# Experiment #2

To study Frequency modulation (FM) and demodulation.

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**Purpose:** To study the Frequency modulation (FM) and demodulation.
**Equipment Required:**

I. N9010A Signal Analyzer/89601
II. AFG3021B Function Generator (2 sets)
III. DPO2024 Oscilloscope, 200 MHz
IV. FM trainer kit (Vinytics CT FM)

**Accessories Required:**

I. BNC(m)-to-BNC(m) coaxial cable
II. SMA(m)-to-BNC(m) coaxial cable
III. SMA(m)-to-SMA(m) coaxial cable
IV. Connecting Chords

- **FM TIME DOMAIN ANALYSIS**

## Procedure:

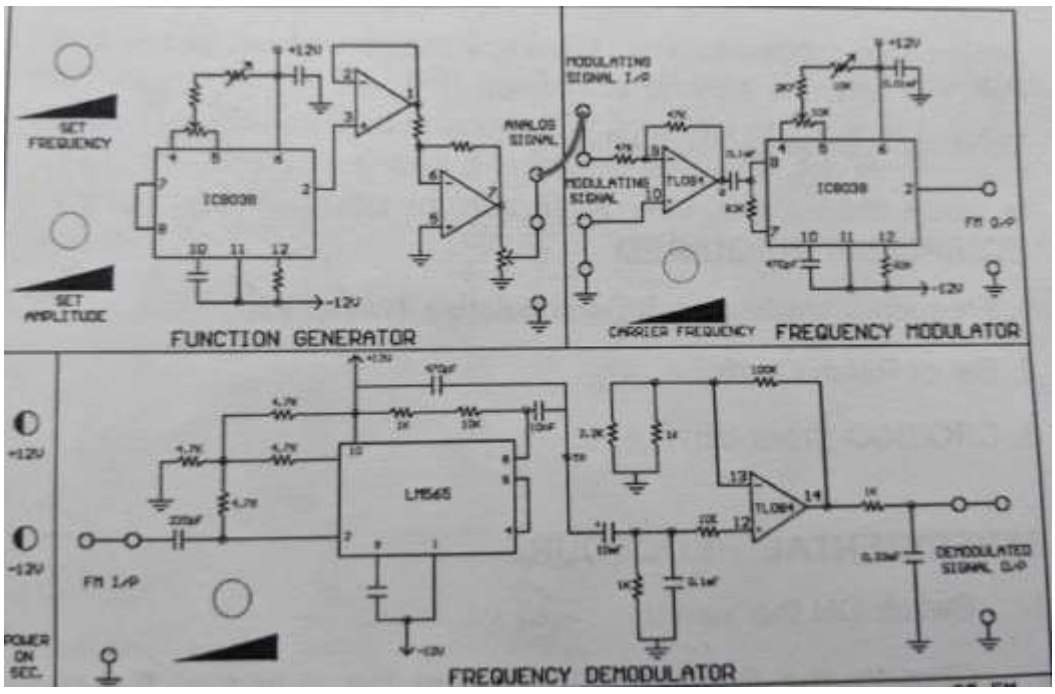


**Figure 2.1** Connection Diagram for FM modulation

1. Make the connection as per Fig. 2.1.
2. Switch on the FM trainer kit.
3. Generate a message signal ($A_m\ sin\ (2\pi f_m t)$ ) of peak-to-peak amplitude = 10 volt and frequency = 4 kHz.
4. Observe the Sine wave signal at the output of the **Function Generator Section**.
5. The modulating signal amplitude and frequency can be changed by tuning the potentiometer marked as **"Amplitude"** and **"Frequency"** in the **Function Generator Section**.
6. Observe the carrier output ($A_c\ sin\ (2\pi f_c t)$ ) at a socket marked as **FM O/P** of the **Frequency Modulation Section,** when **Function Generator O/P** (ANALOG SIGNAL) post is not connected to the input post of **Frequency Modulator** (MODULATING SIGNAL I/P).
7. Observe the FM modulated signal at the socket marked **FM O/P** of the **Frequency Modulator Section** simultaneously with the modulating signal at the O/P of the **Function Generator Section** on the DSO.
8. Vary the amplitude and frequency of the sine wave **Function Generator** section (changing the amplitude and frequency of the message signal) and observe the effect on the modulated signal on the DSO.
9. Vary the potentiometer marked as **Frequency** on the **Frequency modulator Section** (changing the frequency of the carrier) and observe the effect on the modulated signal on the DSO.
10. The proper reception of a modulated signal also depends upon the proper tuning of the potentiometer, i.e., amplitude and frequency knobs of the **Function Generator Section**, etc. Students need to tune these potentiometers properly until the modulated signal is achieved.
11. Adjust the setting of DSO to obtain the desired results.
12. Take the DSO display snapshot of the message signal and the FM signal.

- **FM demodulation**

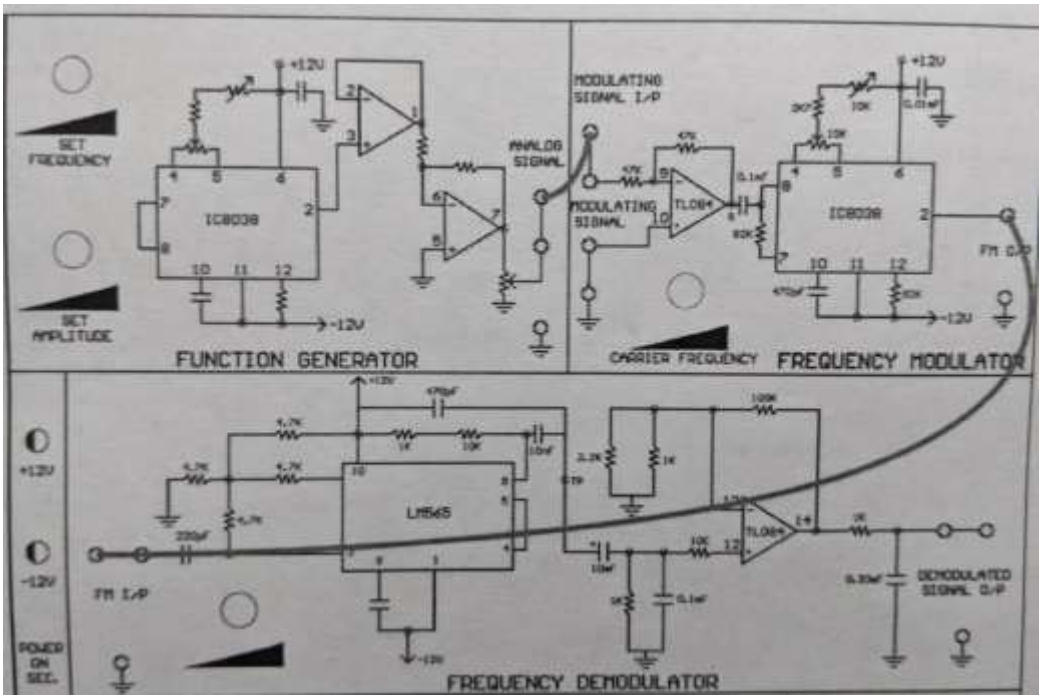


**Figure 2.2** Connection Diagram for FM demodulation

1. Make the connections as per Fig. 2.2.
2. Observe the FM demodulated signal at the Demodulating signal O/P of **FM Demodulation section** simultaneously with the modulating signal at the **O/P** of the **Function Generator Section** on the DSO.
3. Vary the amplitude and frequency of the Sine wave in the **Function generator section** and observe the effect on the DSO.
4. Take the DSO display snapshot of the message signal and the demodulated signal.

**Note:**

**a)** Proper reception of the demodulated signal also depends upon the proper tuning of the potentiometer knob (PLL) on the **Frequency Demodulator section**. Students need to tune this potentiometer properly until the demodulated signal is achieved.

**b)** Once the phase has been locked using PLL, changing the amplitude and frequency of the message signal will not require any further tuning of PLL to recover the message signal. But, on changing the carrier frequency, we need to tune the PLL again to reconstruct the message signal at the demodulator properly.

**c)** Adjust the setting of DSO to obtain the desired results.

## ➢ FREQUENCY DOMAIN ANALYSIS

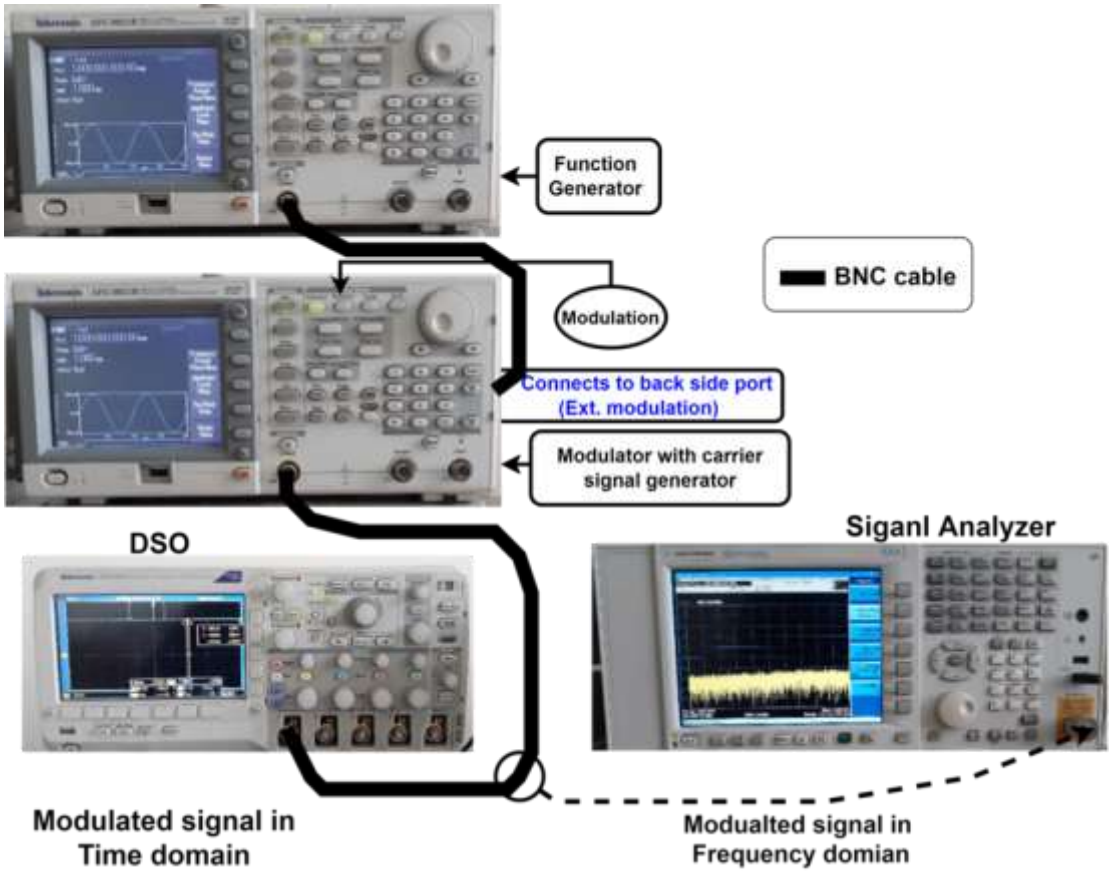


Figure 2.3 Connection diagram of FM for frequency domain analysis.

1. In the **Function Generator** (shown in Fig. 2.3)**,** select the continuous button✇ modulating signal type (Sine, Rectangular, Ramp, etc.) and further set amplitude and frequency of the modulating signal.
2. Take the output (OUT) of the **Function Generator** acting as the modulating signal (Sine, Ramp, Rectangular, etc.) and connect to the function generator labeled as **Modulator with Carrier Signal Generator** (as shown in Fig. 2.3) in the backside port labeled as Ext. Modulation.
3. Next, in the **Modulator with Carrier Signal Generator** (as shown in Fig. 2.3), select Modulation button (AM/**FM**/PM/FSK) ✇select External input ✇ Sine function (set carrier frequency and amplitude) ✇deviation.
4. Further, connect the output (OUT) of the **Modulator with Carrier Signal Generator** to the DSO for time-domain observation as shown in Fig. 2.3.
5. Observe the modulated signal by changing the frequency deviation of **the Modulator with Carrier Signal Generator.**

6. Connect the **Modulator with carrier signal generator** output to the **Signal Analyzer** for the frequency domain analysis.
7. Set all the parameters such as center frequency, span, resolution bandwidth, video bandwidth, marker, etc., of the **Signal Analyzer** and observe the modulated signal spectrum in the **Signal Analyzer**.
8. Take the snapshot of the signal analyzer display for the lab report.

- **OBSERVATIONS:**

| $A_m$ | $A_c$ | $f_m$ | $f_c$ | **Frequency deviation** $(\Delta f)$ | **Bandwidth** $(BW = 2(f_m + \Delta f))$ | **Modulation depth** $\beta = \Delta f / f_m$ |
|---|---|---|---|---|---|---|
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