ATME
College of Engineering

Department of Electronics and Communication Engineering

LABORATORY MANUAL

(ACADEMIC YEAR 2025-26)

COMMUNICATION LAB

BEL404

Institute Vision

Development of academically excellent, culturally vibrant, socially responsible, and globally competent human resources.

Institute Mission

- To keep pace with advancements in knowledge and make the students competitive and capable at the global level.
- To create an environment for the students to acquire the right physical, intellectual, emotional, and moral foundations and shine as torch bearers of tomorrow's society.
- To strive to attain ever-higher benchmarks of educational excellence

Department Vision

To develop highly skilled and globally competent professionals in the field of Electronics and Communication Engineering to meet industrial and social requirements with ethical responsibility.

Department Mission

- To provide State-of-art technical education in Electronics and Communication at undergraduate and post- graduate levels to meet the needs of the profession and society and to adopt the best educational methods and achieve excellence in teaching-learning and research.
- To develop talented and committed human resource, by providing an opportunity for innovation, creativity, and entrepreneurial leadership with high standards of professional ethics, transparency, and accountability.
- To function collaboratively with technical Institutes/Universities/Industries and offer opportunities for Long-term interaction with academia and industry.

PROGRAM OUTCOMES (POs)

PO	Title	Description
PO1	**Engineering Knowledge**	Apply mathematics, science, and engineering fundamentals to solve complex problems.
PO2	**Problem Analysis**	Identify, formulate, research, and analyze complex engineering problems.
PO3	**Design / Development of Solutions**	Design solutions considering health, safety, societal, and environmental factors.
PO4	**Investigation**	Use research-based methods (experiments, data analysis, interpretation) to provide valid conclusions.
PO5	**Engineering Tool Usage**	Select and apply modern engineering tools, software, and techniques, recognizing limitations.
PO6	**The Engineer & The World**	Analyze societal, environmental, sustainability, and economic impacts of engineering solutions.
PO7	**Ethics**	Apply ethical principles, commit to professional ethics, human values, and diversity.
PO8	**Individual & Collaborative Team Work**	Function effectively as an individual and in diverse, multi-disciplinary teams.
PO9	**Communication**	Communicate effectively and inclusively with engineering community and society.
PO10	**Project Management & Finance**	Apply engineering management and financial principles to manage projects in multi-disciplinary environments.
PO11	**Life-Long Learning**	Recognize need for and engage in independent, continuous learning to adapt to evolving technologies.

Index

Experiment Name **Page No.**

Experiment No: 1

Amplitude Modulation & Demodulation

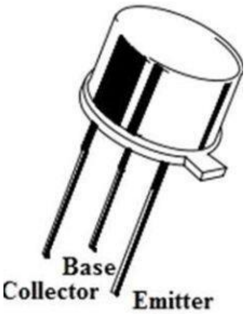
Aim: To design a high-level collector modulator circuit for AM signal generation.

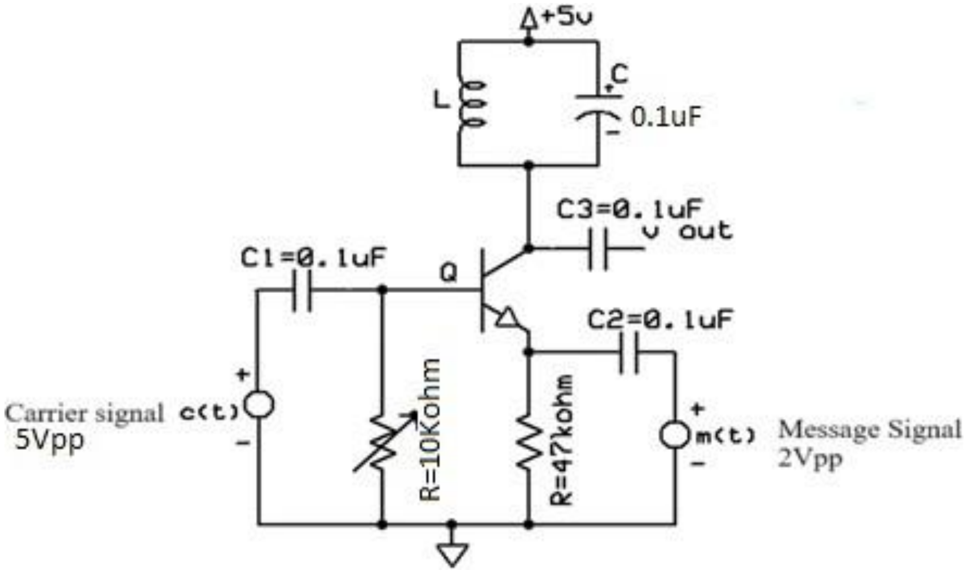
Objective: To understand the principles of amplitude modulation and demodulation

Apparatus Required:

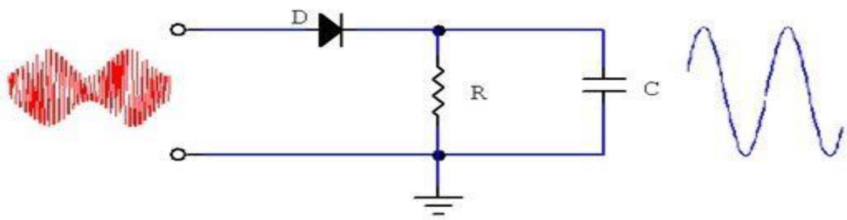
Sl. No	Components	Quantity
1	Transistor SL100	01
2	Resistor 22KΩ (pot), 47KΩ	01
3	Capacitor : 1μF, 0.1μF	03
4	Inductor	01
5	Bread board Connecting wire	01
6	CRO(40MHz), Signal generator(1MHz), DC supply(30V)	01

Circuit Diagram:

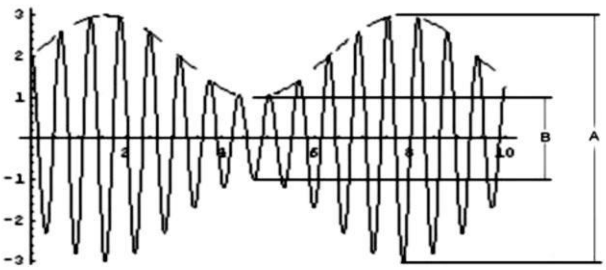




Demodulation

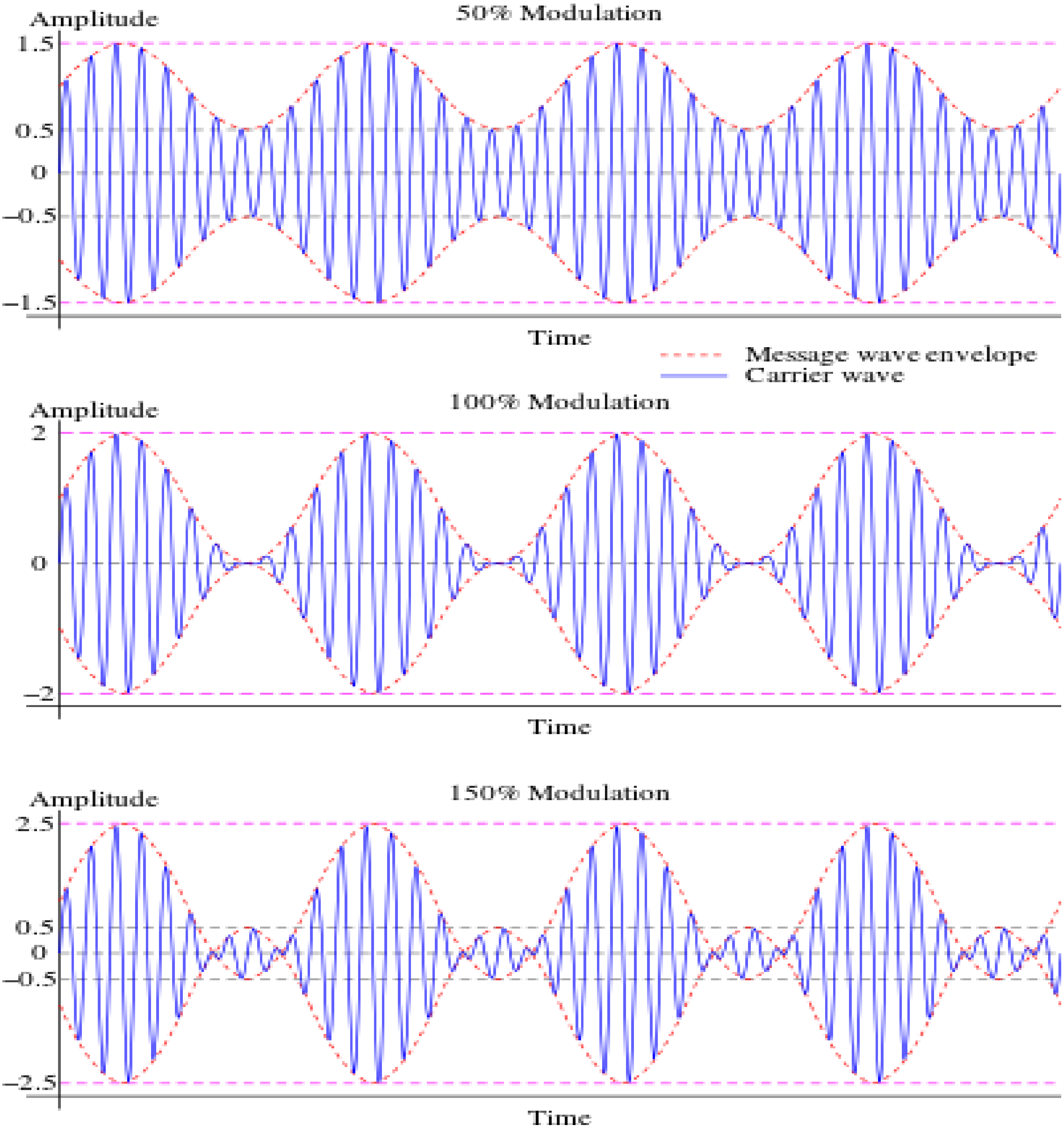


Waveforms:



Where, A = Vmax and B = Vmin
From waveform modulation index, μ is given by

$$\mu = \frac{Vmax - Vmin}{Vmax + Vmin}$$



Design: Reconstruction circuit: concider frequency of message signal as fm =100 Hz, this is the cutoff frequency of LPF. Choose C = 0.1uF and find R using $f_m = \frac{1}{2\pi RC}$

Tuned Circuit frequency is $f_c = \frac{1}{2\pi\sqrt{LC}}$ carrier wave frequency fc=1KHz Assume capacitor =1uF then L= 25.33mH

Tabular Column:

Fc = _________Hz, Fm = ____________Hz

Sl. No	V_{max} in Volts	V_{min} in Volts	Modulation Index $\mu = \frac{V_{max}-V_{min}}{V_{max}+V_{min}}$	Amplitude of $V_m = \frac{V_{max}-V_{min}}{2}$	Amplitude of $V_c = \frac{V_{max}+V_{min}}{2}$
1					
2					
3					

Note: Make sure Amplitude of carrier signal Vc is constant

Procedure

1. Rig up the circuit as shown in the figure.
2. Set the amplitude of c(t) = 2Vp and m(t) = 2Vp using different signal generator.
3. Set the frequency of message signal m(t) =100Hz & carrier wave signal c(t) = 1KHz to get the AM wave.
4. Tune the 22KΩ pot till get clear waveforms of AM in CRO.
5. Note down the Vmax & Vmin.
6. Calculate the modulation index μ along with values of Vm & Vc
7. Repeat step number 4 and 5 for various value of Vmax & Vmin by varying amplitude of modulating signal m(t).

Outcome: Understood the principles of amplitude modulation and demodulation

Result: The AM signal is generated and observed on the oscilloscope and Compared the demodulated signal with the original message signal for resemblance.

Experiment No: 2

Balanced Modulator

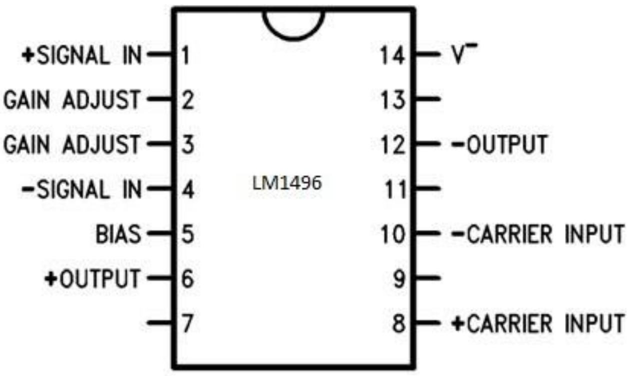
Aim: To test the functionality of a balanced modulator using IC - 1496

Objective: To study the characteristics of a double sideband suppressed carrier (DSB-SC) signal.

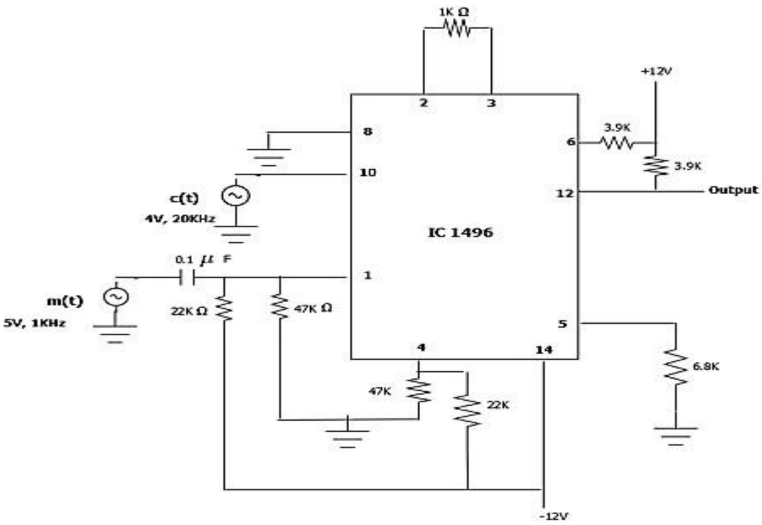
Apparatus Required:

Sl No	Components	Quantity
1	IC-1496, 3.9kΩ-(2), 47 kΩ-(2), 22 kΩ-(2), 1 kΩ-(1), 6.8 kΩ-(1)	
2	Bread board, Connecting wire	01
3	CRO (40MHz), Signal generator(1MHz), DC supply(30V)	01

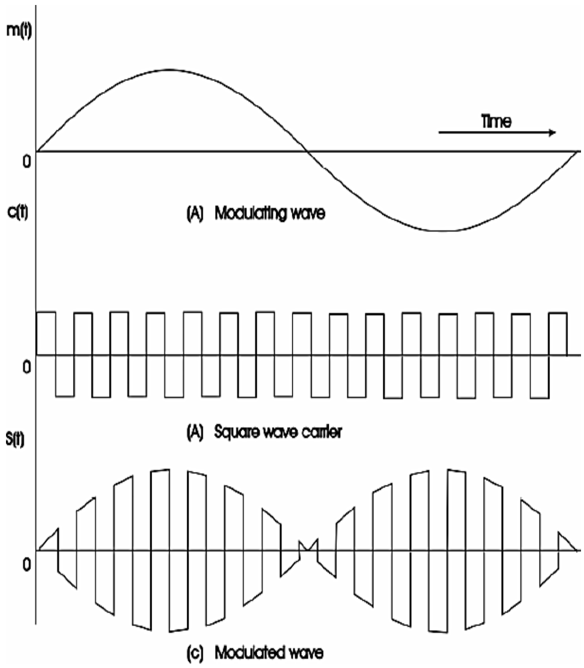
IC 1496 Pin Diagram



Circuit Diagram:



Waveforms



Procedure

1. Connections are made as shown in figure
2. Apply modulating signal (Sine Wave V_m =2Vp-p) with frequency f_m = 1K Hz, and carrier signal (Square Wave V_c = 5Vp-p) with frequency fc = 10 KHz (fc = 10fm).
3. Observe the phase reversal of 180^o at each Zero Crossing modulating signal in the output DSBSC signal.

Outcome: Understood the characteristics of double sideband suppressed carrier (DSB-SC)

Result: Observed the DSB-SC signal on the oscilloscope.

Experiment No: 3

Frequency Modulation and Demodulation

Aim: To design a frequency modulator using a Voltage-Controlled Oscillator (VCO) (IC566) and to demodulate FM using a Phase-Locked Loop (PLL) (IC565).

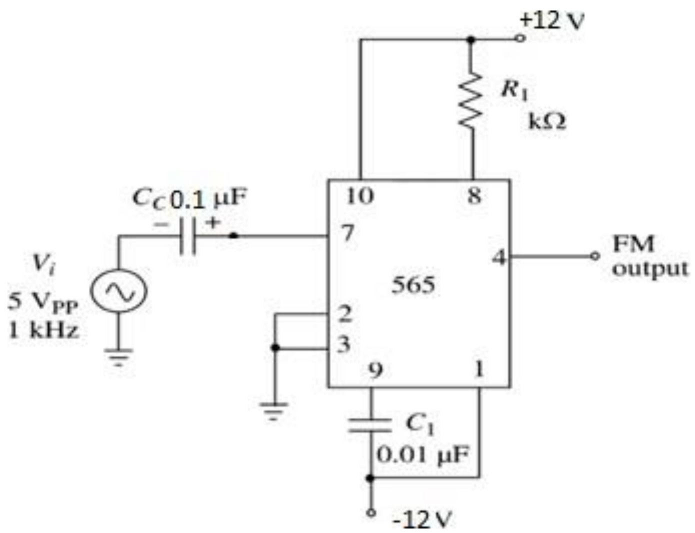
Objective: To understand the principles of Frequency modulation and demodulation

Apparatus Required:

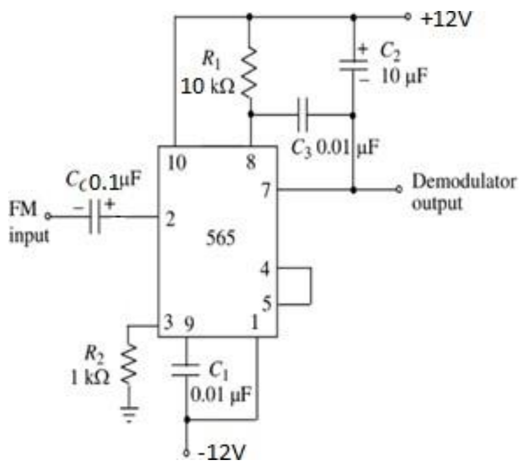
Sl. No	Components	Quantity
1	PLL 565	01
2	Resistor, 12K, 12K, 1KΩ	01
3	Capacitor: 10uF, 0.01uF, 0.01uF	01
4	Bread board, Connecting wire	01
5	CRO (40MHz), Signal generator(1MHz), DC supply(30V)	01

Circuit Diagram:

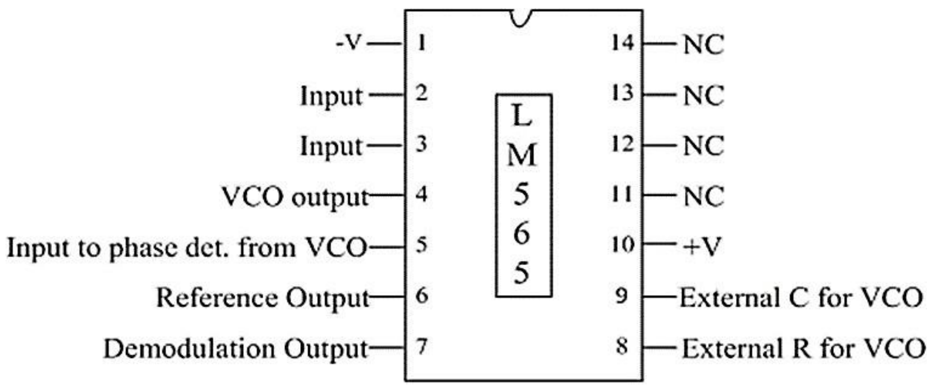
Modulator



Demodulator



Pin Diagram of IC- 565



Design:

Let +V=+12 V and -V=-12V

Let the Centre frequency of the FM be $fo = \frac{0.3}{R1\,C1} = 2.5KHz$

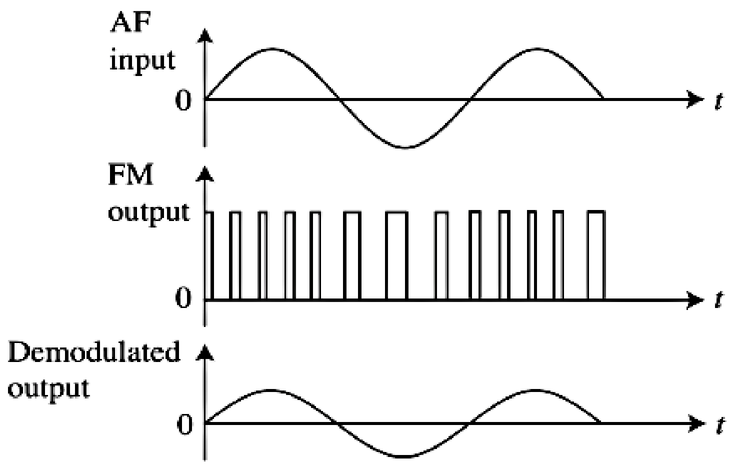
Take C_1=0.01µF. then we get, R_1 = 12 KΩ

The value of R_1 satisfies the required condition 2 KΩ < R_1 < 20 KΩ, as per data sheet.

Take C_C = 10 µF and R_3 = 12 KΩ to couple the input to the IC.

For demodulation circuit, since center frequency is same as that of modulator, frequency determining components are the same. Take same set of coupling capacitor and resistor. Take R_2 = 1 KΩ, C_2 = 10 µF and C_3 = 0.01 µF

Waveforms



Tabular Column:

Ac in (v)	Am in (v)	Fmax in Hz	Fmin in Hz	$\Delta f = f_{max} - f_{min}$.	modulation index $m_i = \Delta f / f_m$

Procedure

1. Setup the FM generator circuit and apply 5Vpp, 1KHz sine wave input and observe the output.
2. Note maximum and minimum frequency fmax and fmin of FM output. Calculate frequency deviation $\Delta f = f_{max} - f_{min}$. Calculate the modulation index $m_i = \Delta f / f_m$ where fm is modulating signal frequency.
3. Set up FM demodulator and apply the FM signal to it. Observe the demodulated output.

Outcome: Understood the principles of Frequency modulation and demodulation.

Result: Observed the FM signal on the oscilloscope and compared the demodulated signal with the original message signal for resemblance.

Experiment No: 4

Pre-Emphasis and De-Emphasis Circuits

Aim: To design pre-emphasis and de-emphasis circuits and to plot their frequency response.

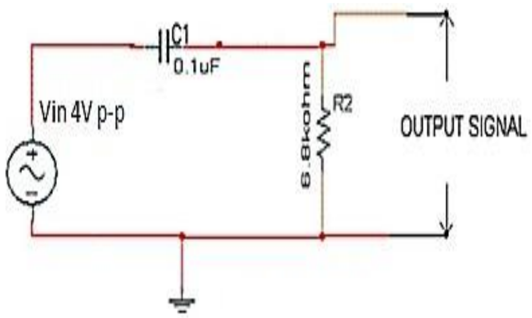
Objective: To gain the Knowledge of pre-emphasis and de-emphasis in improving signal-to-noise ratio in FM systems.

Apparatus Required:

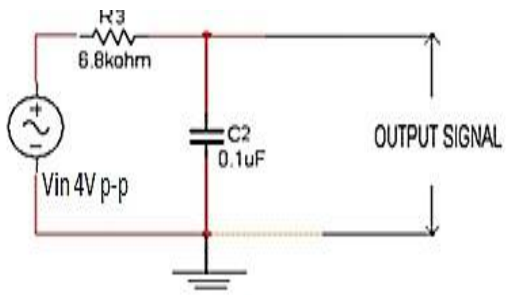
1. Resistors (1K, 7.5K & 6.8K)
2. Capacitors (0.1µF)
3. Function generators
4. CRO
5. Connecting Wires

Circuit Diagram:

Pre-Emphasis



De-Emphasis



Procedure:-

1. Connect the circuit as per circuit diagram as shown in Fig.
2. Apply the sinusoidal signal of amplitude 20mV as input signal to pre emphasis circuit.
3. Then by increasing the input signal frequency from 500Hz to 20 KHz, observe the output voltage (VO) and calculate gain 20 log (vo/vi).
4. Plot the graph between gain Vs frequency.
5. Repeat above steps 2 to 4 for de-emphasis circuit (shown in Fig.2). by applying the sinusoidal signal of 5V as input signal.

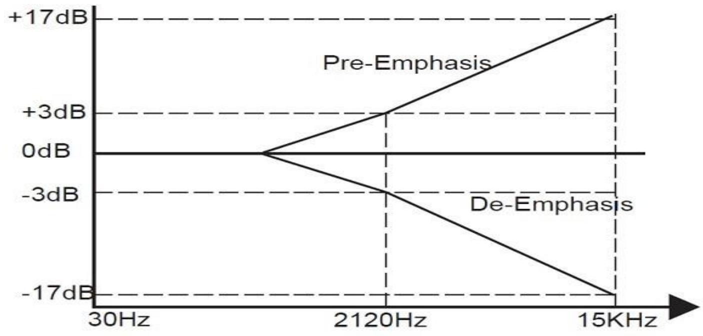
Tabular column for Pre-emphasis :

S.No.	Frequency (Hz)	I/P Voltage Vi	O/P Voltage Vo	Gain in dB 20log(Vo /V i)
1				
2				
3				
4				
5				

Tabular column for De-emphasis :

S.No.	Frequency (Hz)	I/P Voltage Vi	O/P Voltage Vo	Gain in dB 20log(Vo /V i)
1				
2				
3				
4				
5				

Model Graph:



75-µs Emphasis Curves

Outcome: Understood the importance of pre-emphasis and de-emphasis in improving signal-to-noise ratio in FM systems.

Result: Plotted the Frequency response and observed the expected behavior.

Experiment No: 5

BJT/FET Mixer

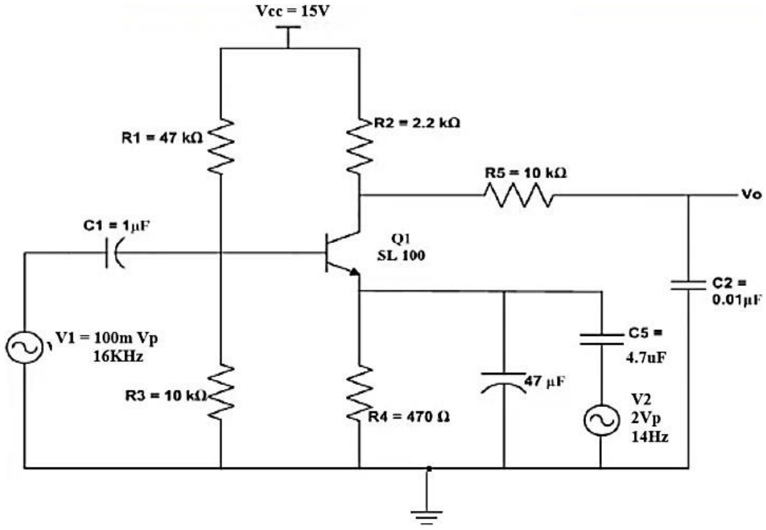
Aim: To design and test a mixer circuit using Bipolar Junction Transistor (BJT).

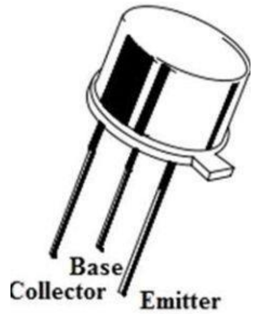
Objective: To Understanding the principles of mixing in communication systems.

Apparatus Required:

Sl. No	Components	Quantity
1	Transistor SL100	**01**
2	Resistors 47K, 10K, 470Ω, 2.2K, 22K, 10KΩ	**01**
3	Capacitors: 1uF, 47uF, 4.7uF, 47uF, 0.01uF	**01**
4	Bread board Connecting wire	**-**
5	CRO (40MHz), Signal generator(1MHz), DC supply(30V)	**-**

Circuit Diagram





Design

Given, $V_{CE} = 5$ V and $I_C = 2$ mA Assume $\beta = 100$

$V_{CC} = 2V_{CE} = 2 \times 5 = 10V$

Let $V_{RE} = 10\%\ V_{CC} = 1$ V

$R_E = V_{RE} / (I_C + I_B)$

$I_B = I_C / \beta = 2\ mA / 100 = 20\ \mu A$

$R_E = 1 / (2\ m = 20\ \mu) = 495\ \Omega$

Choose $R_E = 470\ \Omega$

Apply KVL to collector loop

$V_{CC} - I_C R_C - V_{CE} - V_E = 0$

$R_C = (V_{CC} - V_{CE} - V_E) / I_C = (10 - 5 - 1) / 2\ m$

$R_C = 2\ k\Omega$ Choose $R_c = 2.2\ k\Omega$

$X_{CE} << R_E$

$X_{CE} = R_E / 10$

$1 / (2\pi f C_E) = 470 / 10$ let f = 100 Hz

$C_E = 33\ \mu F$ choose $C_E = 47\ \mu F$

Let $I_{R1} = 10\ I_B = 10 \times 20\ \mu A$

$V_{R2} = V_{BE} + V_E$

$= 0.6 + 1$ (Since transitor is silicon make $V_{BE} = 0.6$)

$R_2 = 8.8\ k\Omega$ choose $R_2 = 10\ k\Omega$

$R_1 = (V_{CC} - V_{R2}) / I_{R1} = (10 - 1.6) / 200\ \mu A$

$R_1 = 42\ k\Omega$ choose $R_1 = 47k\Omega$

Note : Choose coupling cpacitors in such way that Reactance of coupling capacitors Xc1 and Xc5 should be less than 15Ω

Tabular Column

Frequncy F_1 in Hz	Frequency F_2 in Hz	Output frequency $\Delta f = f_1 - f_2$ in Hz
16Hz	14Hz	
16Hz	13Hz	
16Hz	12Hz	
16Hz	11Hz	
16Hz	10Hz	
16 Hz	09Hz	

Procedure

1. Connections are made as shown in the circuit diagram.
2. Apply the input signals as mentioned in the circuit diagram.
3. Observe the output waveforms in CRO
4. Measure the output frequency, it has to be equal to $\Delta f = f_1 - f_2$
5. Repeat the steps 3 and 4 by decreasing frequency of V2 in the step of 1KHz.

Outcome: Understood the principles of mixing in communication systems.

Result: Observed signal with the mixed frequencies

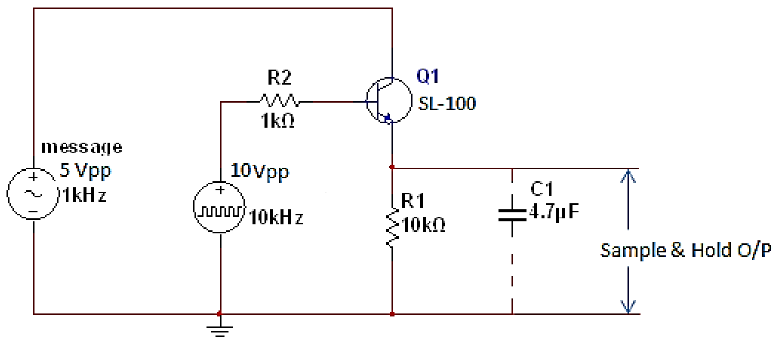
Experiment No: 6

Pulse Sampling, Flat Top Sampling and Reconstruction

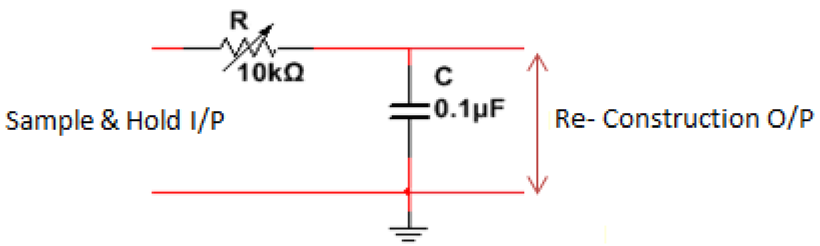
Apparatus Required:

Sl No	Components	Quantity
1	n-EMOSFET (TRS740), OP-AMP(µA741)	1
2	Resistor 22KΩ, 10KΩ(POT), 47KΩ	1
3	Bread board, connecting wires	1
4	CRO, Function Generator and DC Supply	1
5	Capacitor 0.1uF (Electrolyte)	1

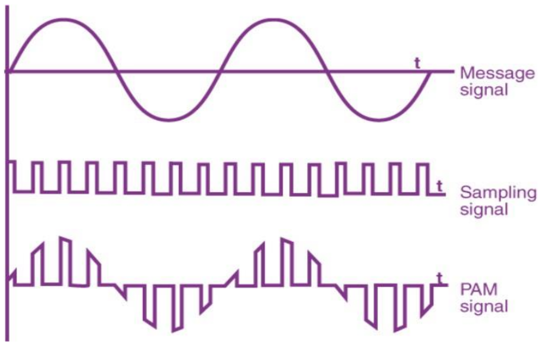
Circuit Diagram: Flat top Sampling



Re – Construction



Wave Form



Procedure

1. Before wiring the circuit checks all the components using multi meter.
2. As per design set the values and do the connections as shown in circuit diagram.
3. Set the carrier amplitude or sampling signal to around 4 Vp and frequency, fs = 1KHz.
4. Set the message signal amplitude to around 2 Vp and frequency, fm = 100 HZ.
5. Connect the CRO at the pin number 6 of OP-AMP and observe the waveform for both circuits.
6. Connect this output to the reconstruction filter and observe the waveforms.

Result:

Experiment No: 7

Pulse Amplitude Modulation and Demodulation

Aim: To design and test a pulse amplitude modulation (PAM) and demodulation circuit.

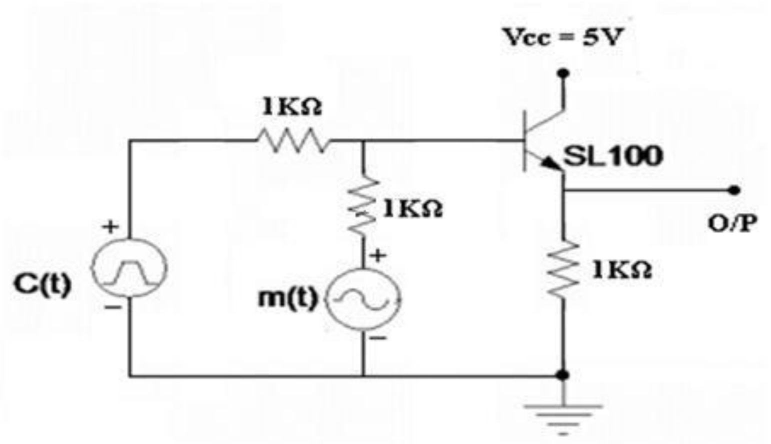
Objective: To Understand the PAM technique and its applications in communication systems

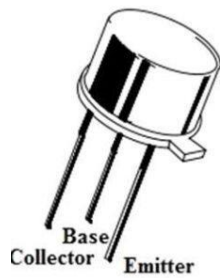
Apparatus Required:

Sl No	Components	Specification
1	Transistor	SL100
2	Resistor	22K, 10K,47K
3	Capacitor	0.1µF
4	Bread board Connecting wire	--
5	CRO (40MHz), Signal generator(1MHz), DC supply(30V)	--

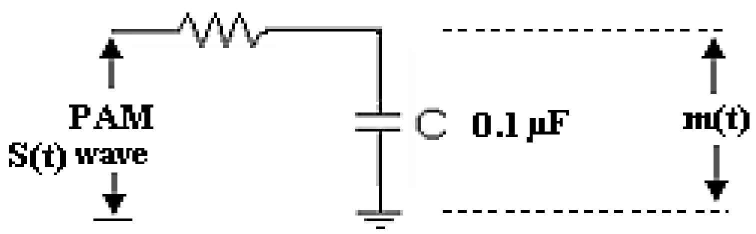
Circuit diagram

Pulse Amplitude Modulation Circuit





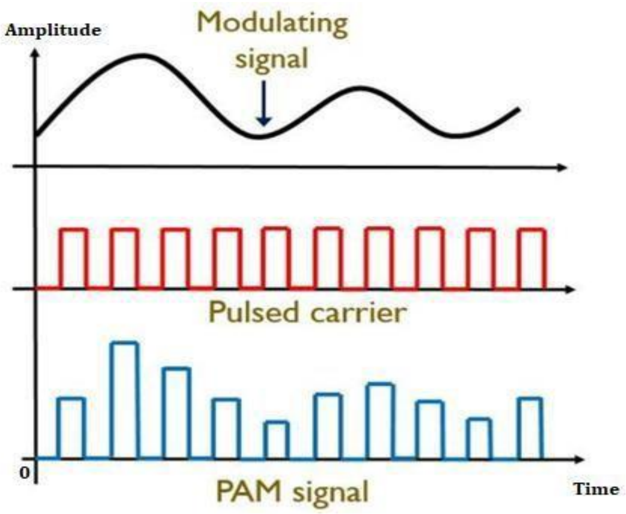
Demodulation circuit



Design

Reconstruction circuit: concider frequency of message signal as fm =100 Hz abd this is the cutoff frequency of LPF. Choose C = 0.1uF and find R using $f_m = \frac{1}{2\pi RC}$

Waveforms



Procedure

1. Before wiring the circuit checks all the components using multi meter.
2. As per design set the values and do the connections as shown in circuit diagram.
3. Set the pulsed carrier amplitude to around 5V (p-p) and frequency, fc = 1 KHz.
4. Set the message signal amplitude to around 3 V (p-p) and frequency, fm = 100HZ.
5. Check the modulated and demodulated output waveform.

Outcome: Understood the PAM technique and its applications in communication systems

Result: Generated the PAM signal and observed on CRO and compared the demodulated signal with the original message signal for resemblance.

Experiment No: 8

Experiment No: 8

Pulse Width Modulation (PWM)

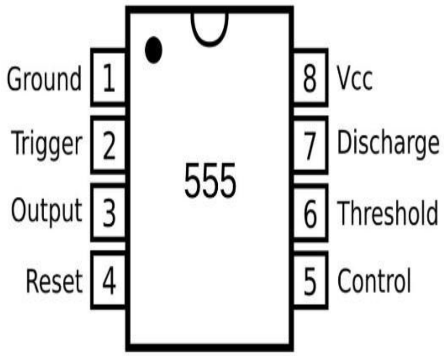
Aim: To design and test a pulse width modulation (PWM) circuit using IC555

Objective: To understand the principle of pulse width modulation (PWM)

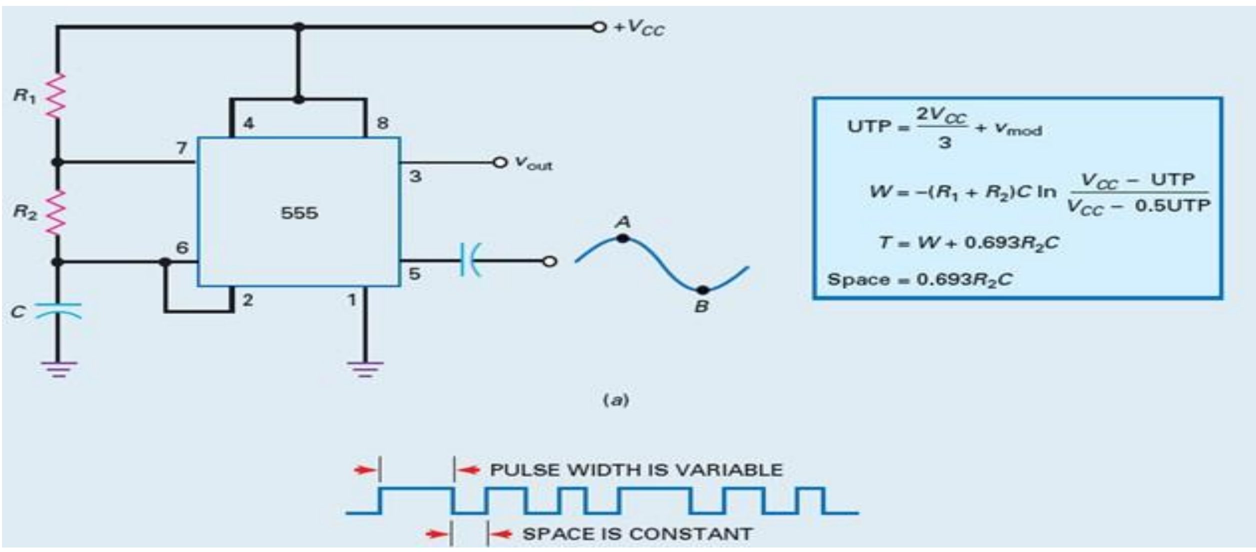
Apparatus Required:

Sl. No	Components	Quantity
1	555 Timer	01
2	Resistors	01
3	Capacitor 0.1uF	01
4	Bread board , Connecting wire	-
5	CRO, DC supply(30V)	01

555 timer IC Pin Diagram



Pulse Width Modulation:

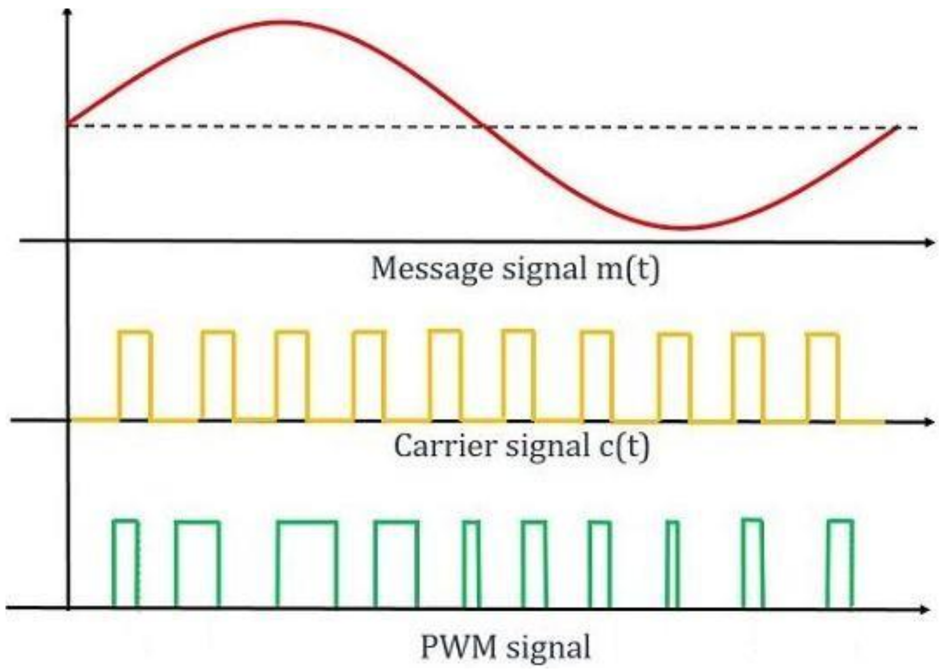


Here 555 timer functions as Astable multivibrator for PWM

We have $T = 1.1RC\ = 1.1 \times 10K \times 0.01\mu = 0.011\mu Sec$

Where T is the time period of signal Choose R_1 & R_2 = 10K Ohms and C = 0.1uF

Waveform of PWM



Procedure

a. Make the connection as per Circuit diagram.
b. Set the M(t) = 2Vp and C(t) = 2Vp amplitudes using different signal generator.
c. Vary the frequency of M(t) =100 Hz and C(t) = 1KHz and adjust until we get proper output.
d. Observe the PWM output waveforms.
e. The output is taken at terminal 3 of timer 555 IC.
f. The wave is observed on CRO and Toff is noted during +Ve & -Ve peak of message signal M(t).

Outcome: Understood the principle of pulse width modulation (PWM)

Result: Observed the PWM signal on CRO.

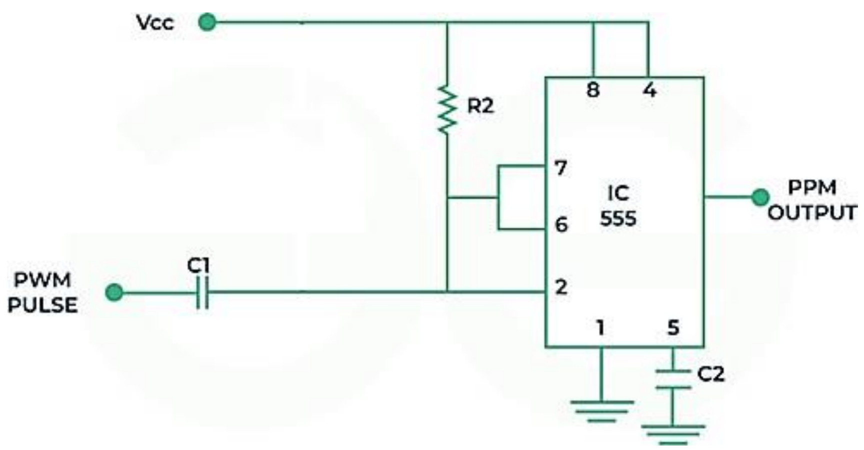
Experiment No: 9

Pulse Position Modulation (PPM)

Aim: To design and test a pulse position modulation (PPM) circuit using IC555

Objective: To understand the principle of pulse position modulation (PPM)

PPM Circuit Diagram:

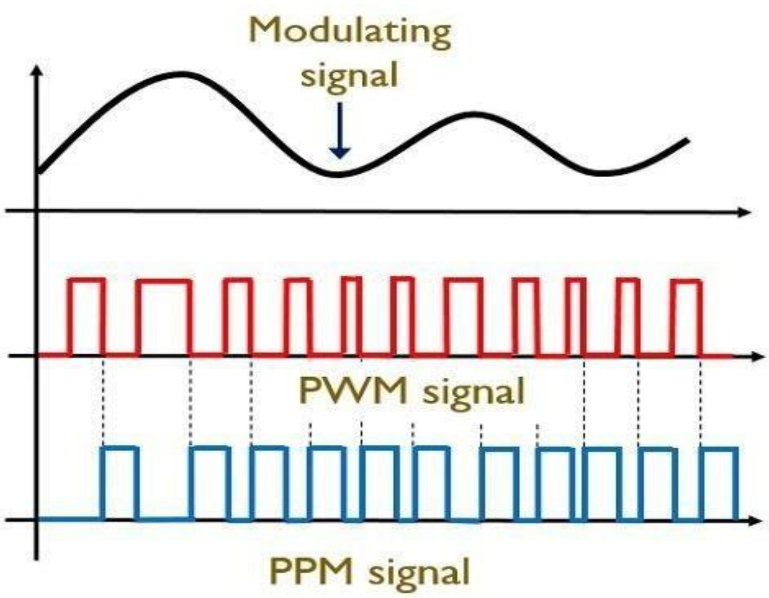


Here 555 timer functions as monostable multivibrator for PPM & Astable multivibrator for PWM

We have $T = 1.1RC \ = 1.1 \times 10K \times 0.01\mu = 0.011\mu Sec$

Where T is the time period of signal Choose R_1 & R_2 = 10K Ohms and C = 0.01uF

Waveform of PWM and PPM



Procedure

a. Make the connection as per Circuit diagram.
b. Set the m(t) = 2Vp and C(t) = 2Vp amplitudes using different signal generator.
c. Vary the frequency of m(t) =100 Hz and C(t) = 1KHz and adjust until we get proper output.
d. Observe the PWM output waveforms.
e. After getting PWM then the output of PWM is fed to triggering input of IC 555 timer to result is PPM.
f. The output is taken at terminal 3 of timer 555 IC.
g. The wave is observed on CRO and Toff is noted during +Ve & -Ve peak of message signal M(t).

Outcome: understood the principle of pulse position modulation (PPM)

Result: Observed the PPM signal on CRO.

Experiment No: 10

PLL Characteristics

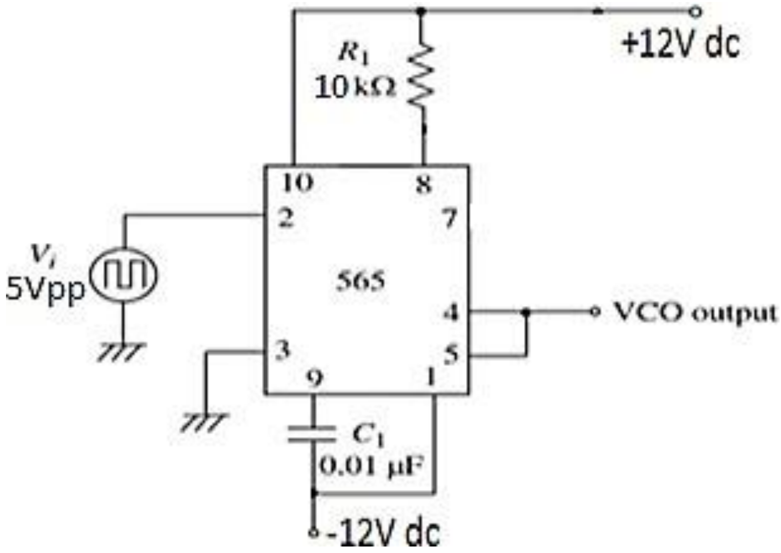
Aim: To test a Phase-Locked Loop (PLL) Characteristics

Objective: To understand the principle of PLL

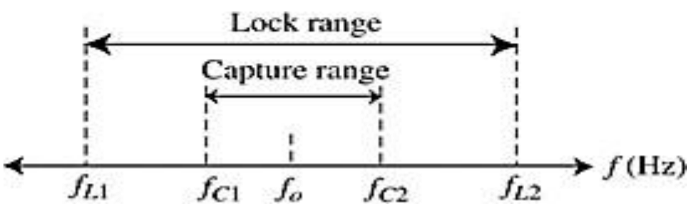
Apparatus Required:

Sl. No	Components	Quantity
1	CRO, Function Generator, Breadboard	1
2	Resistance: 10K	1
3	Capacitor: 0.01uF	1
4	RPS and connecting wires	1

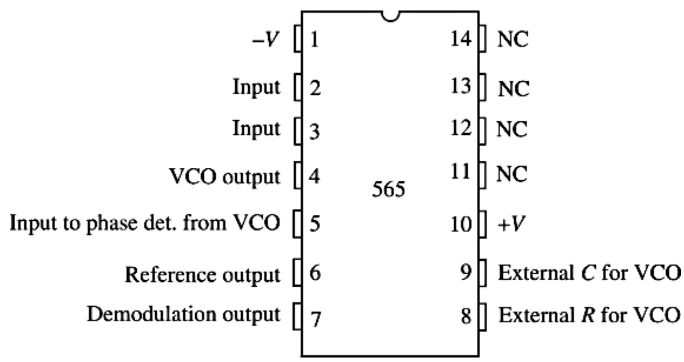
Circuit Diagram



Model Graph



Pin diagram of IC 565



Design: Take $+V = +10$ V and $-V = -10$ V

Assume the free running frequency $f_o = \frac{1.2}{4R_1C_1} = 2.5$ kHz

Take $C_1 = 0.01$ µF. Then we get, $R_1 = 12$ kΩ.

The value of R_1 satisfies the required condition $2\ k\Omega < R_2 < 20\ k\Omega$

Take $C_3 = 0.001$ µF and $C_2 = 10$ µF

The range of frequencies that the loop will remain in lock

$$= \pm \frac{8f_o}{V} = \frac{8 \times 2.5 \times 10^3}{10-(-10)} = 1 \text{ kHz}$$

Procedure

a. Setup the circuit and observe the output at pin 4 or pin 5 and note down the VCO frequency. It is the free running frequency f_0 without any input signal.

b. Apply a signal input to pin 2 either a sine or square wave of 5Vpp, 1 KHz and vary its frequency from low to high and note down f_{c1} and f_{L2}.

c. Decrease the input frequency from a high value to low value and note down f_{c2} and f_{L1}

d. Mark the obtained value on straight line. Calculate lock range $f_L = f_{L2} - f_{L1}$ and capture range fc = fc2 – fc1.

Outcome: Understood the principle of PLL

Result: Plotted and observed the Lack range and Capture range of the PLL