPSK for data transmission due to its low power requirements and dependable performance.
- Military Communications: BPSK is employed in military communication systems to ensure secure and robust transmission in hostile environments where jamming and interference are potential concerns.
- GPS (Global Positioning System): BPSK is used in the signals transmitted from GPS satellites to receivers, ensuring accurate positioning information even under challenging conditions.