4. Frequency Modulation And Demodulation

Aim: 1. To generate frequency modulated signal and determine the modulation index and bandwidth for various values of amplitude and frequency of modulating signal.

2. To demodulate a Frequency Modulated signal using FM detector.

Apparatus required:

Name of the Component/Equipment	Specifications/Range	Quantity
IC 566	Operating voltage –Max-24 Volts Operating current-Max.12.5 mA	1
IC 8038	Power dissipation – 750mW Supply voltage - ±18V or 36V total	1
IC 565	Power dissipation -1400mw Supply voltage - ±12V	1
Resistors	15 K Ω, 10 K Ω, 1.8 K Ω, 39 K Ω, 560 Ω	1,2,1 2,2
Capacitors	470 pF, 0.1μF 100pF , 0.001μF	2,1 1,1 each
CRO	100MHz	1
Function Generator	1MHz	2
Regulated Power Supply	0-30 v, 1A	1

Theory: The process, in which the frequency of the carrier is varied in accordance with the instantaneous amplitude of the modulating signal, is called "Frequency Modulation". The FM signal is expressed as

$$s(t) = A_c \cos\left(2\pi f_c + \beta \sin\left(2\pi f_m t\right)\right)$$

Where A_C is amplitude of the carrier signal, f_C is the carrier frequency

β is the modulation index of the FM wave

Circuit Diagrams:

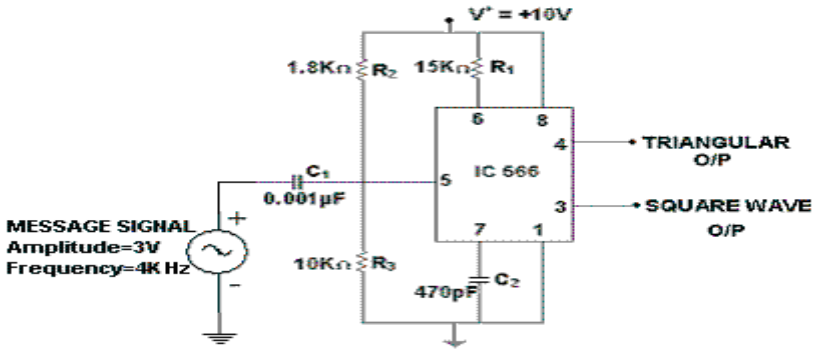


Fig.1. FM Modulator Using IC 566

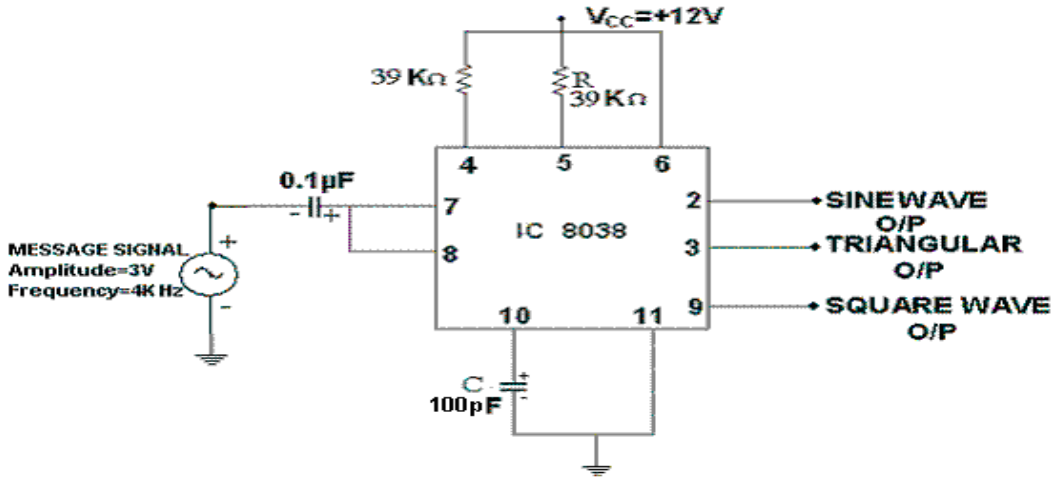


Fig.2. FM Modulator Circuit

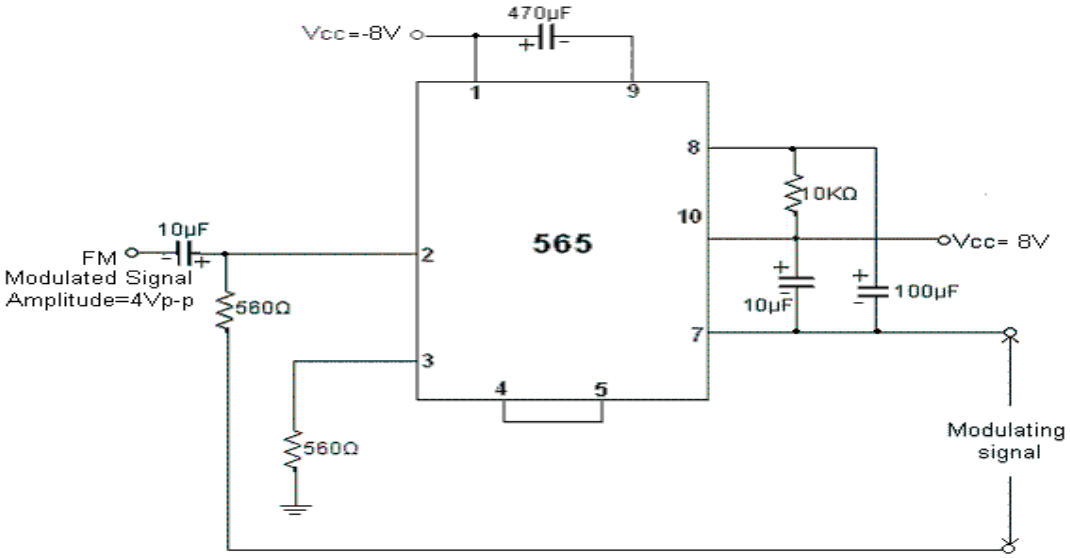


Fig.3. FM Demodulator Circuit

Procedure: Modulation:

1. The circuit is connected as per the circuit diagram shown in Fig.2(Fig.1 for IC 566)
2. Without giving modulating signal observe the carrier signal at pin no.2 (at pin no.3 for IC 566). Measure amplitude and frequency of the carrier signal. To obtain carrier signal of desired frequency, find value of R from f = 1/ (2ΠRC) taking C=100pF.
3. Apply the sinusoidal modulating signal of frequency 4KHz and amplitude 3Vp-p at pin no.7. (pin no.5 for IC 566)

   Now slowly increase the amplitude of modulating signal and measure f_{min} and maximum frequency deviation Δf at each step. Evaluate the modulating index ($m_f = \beta$) using $\Delta f / f_m$ where $\Delta f = |f_c - f_{min}|$. Calculate Band width. $BW = 2(\beta + 1)f_m = 2(\Delta f + f_m)$

4. Repeat step 4 by varying frequency of the modulating signal.

Demodulation:

1. Connections are made as per circuit diagram shown in Fig.3
2. Check the functioning of PLL (IC 565) by giving square wave to input and observing the output
3. Frequency of input signal is varied till input and output are locked.
4. Now modulated signal is fed as input and observe the demodulated signal (output) on CRO.
5. Draw the demodulated wave form.

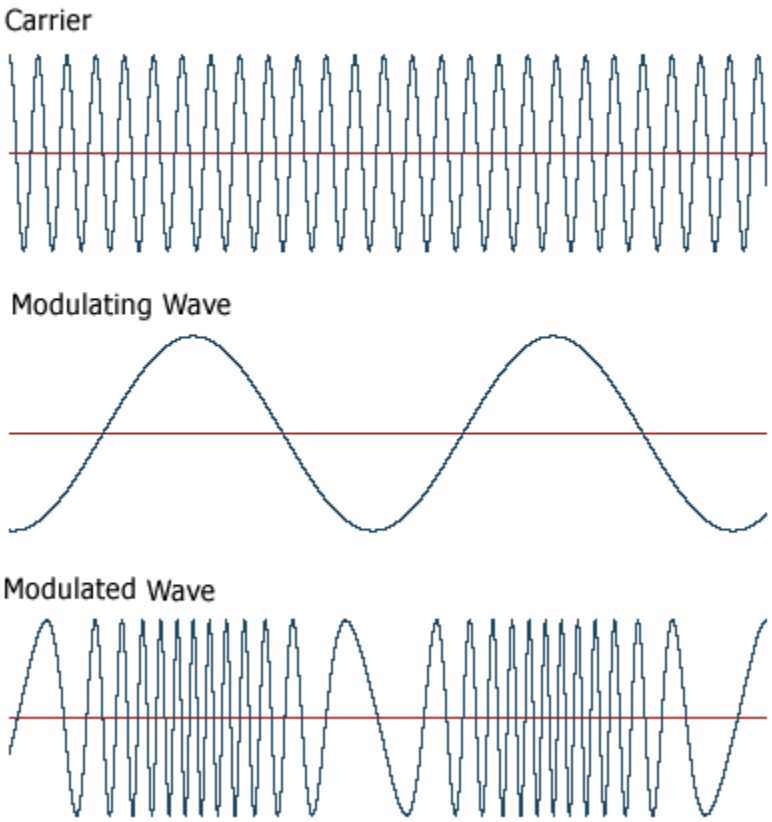
Table: 1 f_c = 45KHz

S.No.	f_m(KHz)	T_{max} (μsec)	f_{min}(KHz)	Δf(KHz)	β	BW (KHz)

Table 2: f_m = 4 KHz, f_c = 45 KHz

S.No.	A_m (Volts)	$T_{(\mu sec)}$	f_{min}(KHz)	Δf (KHz)	β	BW(KHZ)

Waveforms:



Precautions:

1. Check the connections before giving the power supply
2. observations should be done carefully