DESIGN AND WORKING OF FM TRANSMITTER

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ABSTRACT

The first archaic radio transmitter were made by German physicist "HEINRICH HERTZ" in year 1887. They produced radio waves by a high voltage spark in between two metals (conductor).The objective of the project is to design the miniaturize low –power FM transmitter, and used it in different application. For example hearing aid for the tour guiding system, security of small areas, and for entertainment purpose. FM transmitter has many merits over the AM (Amplitude modulation). It protects the signal from interference and unwanted signal i.e. noise. It provides high S/N (signal to noise) than AM. A FM transmitter is an electronic circuit, which converts electric power from battery into radio frequency alternating current (AC). The energy by a such rapidly reversing current radiate off the antenna as EM waves (Electromagnetic waves).

Keywords: Antenna, Filter, Frequency Multiplier, Mixer, Oscillator, RF Amplifier.

I INTRODUCTION

A FM transmitter is a low power FM radio transmitter, which allows listening music or any other audio message from CD player, portable media player or any other audio system which is used to be played by a nearby FM radio. Because of low cost of the equipments for an FM transmitter, leads to rapid growth in the year of world war II. After the 3 years from the war, 600 licensed FM station were broadcasting in the US and, by the end of 1980 there were more than 4,000 stations. Due to crowding in AM broadcast and failure of basic AM receiver to remove noise.FM transmission helped us to overcome from these detriments and therefore, can be used to transmit music, or audio signals and this may leads to rising the number of auditors to famous as well as classical music, by which FM station draw the higher audience ratings as compared to AM stations. FM transmitter consist of mice from where an audio signal is transmitted to different section of transmitter, after processing the signal from these section it will transmit through antenna and these signal catch by receiver side antenna.

1.2 Frequency Table

TABLE 1

DIFFERENT RANGE FOR FREQUENCY AND WAVELENGTH

FREQUENCY	DESIGNATION	ABBREVIATION	WAVELENGTH
3-30KHz	very low frequency	VLF	10^5 to 10^4 m
30-300KHz	low frequency	LF	10^4 to 10^3 m
300-3,000KHz	Medium frequency	MF	10^3 to 100m
3-30MHz	High frequency	HF	100to 10m
30-300MHz	very high frequency	VHF	10to 1m
300-3,000MHz	Ultra high frequency	UHF	1 m to 10 cm
3-30GHz	Super high frequency	SHF	10 cm to 1cm
30-300GHz	Extremely high frequency	EHF	1cm to 10 mm

The frequency range for FM is 88MHz to 108MHz with wavelength between 3.4 to 2.77 m respectively

II BLOCK DIAGRAM

Here is the block diagram of FM transmitter:

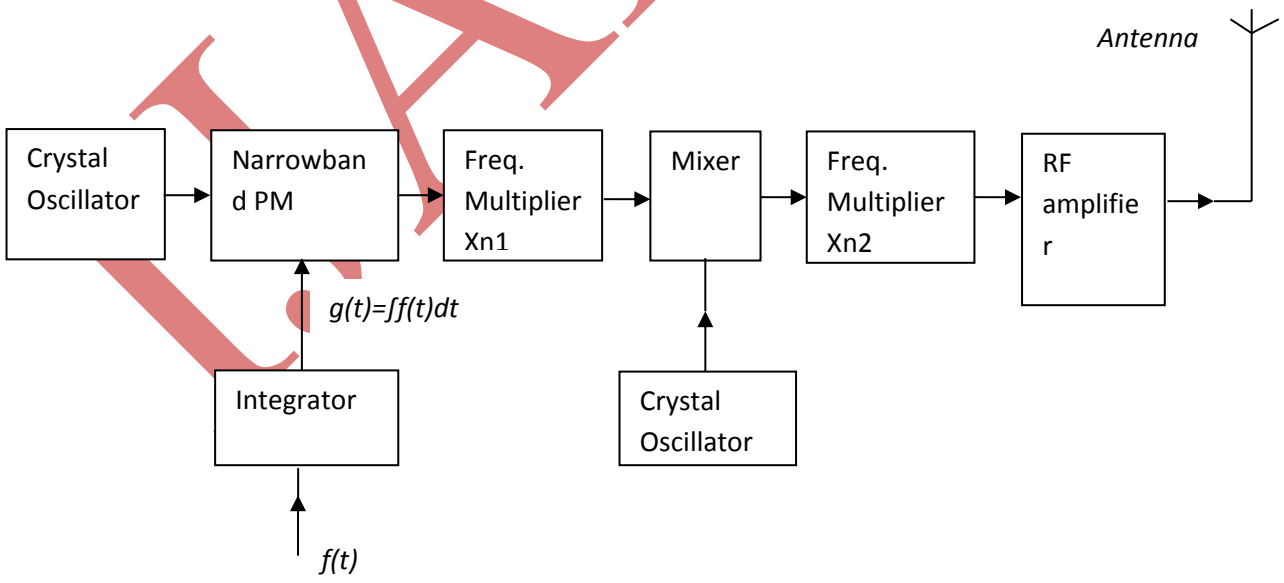

Fig. 1 General Block Diagram of FM Transmitter

In FM transmitter, there will be many multiplication processes in several stages to increase the carrier frequency along with the frequency deviation to accredit value. The multiplication factor for carrier frequency and frequency deviation are not same, if multiplication is completed in one attempt the carrier frequency as well as deviation is multiplied by same factor which does not give the desired result. So, due to these reasons multiplication is done in several stages. For instance, consider the value the carrier frequency f_c and the deviation Δf generated by NBFM(Narrowband frequency modulation) has the typical values :

$$f_c=200\text{kHz} , \Delta f \approx 25\text{Hz}$$

which gives $m_f=0.5$, $f_m = 50$ Hz. The multiplication factor is obtained by lower frequency limit of baseband spectrum (25 Hz to 15 kHz), these incoming carrier frequency and frequency deviation is applied to the frequency multiplier as an input which multiply these frequency by a factor n1=64 , now the carrier frequency and frequency deviation are :

$$f_{c1}=n1*f_c, \Delta f_1=n1*\Delta f$$

$$f_{c1}=12.8\text{MHz}, \Delta f_1=1.56\text{ kHz}$$

These frequencies applied to the mixer mix the frequencies with the local oscillator frequency ($f_c'=10.925$ MHz) and give result as:

$$f_{c2}= f_c'+ n1* f_c$$

$$f_{c2}= f_c'- n1* f_c$$

$$f_{c2}=1.875\text{MHz}, \Delta f_1=1.56\text{ kHz}$$

The resulting carrier frequency f_c as well as frequency deviations applied to the frequency multiplier n2=48 give final result as:

$$f_{c3}=n2* f_{c2}, \Delta f_2=n1*\Delta f_1$$

$$f_{c3}=90\text{MHz}, \Delta f_2=75\text{ kHz}$$

III THEORY OF FM

A signal which is proportional to real baseband signal (amplitude), information is used to change amplitude or its angle of the carrier

$$C(t)=A_c \cos\Theta_c(t)$$

$$\Theta_c(t)=2\pi fct + \alpha$$

Where,

A=amplitude of carrier

$\Theta_c(t)$=angle of the carrier

α= phase of carrier

Angle modulation is characterized into two modulation:

1. Phase modulation
2. Frequency modulation

But our primary focus is on frequency modulation.

Frequency modulation: - The instantaneous frequency is vary linearly with the modulating signal about an un-modulated frequency or we can say that, instantaneous value of angular frequency is equal to sum of frequency of un-modulated carrier and time varying component.

IV DERIVATION FOR VOLTAGE EQUATION OF FM

Assume a voltage control oscillator i.e. VCO having frequency f_c , and the input voltage is $V_m(t)$.

$$V = A_c \cos \Theta_c(t) \quad (1)$$

$$f1 = f_c + \Delta f \quad (2)$$

$$\Delta f = ka * V_m(t)$$

Above equation are the outputs of VCO.

Where,

f= overall frequency of frequency modulated output.

$$W_1 = d\Theta_c(t)/dt = 2\pi f1 \quad (3)$$

From equation (1) take the value of $\Theta_c(t)$ and differentiate it w.r.t velocity of output and put in equal to $2\pi f1$.

$$d\Theta_c(t)/dt = 2\pi f_c + 2\pi\Delta f \quad (4)$$

$$d\Theta_c(t) = 2\pi f_c \, dt + 2\pi\Delta f \, dt \quad (5)$$

Taking the integration of above equation,

$$\Theta_c(t) = 2\pi f_c \int dt + 2\pi ka \int V_m(t)\, dt \quad (6)$$

$$V(t) = V_{peak} \cos(2\pi f_m t) \quad (7)$$

$$d\Theta_c(t) = 2\pi f_c t + 2\pi ka / 2\pi f_m \sin(2\pi f_m t) \quad (8)$$

Now, from equations (1), (6), (7) we get

$$\Theta_c(t) = 2\pi f_c t + ka/fm \; V_{peak} \sin(2\pi f_m t)$$

$$m_f = 2\pi * V_{peak} / f_m$$

$$V = A_c \cos \Theta_c(t)$$

$$V = A_c \cos(2\pi f_c t + ka / f_m \; V_{peak} \sin(2\pi f_m t))$$

This equation is called as voltage equation of FM.

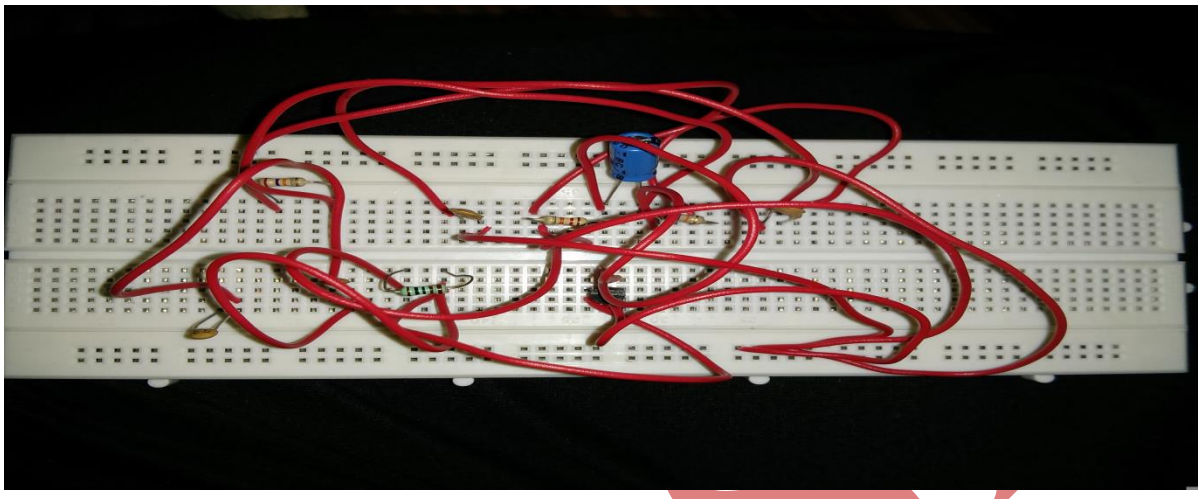

Fig. 2 Implementing the Components for FM Transmitter On Breadboard

V CONCLUSION

We can conclude that, FM is widely used because of several advantages of frequency modulation. Earlier FM was not commonly used because of lack of understand of how to benefit from FM and thus radio communications was used. As soon as the benefits of FM come into existence, its use grew up.

There are many advantages and also disadvantages of FM. Inspite of having disadvantages , it is suitable for many applications and also other modes may be more suited to other applications. In order to enable the choice of the best modulation format to be made, it is required to understand the disadvantages and advantages of FM.

5.1 Advantages

There are many advantages of frequency modulation because of which it has been widely used for many years and have a best future use for many years. Some of the advantages are as listed :

- ✓ One of the main advantages of frequency modulation is its immunity to noise, hence it is widely used with the broadcasting industries. Noise is a short amplitude variations caused by motors, auto-ignitions, power transients etc.
- ✓ Another advantage of it is the capture effect which permits the strongest signal on frequency to dominate without any interference from other signals. It has greater transmitter efficiency as class C amplifier can be used.

5.2 Disadvantages

There are number of disadvantages of using the frequency modulation. Some of them can be overcome quiet easily but some of them indicate that another modulation format is more suitable.

- ✓ Bandwidth for the FM is comparatively wide. The spectrum space taken by the frequency modulation can be limited simply by controlling the deviation ratio.
- ✓ Another minor dis-advantage of FM is that the demodulation is little complex and hence quiet expensive. Thus the low cost broadcasting market faces some issues.

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