BINARY FREQUENCY SHIFT KEYING(BFSK) MODULATION AND DEMODULATION KIT

EC23502-DIGITAL COMMUNICATION

PROJECT REPORT

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In partial fulfillment for the award of the degree of

BACHELOR OF ENGINEERING IN

ELECTRONICS AND COMMUNICATION ENGINEERING

DEPARTMENT OF ELECTRONICS ENGINEERING

MADRAS INSTITUTE OF TECHNOLOGY

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INDEX

1.ABSTRACT

In the BFSK modulation and demodulation kit, the input binary signal (0s and 1s) is applied to the modulator circuit, which generates a signal with two distinct carrier frequencies (one representing ‘1’ and the other representing ‘0’). As the input changes, the carrier frequency switches accordingly, producing a BFSK signal that encodes the digital data for transmission.

In the kit, the BFSK signal is then fed to the demodulator circuit, which identifies the present frequency at each moment and converts it back into the original binary signal. This hardware kit provides an interactive platform for studying BFSK signal behavior and real-time data recovery.

2.INTRODUCTION

Binary Frequency Shift Keying (BFSK) offers several advantages that make it a reliable and efficient digital modulation technique. The circuit design for BFSK is simple and easy to construct, making it suitable for both educational and practical implementations. Since the modulation involves only frequency variations, there are zero amplitude fluctuations, which minimizes distortion and improves signal stability.

BFSK supports a relatively high data rate and exhibits a low probability of error due to its high Signal-to-Noise Ratio (SNR). It provides greater noise immunity compared to Amplitude Shift Keying (ASK) and allows nearly error-free reception in many cases. Additionally, BFSK is highly useful for high-frequency radio transmissions and is often preferred in high-frequency communication systems and low-speed digital applications, such as telemetry and remote data links.

However, despite its advantages, BFSK also has some limitations. It requires more bandwidth than ASK and Phase Shift Keying (PSK), making it less suitable for bandwidth-limited systems. Because of this large bandwidth requirement, BFSK is typically used only in low-speed modems where bit rates are around 1200 bits per second. Moreover, the bit error rate of BFSK in an Additive White Gaussian Noise (AWGN) channel is slightly higher than that of PSK. In summary, Frequency Shift Keying is an effective digital modulation technique that enables reliable and error-free communication in many low-speed digital applications.

3. COMPONENTS DESCRIPTION

1. IC 741 (Operational Amplifier)

The IC 741 is a general-purpose operational amplifier widely used for analog signal processing. In the BFSK kit, it can be used for signal amplification, filtering, or as a comparator in the modulation or demodulation stages. It operates on dual power supply and provides high input impedance and low output impedance. The 741 op-amp ensures stable gain and good linearity, making it suitable for waveform shaping. Its versatility and ease of use make it a key component in analog communication circuits.

2. BC547 (NPN Transistor)

The BC547 is an NPN bipolar junction transistor (BJT) commonly used for low-current switching and amplification. In this project, it can be used to amplify weak signals or drive other circuit components. It operates efficiently with low leakage current and high current gain. The transistor is often used in signal modulation circuits to handle the binary input. Its compact size and reliable performance make it ideal for educational and experimental kits.

3. BC557 (PNP Transistor)

The BC557 is a PNP transistor complementary to the BC547. It is typically used in the demodulator section for switching, amplification, or waveform shaping. It operates with low noise and can handle small signal currents effectively. The BC557 ensures stable performance when paired with BC547 in push-pull or complementary configurations. It enhances signal fidelity and helps in detecting or regenerating the binary data from the received signal.

4. Resistors

Resistors are used to control the current flow and set the voltage levels in the circuit. In the BFSK kit, they help bias transistors, set op-amp gains, and define timing constants. Proper resistor selection ensures stable circuit operation and prevents component damage due to excess current. They also play a key role in shaping the frequency and amplitude of the modulated signal.

5. Capacitors

Capacitors are used for filtering, coupling, and timing applications in the circuit. They store and release charge, helping to smooth voltage fluctuations and remove noise from the signal. In BFSK circuits, capacitors determine the frequency response and are critical in the tuning and timing networks of oscillators.

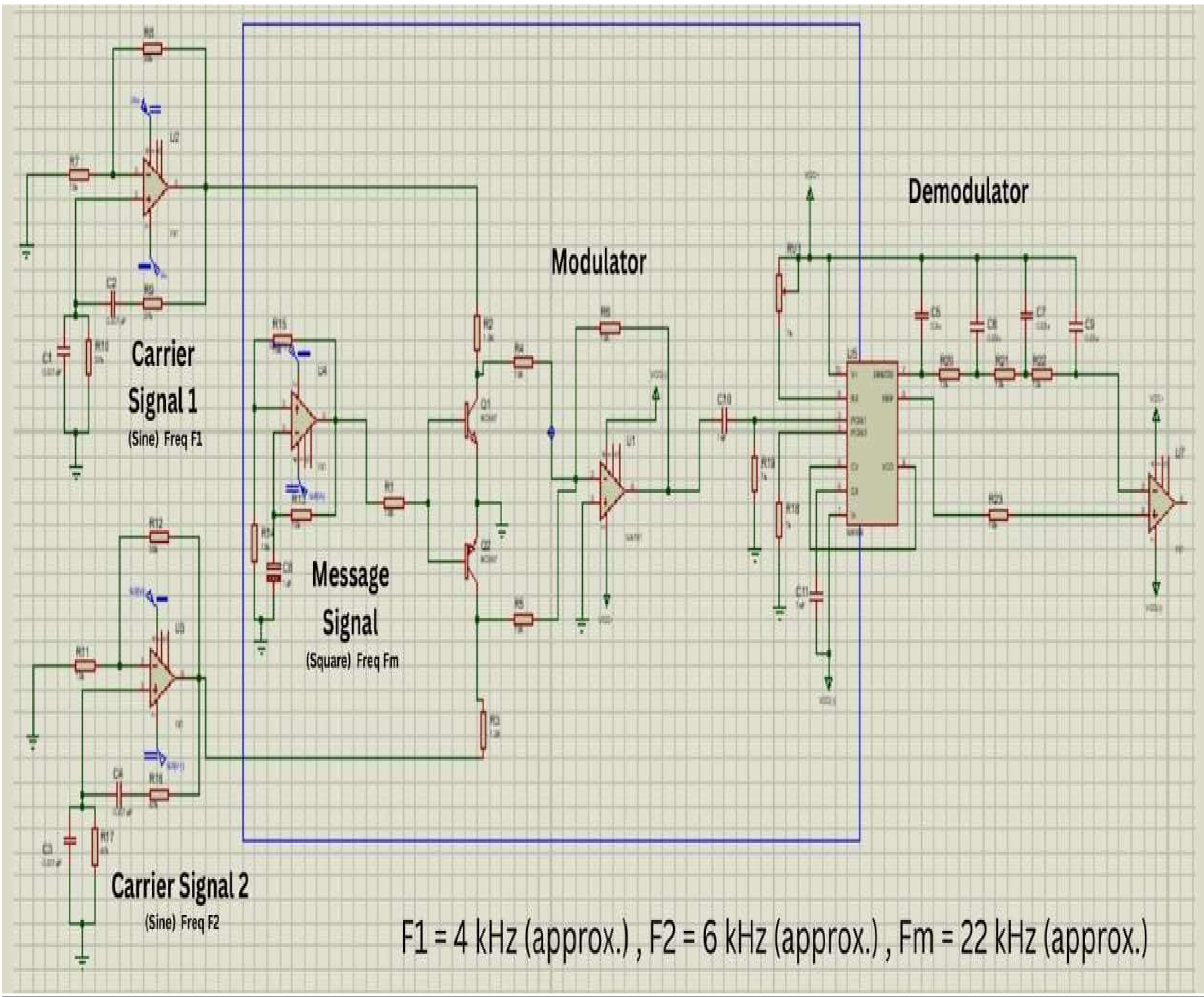
6. NE565 (PLL – Phase Locked Loop IC)

The NE565 is a Phase-Locked Loop IC used primarily for frequency demodulation in BFSK systems. It locks onto the input signal frequency and generates an output proportional to frequency variations. This helps in detecting the frequency shifts that represent binary ‘1’ and ‘0’. The NE565 offers high stability and accuracy, even in noisy environments. It is the core component in recovering the original digital data from the modulated signal.

7. Potentiometer

A potentiometer is a variable resistor used to adjust voltage or signal levels in the circuit. In the BFSK kit, it can be used to fine-tune the frequency deviation, adjust amplitude, or control bias levels. It allows real-time adjustment for calibration and testing.

4.CIRCUIT DIAGRAM



5.WORKING PRINCIPLE

1. Sine Wave Generator Circuits (Two Frequencies)

Two sine wave generators are used to produce different carrier frequencies -one for binary ‘1’ and another for binary ‘0’. Each generator uses RC components to set the frequency and op-amp for stable oscillation. These clean sine waves act as the carriers for the modulation process.

2. Square Wave Generator Circuit (Input Source)

A square wave generator provides the binary input signal that controls which carrier frequency is transmitted. When the input is high (‘1’), one carrier frequency is selected, and when low (‘0’), the other carrier is used. This square wave represents the digital data to be modulated.

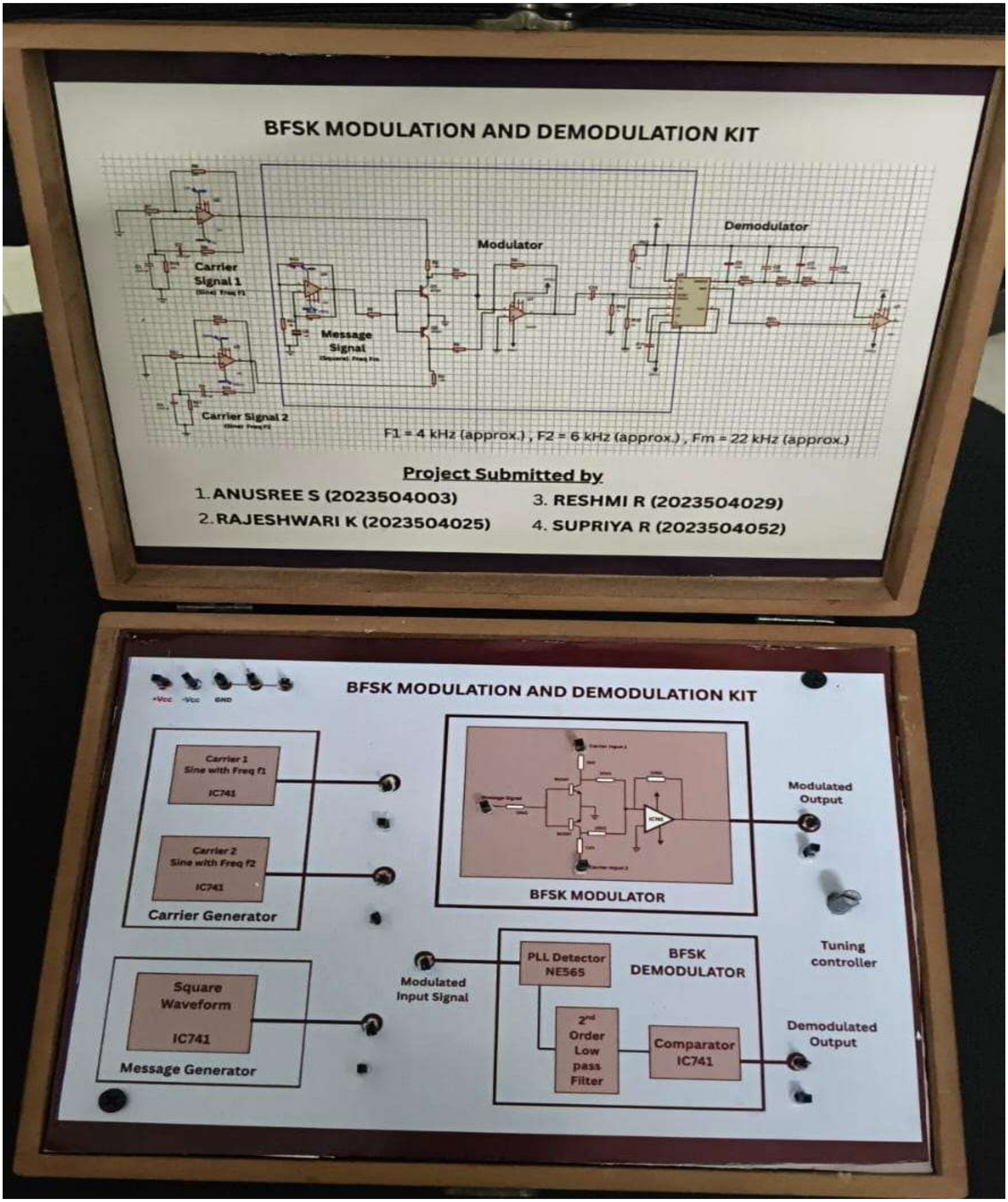
3.Modulation Circuit

The modulation circuit is the core part of the BFSK system, where digital data is converted into a frequency-varying signal. It receives two sine waves from the sine wave generator circuits -one corresponding to binary ‘1’ (6kHz) and the other to binary ‘0’(4kHz). A square wave from the data generator controls which sine wave is selected at any given time. When the input is logic ‘1’, the circuit connects the higher-frequency carrier to the output; when the input is logic ‘0’, it switches to the lower-frequency carrier. Transistors (BC547 and BC557) or an analog switch are used to perform this frequency selection. As a result, the output signal alternates between two carrier frequencies according to the binary input, forming a Binary Frequency Shift Keyed (BFSK) waveform suitable for transmission.

4.Demodulation Circuit

The demodulation circuit extracts the original binary data from the received BFSK signal. In this project, a Phase-Locked Loop (PLL) IC, NE565, is used to detect frequency changes in the incoming waveform. The PLL locks onto the input signal's frequency and produces a DC output voltage that varies with frequency. When the input corresponds to the '1' frequency, the output voltage shifts to one level, and when it corresponds to the '0' frequency, it moves to another level.
This varying voltage is then passed through a comparator (IC741) that converts it into a clean digital square wave. Thus, the demodulator successfully regenerates the original binary sequence transmitted by the modulator, completing the BFSK process.

<u>6.PROJECT IMAGES</u>


BFSK MODULATION AND DEMODULATION KIT
Carrier Signal 1
Message Signal
Carrier Signal 2
Modulator
Demodulator
F1 = 4 kHz (approx.) , F2 = 6 kHz (approx.) , Fm = 22 kHz (approx.)
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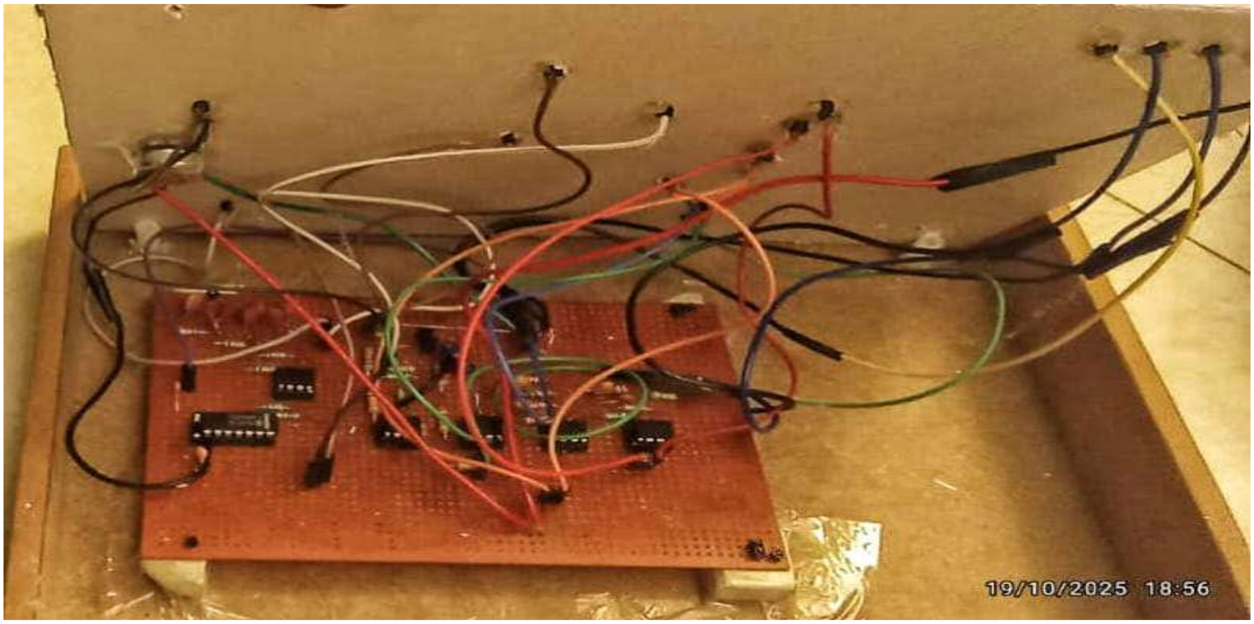
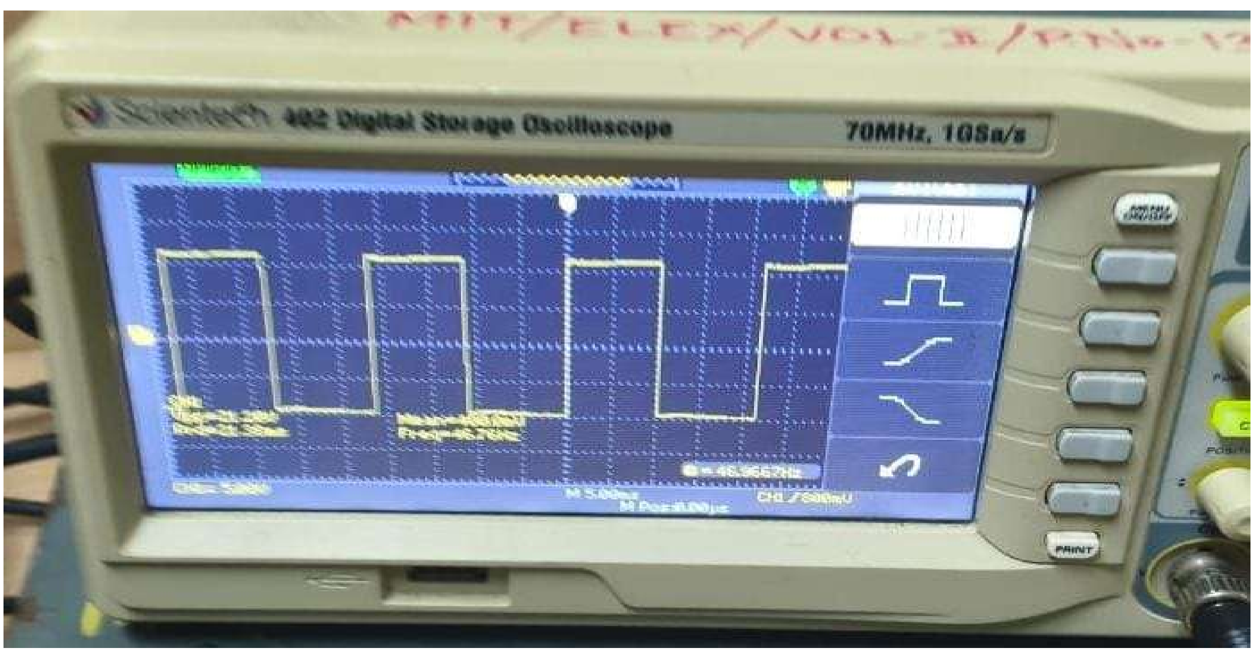
BFSK MODULATION AND DEMODULATION KIT
+Vcc
-Vcc
GND
Carrier 1
Sine with Freq f1
IC741
Carrier 2
Sine with Freq f2
IC741
Carrier Generator
Square
Waveform
IC741
Message Generator
BFSK MODULATOR
Modulated
Output
Tuning
controller
Modulated
Input Signal
PLL Detector
NE565
BFSK
DEMODULATOR
2nd
Order
Low
pass
Filter
Comparator
IC741
Demodulated
Output

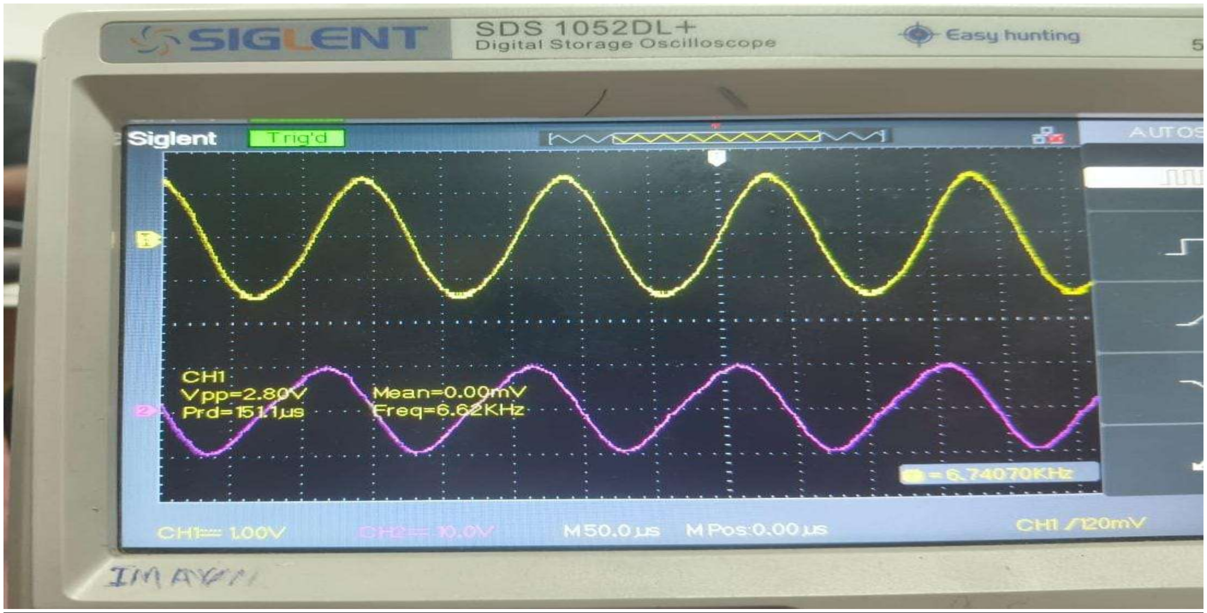


7.OUTPUT IMAGES

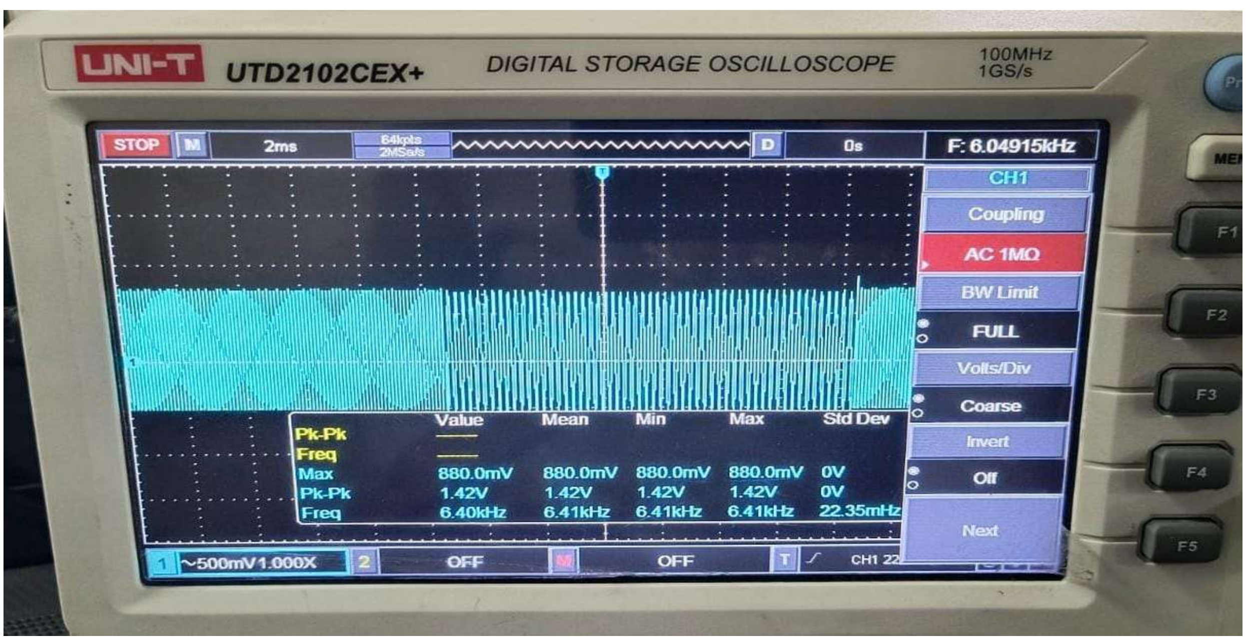
a. SQUARE_WAVE_(INPUT)



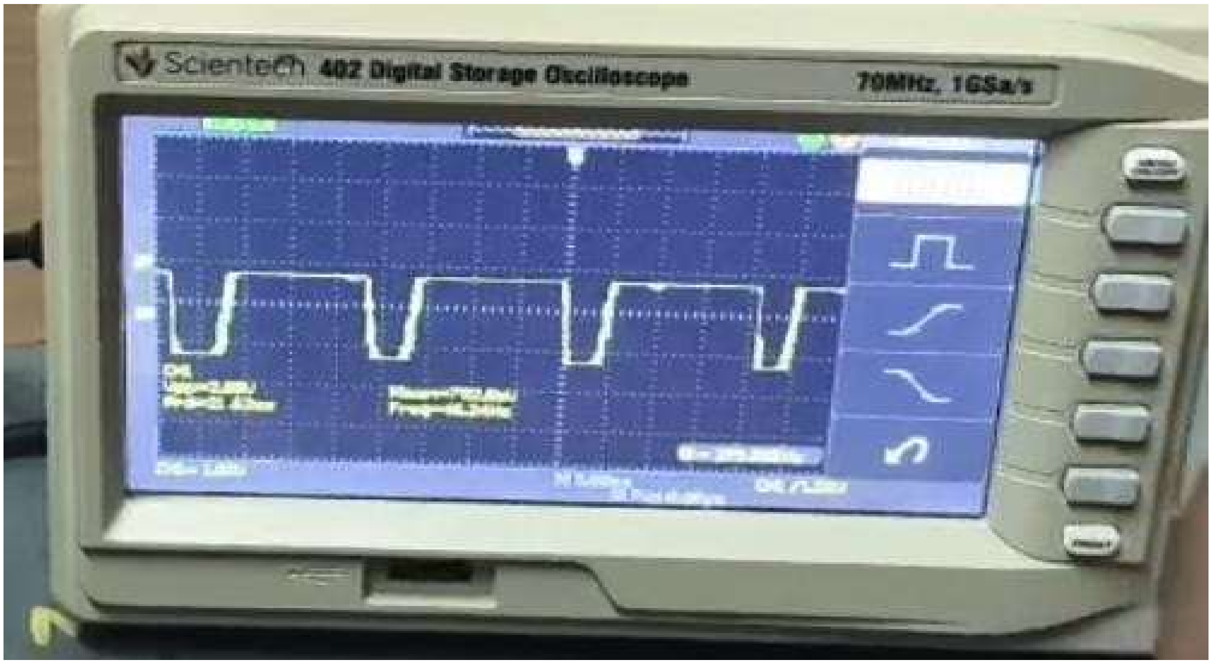
b. SINE WAVE(2 different carrier frequencies)



c. MODULATED (BFSK)_SIGNAL



d. DEMODULATED SIGNAL



8.APPLICATIONS

- BFSK is used in modems for data communication, such as early telephone-line modems (e.g., Bell 103 standard), where digital computer data is converted into analog tones for transmission over telephone networks.
- It is employed in low-frequency radio communication, including VHF/UHF radio links and two-way radios, because BFSK provides better noise resistance than amplitude-based modulation schemes.
- BFSK is used in telemetry systems to transmit sensor data from remote or moving devices, such as satellites, weather balloons, and rockets, ensuring reliable communication over long distances or in noisy environments.

- Some RFID systems use BFSK modulation for dependable short-range communication between tags and readers.
- Early wireless LAN and Bluetooth systems utilized Gaussian Frequency Shift Keying (GFSK), a smoothed version of BFSK, for efficient spectrum usage and reduced interference.
- BFSK is applied in marine and aeronautical communication, including Digital Selective Calling (DSC) and Automatic Link Establishment (ALE), to maintain reliable HF communication.
- Space communication systems, such as those used by NASA and satellites, use BFSK or its variants due to their robustness against noise and Doppler effects.

9.CONCLUSION

Through practical experimentation and simulation, it is observed that BFSK provides good noise immunity, stable signal transmission, and simple circuit design, making it suitable for low- and medium-speed digital communication systems. The demodulation process successfully recovers the transmitted binary data with minimal distortion, verifying the effectiveness of the technique. Overall, BFSK proves to be a robust and reliable digital modulation scheme, widely applicable in wireless communication, telemetry, and data transmission systems where simplicity and accuracy are key requirements.