Department of Electronics & Communication Engineering

LAB MANUAL

SUBJECT: DIGITAL COMMUNICATION LABORATORY [ECE324]

B.Tech Year – 3^{rd}, Semester - 5^{th}

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The LNM Institute of Information Technology, Jaipur, Rajasthan-302031

Digital Communication Laboratory

Semester - ODD

List of Experiments:

S. No.	**Aim of Experiments**	Page No.
1	(a) To generate Delta modulated signal and Demodulation. (b) Determine the conditions for slope overloading and step size.	1 – 4
2	To study of Pseudo Random Binary Sequence (PRBS) and Generate various Line Codes i.e. Polar NRZ, Unipolar RZ, Bipolar Manchester.	5 – 6
3	To implement BPSK Modulation and Demodulation.	7 – 8
4	To implement Carrier Recovery using Square Loop Method and demodulate the BPSK Signal using the recovered carrier.	9 – 10
5	Implementation of FSK Modulation and Non-Coherent Demodulation.	11 – 13
6	Implementation of ASK Modulation and Non-Coherent Demodulation.	14 – 15
7	To implement Matched Filter Receiver for Rectangular Pulse Shaped Transmitted Symbols.	16 – 17
8	Performance analysis of BPSK/QPSK/QAM over AWGN channel.	18–
9	Performance analysis of Linear Block Codes/Repetition Coding.	–
10	Performance analysis of Convolutional Encoding and Viterbi Decoding.	–

Experiment No: 01

1 Aim

1. Generate Delta modulated signal and determine the conditions for slope overloading.

2 Apparatus Used

1. ICs: 393(comparator)
2. Capacitor
3. DSO Probe
4. LM741
5. Connecting wires
6. Function Generator
7. 7474 (D Flip Flop IC)
8. Breadboard
9. Digital signal oscilloscope
10. Resistance
11. DC power supply

3 Theory

Delta Modulation (DM) is a simplified PCM. In some type of signals, the neighboring samples are closely correlated with each other. Therefore, once a sample value is known this enables the determination of the following sample values most probably. Thus, instead of sending the real value of each sample at each time, differences (variances) between adjacent samples are sent in DM.

In DM, two-level quantizer and one-bit coding is used. Transmitted code pulses do not carry the data related to the message signal itself; instead they carry data regarding the differentials of the message function. The output of a delta modulator is a bit stream of samples at a relatively high rate, the value of each bit being determined according to whether the input message sample amplitude has increased or decreased relative to the previous sample.

Block Diagram of Delta Modulation and Demodulation

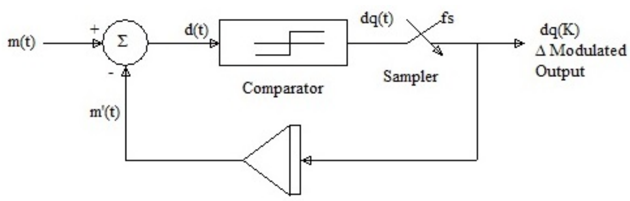


Figure: Delta Modulator

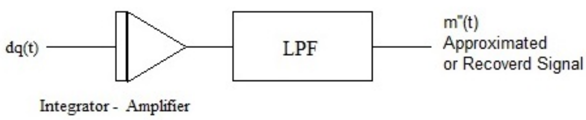


Figure: Delta Demodulator

Condition to avoid Slope overloading

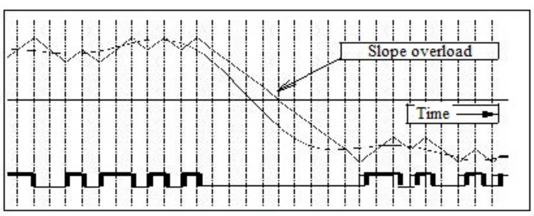


Figure: (a) Slope overload

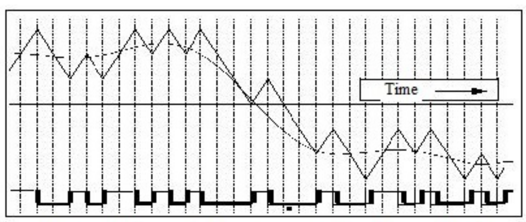


Figure: (b)Increased step size to reduce slope overload

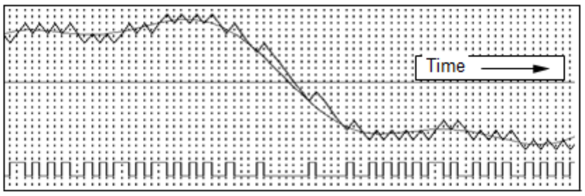


Figure: (c) increased sampling rate to reduce slope overload

This occurs when the sawtooth approximation cannot keep up with the rate-of-change of the input signal in the regions of greatest slope. The step size is reasonable for those sections of the sampled waveform of small slope, but the approximation is poor elsewhere. This is 'slope overload', due to too small a step. Slope overload is illustrated in Figure (a).

- To reduce the possibility of slope overload the step size can be increased (for the same sampling rate).This is illustrated in Figure (b). The sawtooth is better able to match the message in the regions of steep slope.
- An alternative method of slope overload reduction is to increase the sampling rate. This is illustrated in Figure (c), where the rate has been increased by a factor of 2.4 times, but the step is the same size as in Figure (a).

3.1 Connection Diagram

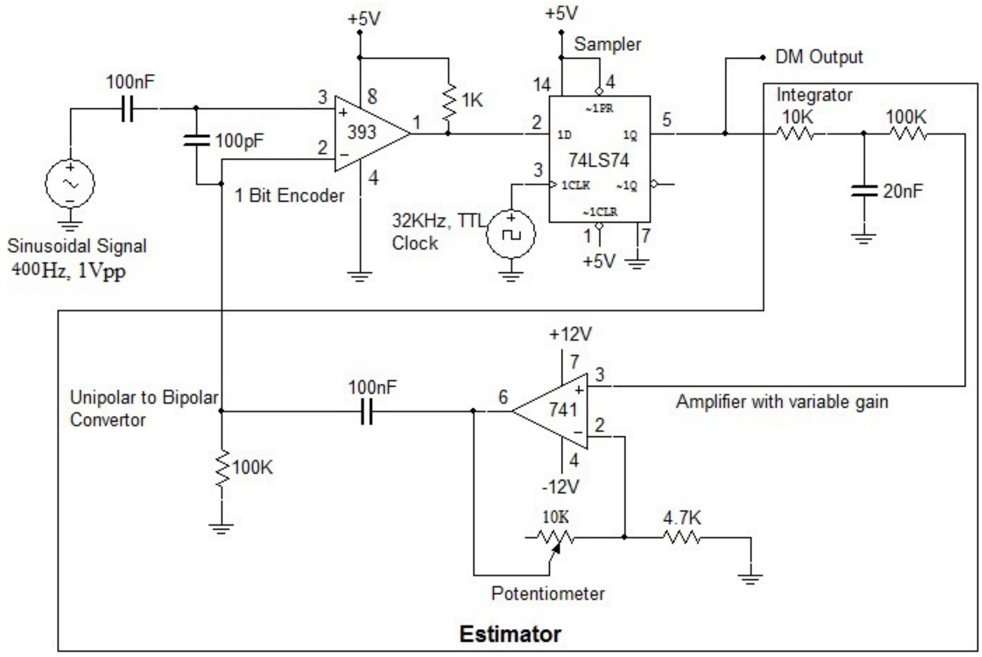


Figure 1: Delta modulation

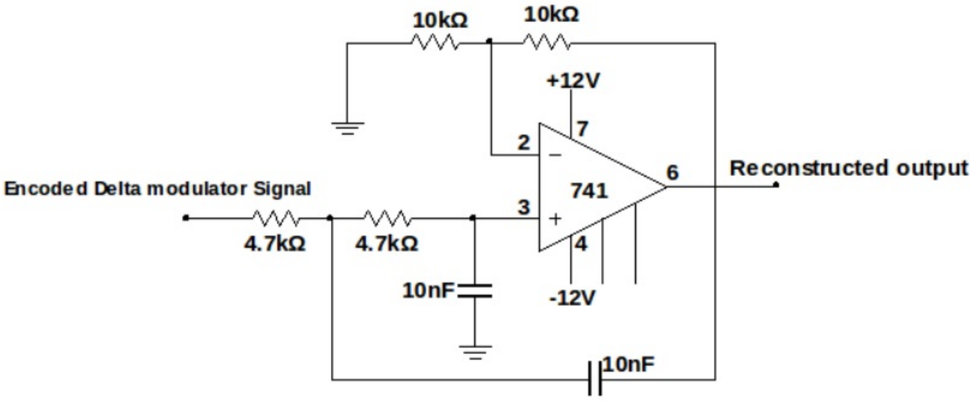


Figure 2: Delta Demodulation

4 Procedure

1. Connect the circuit as given in Figure 1.
2. Give a sinusoidal message signal of 1 Vpp and 400 Hz at the input of comparator as shown in Figure 1. Give a TTL clock of 32 KHz at the clock input of D filp flop.
3. Connect the inverting and non-inverting input of comparator to the different channels of DSO. Make voltage levels of both signal comparable by adjusting potentiometer of amplifier. (Why we did that?)
4. Observe output after each stage of Figure 1 and draw it in your copy with proper specification.
5. Step size of delta modulator circuit can be calculated by observing the change in amplitude of unipolar to bipolar output in the sampling duration (Why?). Compute following table

$S.No$	Sampling Frequency	Step Size(Volt)
1	$32KHz$	
2	$16KHz$	
3	$8KHz$	
4	$4KHz$	

6. Now Fix sampling frequency to 32KHz. Increase the frequency of message signal by varying the frequency of sinusoid and record the maximum frequency at which the integrator's output ceases to follow the message signal on DSO. This condition is called slope overloading. Now restore the frequency and start increasing the amplitude of message signal. Note the amplitude at which slope overloading occurs.
7. The estimated message signal from unipolar to bipolar output is passed through a low pass filter as shown in Figure 2. Low pass filter will recover the message signal.

5 Analysis of Results

6 Conclusion

Precautions

1. Check the connections before switching on the kit.
2. Connections should be done properly.
3. Observation should be taken properly.

Experiment No.: 02

1 Aim

1. Generation and study of Pseudo Random Binary Sequence (PRBS).
2. Generation and study of Various Line Codes ie NRZ, RZ, Manchester.

2 Apparatus Used

ICs: 7474 (D Flip Flop IC)	7404 (NOT Gate)	7408 (AND Gate)	7486 (Ex-OR Gate)
Capacitor	Connecting wires	Breadboard	DC power supply
DSO Probe	Function Generator	Digital signal oscilloscope	

3 Theory

3.1 Connection Diagram

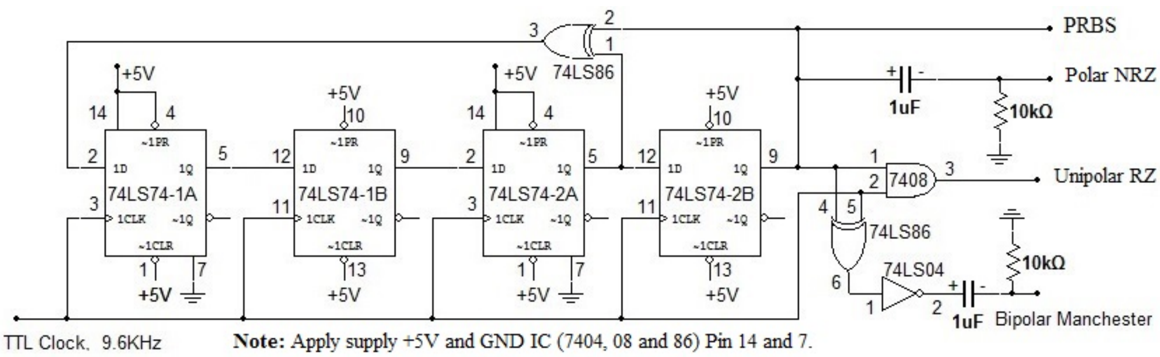


Figure 1: Generation of Line Codes

4 Procedure

1. Connect the circuit as given in Figure 1.
2. Give 9.6KHz TTL clock to the input of D Flip-Flops. Observe time domain waveform of PRBS output. Note down output sequence. What is the periodicity of output sequence? What is the bit rate of output sequence? Now take FFT of PRBS Output. What is the distance between spectral lines?
3. Observe output time domain waveforms of different line codes. Draw it in your copy and compare it.
4. Observe and draw discrete line PSD of all line codes What is the distance between spectral lines? Compute following table

S.No	Line Code	Bandwidth(Hz)	Spectral Efficiency (bits/sec)/Hz	Power at DC
1	Polar NRZ			
2	Unipolar RZ			
3	Bipolar Manchester			

Table 1: Observation Table

5 Analysis of Results

6 Conclusions

Precautions

1. Check the connections before switching on the kit.
2. Connections should be done properly.
3. Observation should be taken properly.

Experiment No.: 03

1 Aim

1. Implement BPSK Modulation and Demodulation.
2. Implement carrier recovery using square-loop method.

2 Apparatus Used

1. ICs: LM741
2. Diode
3. DC power supply
4. Digital signal oscilloscope
5. 7476 (J-K Flip Flop IC)
6. Resistance
7. Connecting wires
8. 565 (PLL)
9. Capacitor
10. DSO Probe
11. BJT [BC547, BC557]
12. Breadboard
13. Function Generator

3 Theory

3.1 Connection Diagram

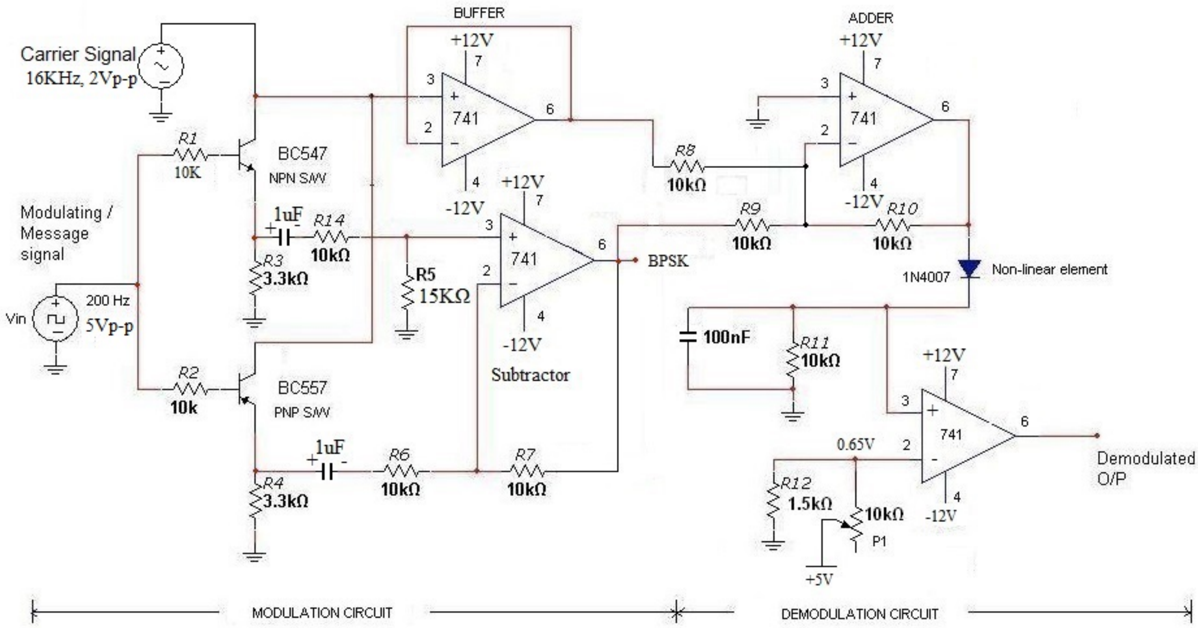


Figure 1: BPSK Modulation and Demodulation

4 Procedure

1. Connect the circuit as given in Figure 1.
2. Give Square wave as a message signal of $5V_{pp}$ and $200Hz$ at the base of NPN and PNP BJT switches as shown in Figure 1. Give sinusoidal carrier signal of $16KHz$ and $2V_{pp}$ at the collector of NPN BJT switch.
3. Observe BPSK Modulated output after Subtractor. Draw it on your copy.
4. Observe demodulated output and draw and compare it with message signal.

5 Analysis of Results

6 Conclusions

Precautions

1. Check the connections before switching on the kit.
2. Connections should be done properly.
3. Observation should be taken properly.

Experiment No.: 04

1 Aim

1. Implement BPSK Modulation and Demodulation.
2. Implement carrier recovery using square-loop method.

2 Apparatus Used

1. ICs: LM741
2. Diode
3. DC power supply
4. Digital signal oscilloscope
5. 7476 (J-K Flip Flop IC)
6. Resistance
7. Connecting wires
8. 565 (PLL)
9. Capacitor
10. DSO Probe
11. BJT [BC547, BC557]
12. Breadboard
13. Function Generator

3 Theory

3.1 Connection Diagram

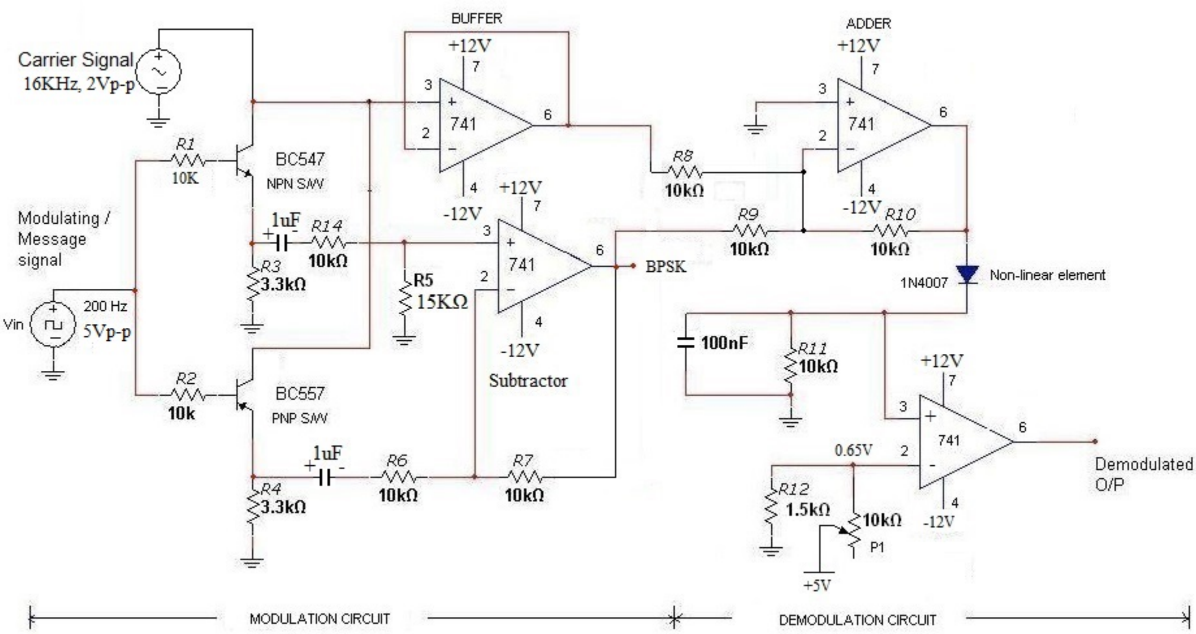
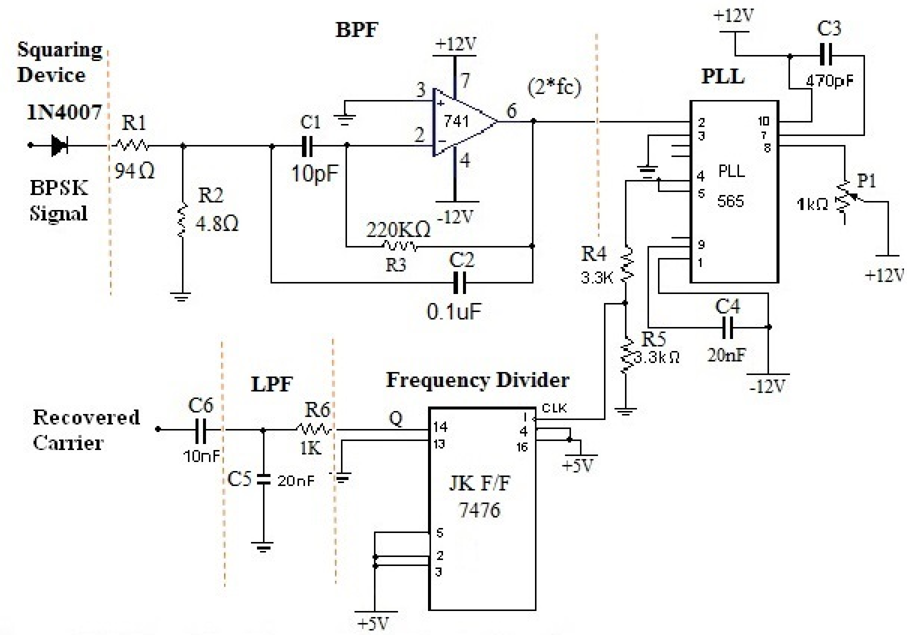


Figure 1: BPSK Modulation and Demodulation

4 Procedure

1. Connect the circuit as given in Figure 1.
2. Give Square wave as a message signal of $5V_{pp}$ and $200Hz$ at the base of NPN and PNP BJT switches as shown in Figure 1. Give sinusoidal carrier signal of $16KHz$ and $2V_{pp}$ at the collector of NPN BJT switch.
3. Observe BPSK Modulated output after Subtractor. Draw it on your copy.



Note:- First connection LM565 circuit. Now adjust the Potentiometer P1 to get the free running frequency 32 KHz. Then you will complete remaining circuit.

Figure 2: Carrier Recovery

4. Observe BPSK Demodulated output and draw it in your copy, compare it with message signal.
5. Now connect circuit as shown in Fig. 2.
6. Give BPSK Modulated signal at the input of diode (Fig 2). Observe output after each stage of Figure 2 and compare recovered carrier with original carrier signal. Draw it in your copy with proper specification.
7. Now disconnect carrier input at demodulator circuit (Fig 1) and connect recovered carrier signal.
8. Observe demodulated output and draw it.

5 Analysis of Results

6 Conclusions

Precautions

1. Check the connections before switching on the kit.
2. Connections should be done properly.
3. Observation should be taken properly.

Experiment No.: 05

1 Aim

1. Implementation of FSK Modulation.
2. Non-Coherent Demodulation of modulated FSK.

2 Apparatus Used

ICs: XR-2206 (Monolithic Function Generator)	LM741 (Op - Amp)	LM393 (Voltage Comparator)
1N4007 (Diode)	Capacitor	Connecting wires
DSO Probe	Breadboard	DC power supply
Digital signal oscilloscope	Function Generator	

3 Theory

3.1 FSK Modulator circuit and Block diagram of FSK Demodulation

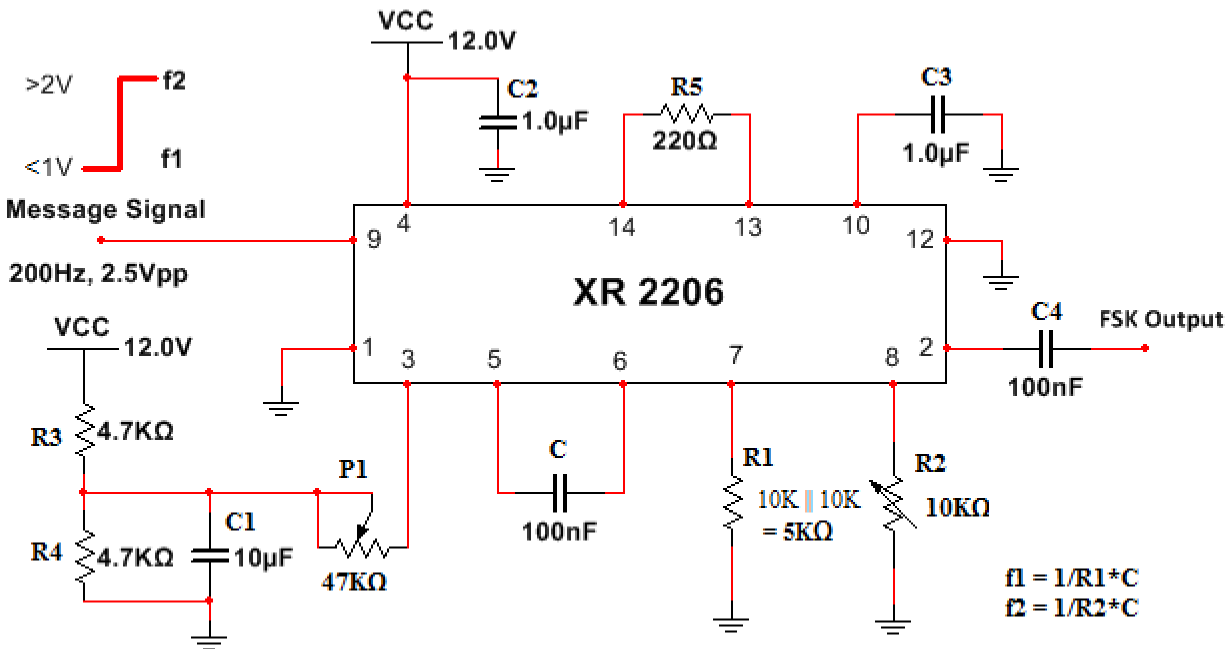


Figure 1: FSK Modulator circuit

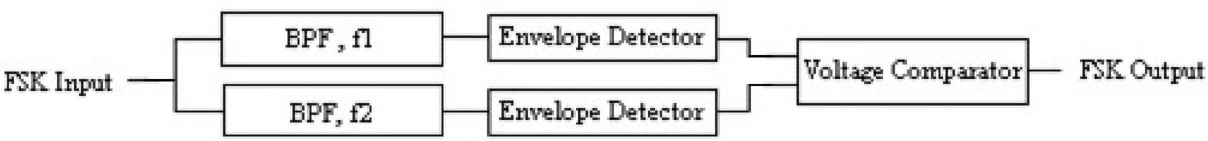


Figure 2: Block Diagram of FSK Demodulation

3.2 Band Pass Filter Circuit and Designing Equations

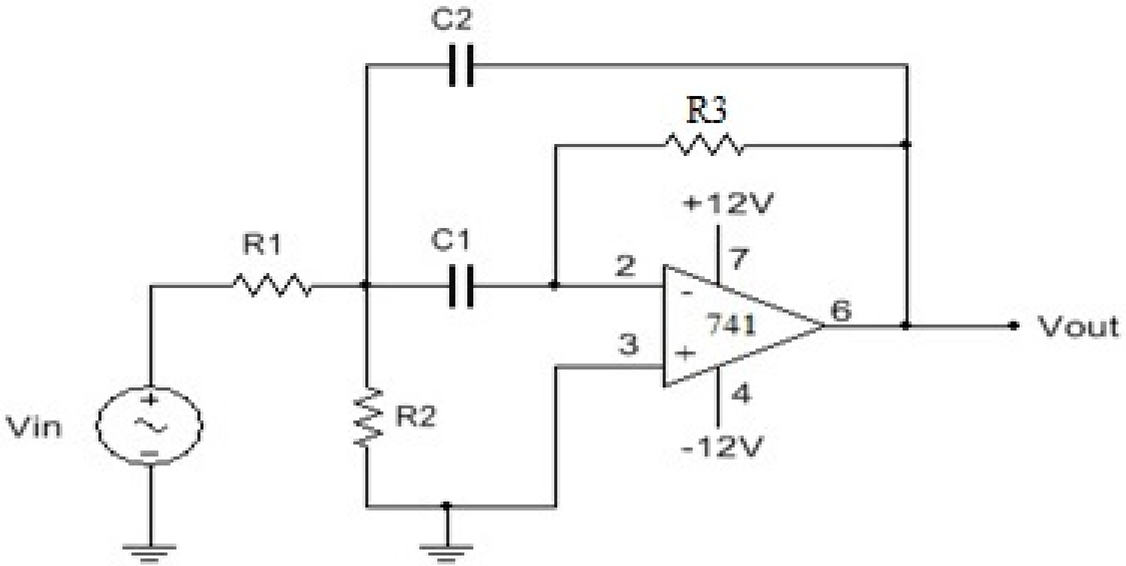


Figure 3: Band Pass Filter

$C_1 = C_2 = \mathrm{C} = 0.01\mathrm{uF}$; BW = 500Hz					
1.	$R_1 = \dfrac{Q}{2\pi f_c C A_f}$	3.	$R_3 = \dfrac{Q}{\pi f_c C}$	5.	$\mathrm{A}_f < 2Q^2$
2.	$R_2 = \dfrac{Q}{2\pi f_c C(2Q^2 - A_f)}$	4.	$Q = \dfrac{f_c}{BW}$	6.	$\mathrm{A}_f = \dfrac{R_3}{2R_1}$

Table 2: BPF Designing Equations

3.3 Envelope Detector Circuit

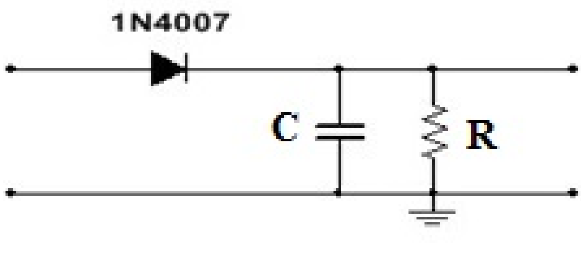


Figure 4: Envelope Detector Circuit

4 Procedure

(FSK Modulation)

1. Connect the FSK Modulator circuit shown in Figure 1 and Give Square wave signal of 200 Hz and 2.5 Vpp as input.
2. As the formula given in the data sheet calculate R1 and R2 with the given carrier signals frequencies, $f1$ = 2 KHz and $f2$ =5.2 KHz.
3. Observe the time and frequency domain wave forms of FSK modulator output. Draw the output and analyze it in both domains.

(FSK Demodulation)

1. Design the Band pass filter for different carrier frequencies and envelope detector circuit. Connect as shown in Figure 2.
2. Give a FSK Modulated signal as input.
3. Observe FSK Demodulated output and draw it in your copy, compare it with message signal.

5 Analysis of Results

6 Conclusions

Precautions

1. Check the connections before switching on the kit.
2. Connections should be done properly.
3. Observation should be taken properly.

IC's Pin Diagrams

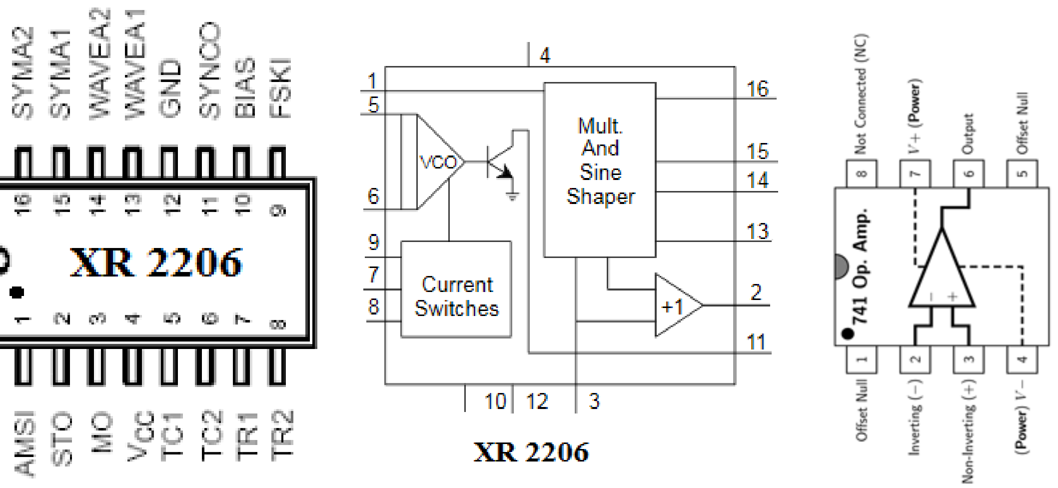


Figure 5: Pin Diagrams

Experiment No.: 06

1 Aim

1. Implementation of ASK Modulation.
2. Non-Coherent Demodulation of modulated ASK.

2 Apparatus Used

ICs: LM741 (Op - Amp)	Transistor BC547 (NPN)	1N4007 (Diode)
Capacitors	Resistors	Potentiometer (1KΩ)
Breadboard	DC power supply	Connecting wires
Digital signal oscilloscope	Function Generator	DSO Probes

3 Theory

The binary ASK system was one of the earliest form of digital modulation used in wireless telegraphy. In a binary, ASK system binary symbol $'1'$ is represented by transmitting a sinusoidal carrier wave of fixed amplitude Ac and fixed frequency f_c for the bit duration T_b, whereas binary symbol $'0'$ is represented by switching of the carrier for T_b seconds. This signal can be generated simply by turning the carrier of a sinusoidal ON and OFF for the prescribed periods indicated by the modulating pulse train. For this reason the scheme is also known as on-off shift Keying. Let the sinusoidal carrier can be represented by $C(t) = A_c cos(2\pi f_c t)$ then the binary ASK signal can be represented by a wave $S(t)$ given by $S(t) = A_c cos(2\pi f_c t)$, symbol $'1'$ ASK signal can be generated by applying the incoming binary data and the sinusoidal carrier to the two inputs of a product modulator. The resulting output is the ASK wave.

4 Circuit Diagram

4.1 ASK Modulator Circuit

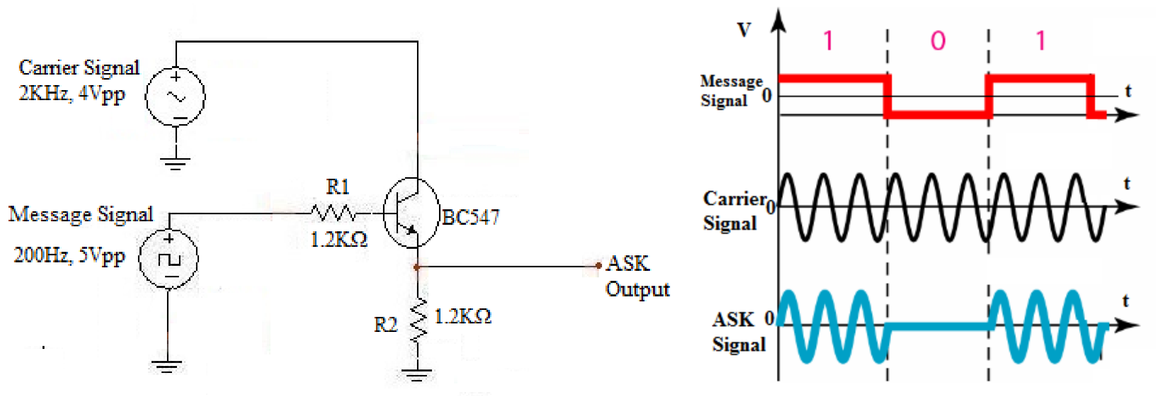


Figure 1: ASK Modulator circuit and Waveforms

4.2 Block Diagram of ASK Demodulator

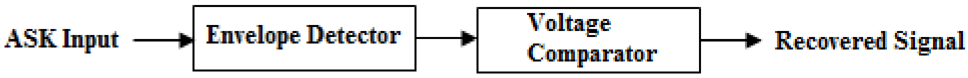


Figure 2: Block Diagram of ASK Demodulator

4.2.1 Envelope Detector Circuit

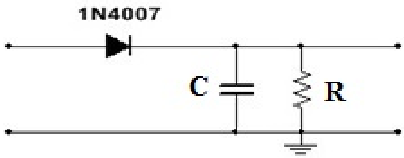


Figure 3: Envelope Detector Circuit

5 Procedure

1. Connect the ASK modulator circuit as per the circuit diagram.
2. Give Square wave as a message signal of $5V_{pp}$ and $200Hz$ at the base of BJT (BC547) and sinusoidal carrier signal of $2KHz$ and $4V_{pp}$ at the collector of BJT (BC547) shown in Figure 1
3. Observe the time and frequency domain wave forms of ASK modulator output. Trace the output and analyze it in both domains.
4. Design the Demodulator circuit according to ASK Demodulation block diagram shown in Figure 2 and Observe ASK Demodulated output and Trace it on trace paper, compare it with message signal.

6 Analysis of Results

7 Conclusions

Precautions

1. Check the connections before switching on the kit.
2. Connections should be done properly and tight.
3. Observation should be taken properly.

Experiment No.: 07

1 Aim

1. Implement Matched Filter Receiver for Rectangular Pulse Shaped Transmitted Symbols.

2 Apparatus Used

1. ICs: 555(Timer IC)
2. CD4016 (Analog Switch)
3. Digital signal oscilloscope
4. 74161(4 bit Counter IC)
5. LM741
6. Resistance
7. Breadboard
8. 7474 (D Flip Flop IC)
9. Capacitor
10. DSO Probe
11. Connecting wires
12. DC power supply
13. Function Generator

3 Theory

3.1 Circuit Diagram

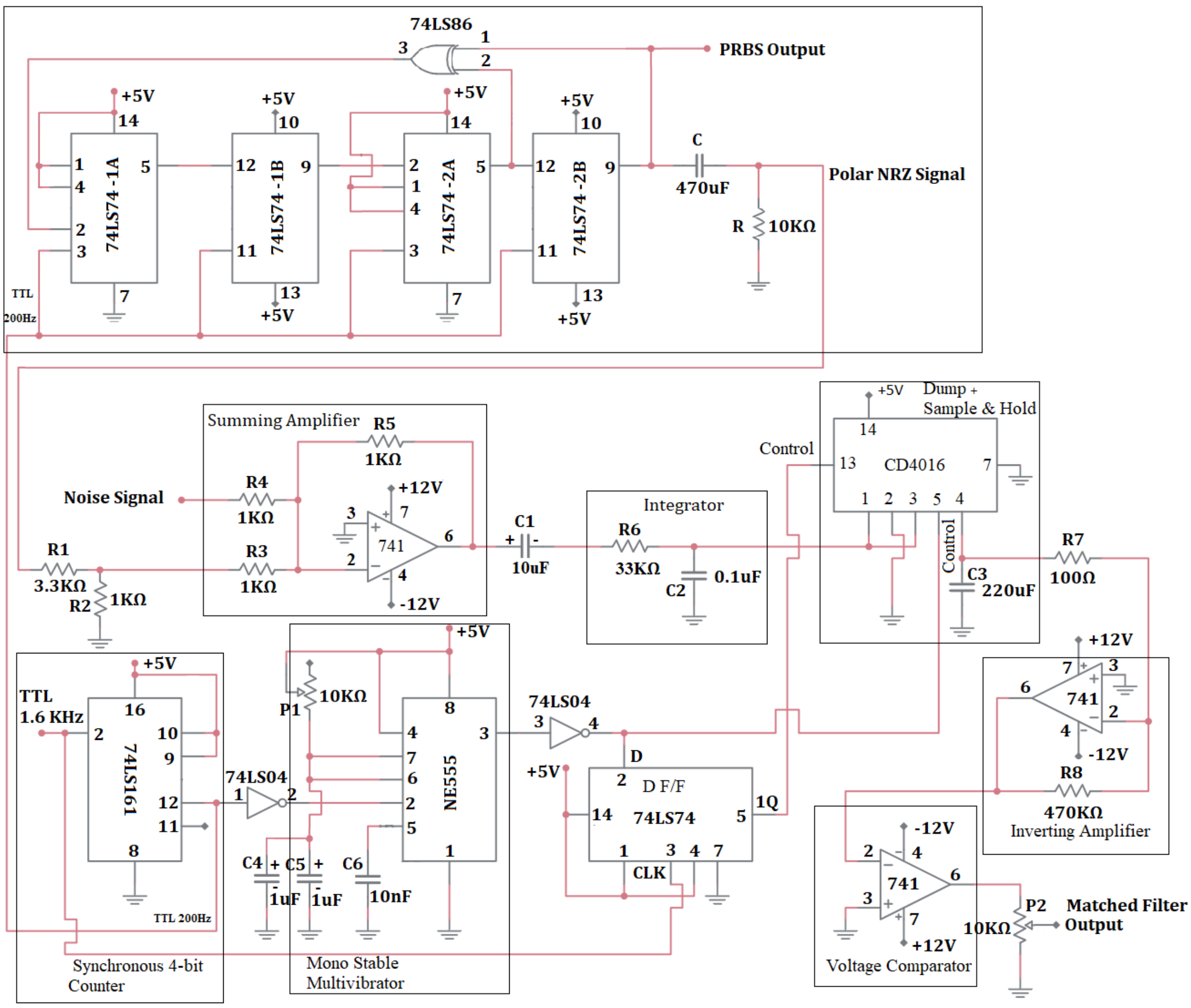


Figure 1: Matched Filter Circuit

4 Procedure

1. Connect the circuit as given in $Figure 1$.
2. Give Polar NRZ Message signal of $200Hz$ from PRBS generator or Function Generator as shown in $Figure 1$. Observe output after adder, this is transmitted signal. Compute Signal Power in watts and dBW.
3. Now add Noise to the signal of different Peak to Peak amplitude. Observe and draw transmitted signal in your Notebook. Refer Noise power table given in Matched Filter design document for computing Noise Power. Make a table for Signal to Noise ratio for different Peak to Peak Noise voltages.
4. Give transmitted signal to the input of Matched Filter/ Integrate and Dump Circuit. Observe output of the Matched Filter and validate it.
5. Now observe the output after sampler. Compare the recovered bits with the original. Do the same for different SNR values and conclude when recovered bits cease to follow the original ones.

5 Analysis of Results

6 Conclusions

Precautions

1. Check the connections before switching on the kit.
2. Connections should be done properly.
3. Observation should be taken properly.

Experiment No: 08

1 Aim

1. Performance analysis of BPSK/QPSK/QAM over AWGN channel.

2 Software Used

1. MAT LAB

3 Theory

4 Procedure

5 Observation

Write/ Plot Your Own With Observation Table (If Required).

6 Analysis of Results

Write Your own.

7 Conclusions

Write Your Own.

Precautions

Observation should be taken properly.

Experiment No: 09

1 Aim

1. Performance analysis of Linear Block Codes/Repetition Coding.

2 Software Used

1. MAT LAB

3 Theory

4 Procedure

5 Observation

Write/ Plot Your Own With Observation Table (If Required).

6 Analysis of Results

Write Your own.

7 Conclusions

Write Your Own.

Precautions

Observation should be taken properly.

Experiment No: 10

1 Aim

1. Performance analysis of Convolutional Encoding and Viterbi Decoding.

2 Software Used

1. MAT LAB

3 Theory

4 Procedure

5 Observation

Write/ Plot Your Own With Observation Table (If Required).

6 Analysis of Results

Write Your own.

7 Conclusions

Write Your Own.

Precautions

Observation should be taken properly.