WIRELESS AUDIO VIDEO TRANSMISSION

Submitted in partial fulfillment of the Degree of Bachelor of Technology

2nd June – 2012

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CERTIFICATE

This is to certify that the work titled "WIRELESS AUDIO VIDEO TRANSMISSION" submitted by "SAHIL KAPANI,RACHIT BANSAL,UJJWAL MEHRA" in partial fulfillment for the award of degree of B. Tech, of Jaypee University of Information Technology, Waknaghat has been carried out under my supervision. This work has not been submitted partially or wholly to any other University or Institute for the award of this or any other degree or diploma.

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We are equally indebted to all the staff members of Electronics Department of our University. This project work has been greatly assisted by the cooperation of Project lab staff that provided full support and facilities. We have tried to produce the very best out of our Endeavor.

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ABSTRACT

In this fast-paced world, there is little time for inconveniences and a greater need for portability and adaptability. The idea for an Audio/Video transmitter stems from this need. There may have been times when you've wanted to hook up your DVD from one room to another TV set in another room. But that would have entailed that you first unhook all kinds of wires and plugs from the primary LCD set; carry the DVD to the next LCD set; and then finally re-wire everything together. A WIRELESS AUDIO/VIDEO TRANSMITTER will let you do all the things with convenience .

The most difficult part of this project is coming up with a design that would work. The approach we took, is to first create a audio transmitter and receiver through FM and then video transmitter and receiver using AM. Then mixing both signals and send it using RF waves.This way we could test each component individually and then integrate them later when we know both parts are working correctly. We first research various transmitters designs and how they were built. Although all the books were very old, we were able to get certain basic concepts. Most of the books had only information about sending audio transmission and had very little on video signal transmissions. This is not too far from what our original intentions were on building two different types of transmitters.

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CHAPTER 1

INTRODUCTION

1.1 Basic Concepts

In this chapter the fundamentals of the wireless transmission will be discussed. In this mobile world most of the devices are running wirelessly. For wireless transmission we need air as medium. Wireless communication actually involves combining two different forms of electrical energy: one to store the information and one to carry the information. Basics of wireless in our project involve transmitter, receiver, analog signals, analog modulation technique and RF as transmission waves.

1.1.1Transmitters and Receivers

Electrical energy moves from place to place in one of two ways. It either flows as current along a conductor (a bunch of electrons moving down a metal wire), or it travels in the air as invisible waves. In a typical wireless system ,the electrical energy starts out as current flowing along a conductor, gets changed into waves traveling in the air, and then gets changed back into current flowing along a conductor again (see Figure 1.1).

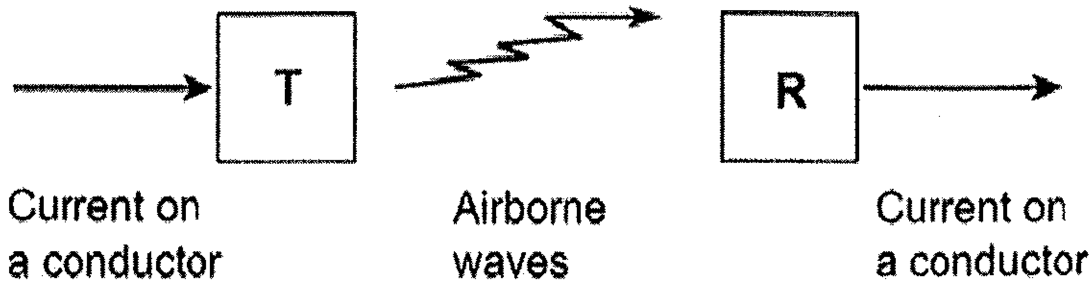

Figure 1.1 - Block Diagram of a Generic Wireless System

In Figure 1.1, the electrical signal flows as current along a conductor (from the left) into the box marked "T." Inside box T, a bunch of stuff happens and out comes essentially the same electrical signal—only this time it is traveling through the air. Box T is known as the *transmitter*. It turns electrical current into airborne waves. Now traveling at the speed of light, the airborne signal reaches the box marked "R." Inside of the box marked R, some more stuff happens and out pops, you guessed it, the same electrical signal as current flowing along a conductor. Box R is known as the *receiver*. It turns airborne waves into electrical current.

1.1.2 Analog Signals

An **analog** or **analogue signal** is any continuous signal for which the time varying feature (variable) of the signal is a representation of some other time varying quantity, i.e., analogous to another time varying signal. It differs from a digital signal in terms of small fluctuations in the signal which are meaningful. Analog is usually thought of in an electrical context; however, mechanical, pneumatic, hydraulic, and other systems may also convey analog signals .An analog signal uses some property of the medium to convey the signal's information. For example, an aneroid barometer uses rotary position as the signal to convey pressure information. Electrically, the property most commonly used is voltage followed closely by frequency, current, and charge.

Any information may be conveyed by an analog signal; often such a signal is a measured response to changes in physical phenomena, such as sound, light, temperature, position, or pressure, and is achieved using a transducer. An analog signal is one where at each point in time the value of the signal is significant, whereas a digital signal is one where at each point in time, the value of the signal must be above or below some discrete threshold.For example, in sound recording, fluctuations in air pressure (that is to say, sound) strike the diaphragm of a microphone which induces corresponding fluctuations in the current produced by a coil in an electromagnetic microphone, or the voltage produced by a condensor microphone. The voltage or the current is said to be an "analog" of the sound.

An analog signal has a theoretically infinite resolution. In practice an analog signal is subject to electronic noise and a finite slew rate. Therefore, both analog and digital systems are subject to limitations in resolution and bandwidth. As analog systems become more complex, effects such as non-linearity and noise ultimately degrade analog resolution to such an extent that the performance of digital systems may surpass it. Similarly, as digital systems become more complex, errors can occur in the digital data stream. A comparable performing digital system is more complex and requires more bandwidth than its analog counterpart. In analog systems, it is difficult to detect when such degradation occurs. However, in digital systems, degradation can not only be detected but corrected as well.

The process of combining information signals on top of carrier signals is called *modulation*. When an information signal is combined with a carrier signal the result is known as **wireless communications**.

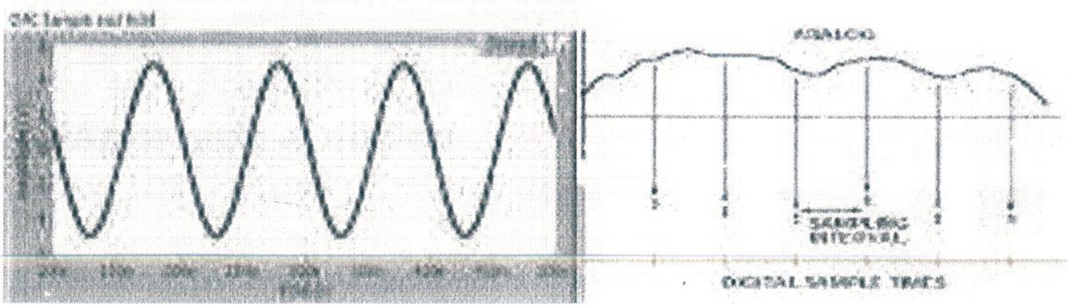

Figure 1.2 - Analog Signals

1.1.3 Analog Modulation Technique

In electronics and telecommunications, **modulation** is the process of varying one or more properties of a high-frequency periodic waveform, called the *carrier signal*, with a *modulating signal* which typically contains information to be transmitted. This is done in a similar fashion to a musician modulating a tone (a periodic waveform) from a musical instrument by varying its volume, timing and pitch. The three key parameters of a periodic waveform are its amplitude ("volume"), its phase ("timing") and its frequency ("pitch"). Any of these properties can be modified in accordance with a low frequency signal to obtain the modulated signal. Typically a high-frequency sinusoid waveform is used as carrier signal, but a square wave pulse train may also be used. Modulation is used to reduce antenna size, effective noise, and the sending data size

In telecommunications, modulation is the process of conveying a message signal, for example a digital bit stream or an analog audio signal, inside another signal that can be physically transmitted. Modulation of a sine waveform is used to transform a baseband message signal into a passband signal, for example low-frequency audio signal into a radio-frequency signal (RF signal). In radio communications, cable TV systems or the public switched telephone network for instance, electrical signals can only be transferred over a limited passband frequency spectrum, with specific (non-zero) lower and upper cutoff frequencies. Modulating a sine-wave carrier makes it possible to keep the frequency content of the transferred signal as close as possible to the centre frequency (typically the carrier frequency) of the passband.

1.2 Advantages of wireless

The following are the advantages of wireless communication:-

Mobility of devices

Less operational cost

flexible

No planning

(almost) no wiring difficulties (e.g. historic buildings, firewalls)

more robust against disasters like, e.g., earthquakes, fire - or users pulling a plug.

CHAPTER 2

AMPLITUDE MODULATION

2.1 Introduction

Amplitude modulation (AM) is a technique used in electronic communication, most commonly for transmitting information via a radio carrier wave. AM works by varying the strength of the transmitted signal in relation to the information being sent. For example, changes in signal strength may be used to specify the sounds to be reproduced by a loudspeaker, or the light intensity of television pixels. Contrast this with frequency modulation, in which thefrequency is varied, and phase modulation, in which the phase is varied.

In the mid-1870s, a form of amplitude modulation—initially called "undulatory currents"—was the first method to successfully produce quality audio over telephone lines. Beginning with Reginald Fessenden's audio demonstrations in 1906, it was also the original method used for audio radio transmissions, and remains in use today by many forms of communication—"AM" is often used to refer to the medium wave broadcast band

2.2 Forms of Amplitude Modulation

In radio communication, a continuous wave radio-frequency signal (a sinusoidal carrier wave) has its amplitude modulated by an audio waveform before transmission. The audio waveform modifies the amplitude of the carrier wave and determines the *envelope* of the waveform. In the frequency domain, amplitude modulation produces a signal with power concentrated at the carrier frequency and two adjacent sidebands. Each sideband is equal in bandwidth to that of the modulating signal, and is a mirror image of the other. Amplitude modulation resulting in two sidebands and a carrier is called "double-sideband amplitude modulation" (DSB-AM). Amplitude modulation is inefficient in power usage; at least two-thirds of the power is concentrated in the carrier signal, which carries no useful information (beyond the fact that a signal is present).

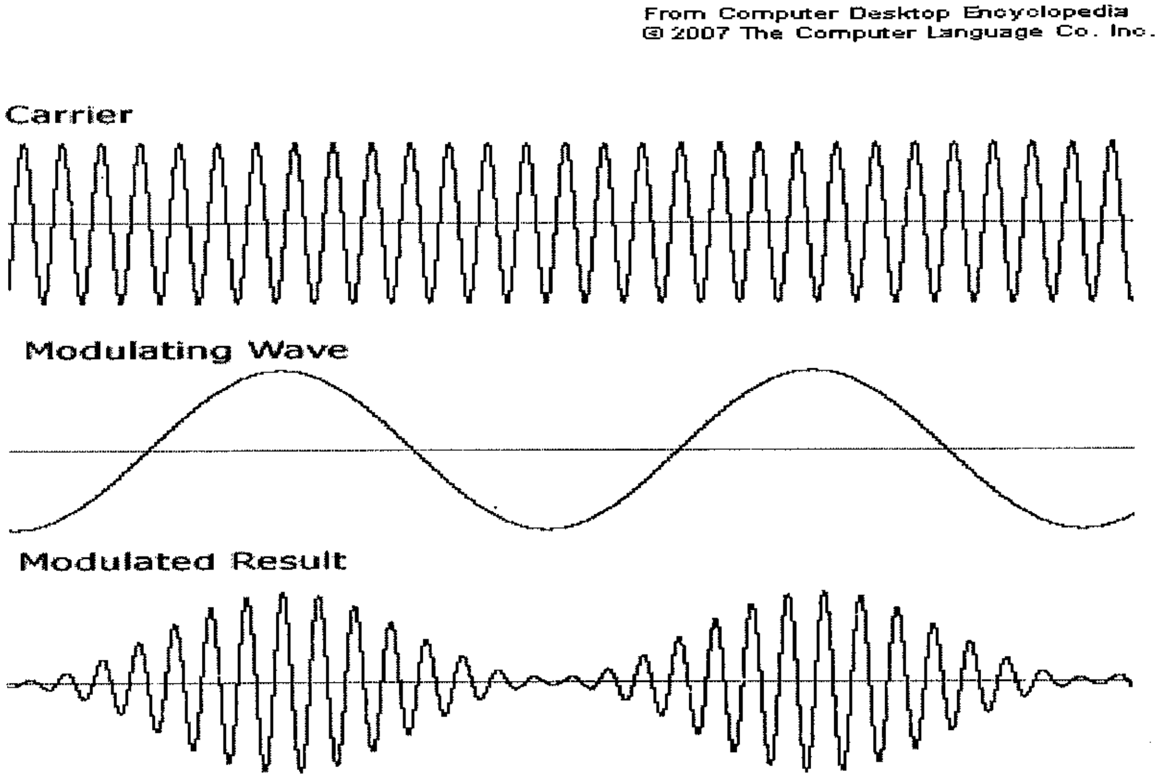

Figure 2.1- Amplitude modulated waveform

To increase transmitter efficiency, the carrier may be suppressed. This produces a reduced-carrier transmission, or DSB "double-sideband suppressed-carrier" (DSB-SC) signal. A suppressed-carrier AM signal is three times more power-efficient than AM. If the carrier is only partially suppressed, a double-sideband reduced-carrier (DSBRC) signal results. For reception, a local oscillator will typically restore the suppressed carrier so the signal can be demodulated with a product detector.

Improved bandwidth efficiency is achieved at the expense of increased transmitter and receiver complexity by completely suppressing both the carrier and one of the sidebands. This is single-sideband modulation, widely used in amateur radio and other communications applications. A simple form of AM, often used for digital communications, is on-off keying: a type of *amplitude-shift keying* in which binary data is represented by the presence or absence of a carrier. This is used by radio amateurs to transmit Morse code and is known as continuous wave (CW) operation.

2.2.1 Double Sideband AM

A carrier wave is modeled as a sine wave:

$$c(t) = A \cdot \sin(\omega_c t + \phi_c),$$

in which the frequency in Hz is given by: $\omega_c/(2\pi)$.

The constants A and ϕ_c represent the carrier amplitude and initial phase, and are introduced for generality. For simplicity, their respective values can be set to 1 and 0.

Let $m(t)$ represent an arbitrary waveform that is the message to be transmitted, and let the constant M represent its largest magnitude:

$$m(t) = M \cdot \cos(\omega_m t + \phi).$$

The message might be just a simple audio tone of frequency:

$$\omega_m/(2\pi).$$

It is assumed that $\omega_m \ll \omega_c$ and that

$$\min[m(t)] = -M.$$

Amplitude modulation is formed by the product:

$$y(t) = [1 + m(t)] \cdot c(t),$$
$$= A.[1 + M \cdot \cos(\omega_m t + \phi)] \cdot \sin(\omega_c t).$$

A represents the carrier amplitude, which is a constant that demonstrates the modulation index. The values A=1 and M=0.5 produce $y(t)$, depicted by the top graph (labelled "50% Modulation") in Figure .In this example, $y(t)$ can be trigonometrically manipulated into the following (equivalent) form:

$$y(t) = A \cdot \sin(\omega_c t) + \frac{AM}{2}\left[\sin((\omega_c + \omega_m)t + \phi) + \sin((\omega_c - \omega_m)t - \phi)\right].$$

Therefore, the modulated signal has three components: a carrier wave and two sinusoidal waves (known as sidebands), whose frequencies are slightly above and below ω_c.

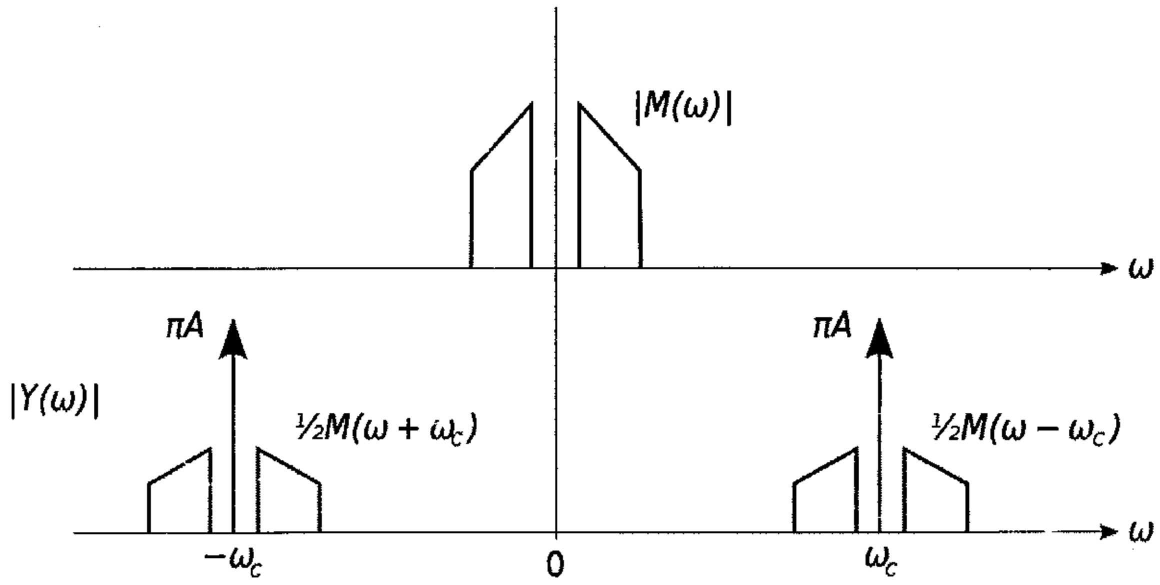

Figure 2.2 - Double-sided spectra of AM signal

2.2.1.1 Spectrum

For more general forms of *m(t)*, trigonometry is not sufficient; however, if the top trace of Figure depicts the frequency of *m(t)* the bottom trace depicts the modulated carrier. It has two components: one at a positive frequency (centered on $+\omega_c$) and one at a negative frequency(centered on $-\omega_c$). Each component contains the two sidebands and a narrow segment in between, representing energy at the carrier frequency. Since the negative frequency is a mathematical artifact, examining the positive frequency demonstrates that an AM signal's spectrum consists of its original (two-sided) spectrum, shifted to the carrier frequency. Figure is a result of computing the Fourier Transform of: $[A + m(t)] \cdot \sin(\omega_c t)$, using the following transform pairs:

$$
\begin{aligned}
m(t) &\overset{\mathcal{F}}{\Longleftrightarrow} M(\omega) \\
\sin(\omega_c t) &\overset{\mathcal{F}}{\Longleftrightarrow} i\pi \cdot [\delta(\omega + \omega_c) - \delta(\omega - \omega_c)] \\
A \cdot \sin(\omega_c t) &\overset{\mathcal{F}}{\Longleftrightarrow} i\pi A \cdot [\delta(\omega + \omega_c) - \delta(\omega - \omega_c)] \\
m(t) \cdot A\sin(\omega_c t) &\overset{\mathcal{F}}{\Longleftrightarrow} \frac{A}{2\pi} \cdot \{M(\omega)\} * \{i\pi \cdot [\delta(\omega + \omega_c) - \delta(\omega - \omega_c)]\} \\
&= \frac{iA}{2} \cdot [M(\omega + \omega_c) - M(\omega - \omega_c)]
\end{aligned}
$$

2.2.1.2 Power and spectrum efficiency

In terms of positive frequencies, the transmission bandwidth of AM is twice the signal's original (baseband) bandwidth; both the positive and negative sidebands are shifted up to the carrier frequency. Thus, double-sideband AM (DSB-AM) is spectrally inefficient since fewer radio stations can be accommodated in a given broadcast band. The suppression methods described above may be understood in terms of Figure . With the carrier suppressed, there would be no energy at the center of a group; with a sideband suppressed, the "group" would have the same bandwidth as the positive frequencies of $M(\omega)$. The transmitter-power efficiency of DSB-AM is relatively poor (about 33 percent). The benefit of this system is that receivers are cheaper to produce. Suppressed-carrier AM is 100 percent power-efficient, since no power is wasted on the carrier signal (which conveys no information).

2.2.2 Modulation Index

The AM modulation index is the measure of the amplitude variation surrounding an unmodulated carrier. As with other modulation indices, in AM this quantity (also called "modulation depth") indicates how much the modulation varies around its "original" level. For AM, it relates to variations in carrier amplitude and is defined as:

$$h = \frac{\text{peak value of } m(t)}{A} = \frac{M}{A},$$

where M and A are the message amplitude and carrier amplitude, respectively.

So if $h = 0.5$, carrier amplitude varies by 50% above (and below) its unmodulated level; for $h = 1.0$, it varies by 100%. To avoid distortion, modulation depth must not exceed 100 percent. Transmitter systems will usually incorporate a limiter circuit (such as a VOGAD) to ensure this. However, AM demodulators can be designed to detect the inversion (or 180-degree phase reversal) that occurs when modulation exceeds 100 percent; they automatically correct for this defect. Variations of a modulated signal with percentages of modulation are shown below. In each image, the maximum amplitude is higher than in the previous image (note that the scale changes from one image to the next).

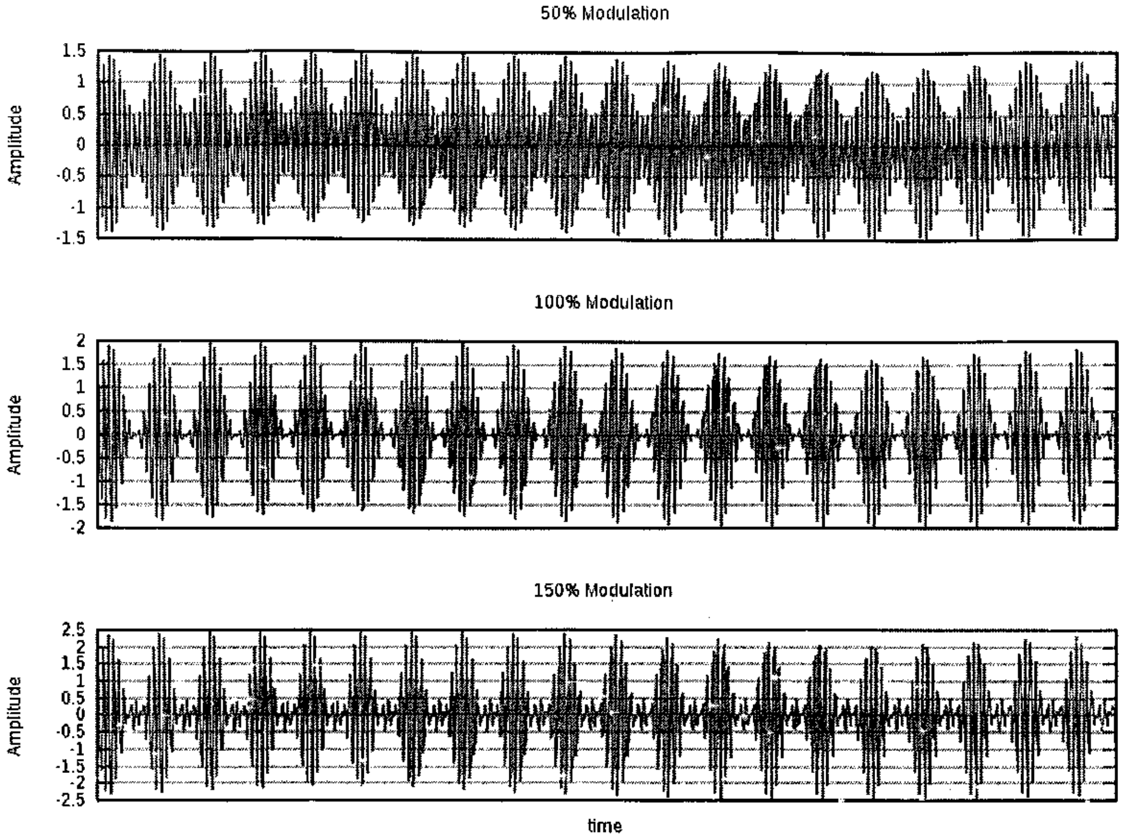

Figure 2.3 - Modulation Depth

2.3 Modulation Methods

Modulation circuit designs may be classified as low- or high-level (depending on whether they modulate in a low-power domain—followed by amplification for transmission—or in the high-power domain of the transmitted signal).

Low-level generation

In modern radio systems, modulated signals are generated via digital signal processing (DSP). With DSP many types of AM modulation are possible with software control (including DSB with carrier, SSB suppressed-carrier and independent sideband, or

ISB). Calculated digital samples are converted to voltages with a digital to analog converter, typically at a frequency less than the desired RF-output frequency. The analog signal must then be shifted in frequency, and linearly amplified to the desired frequency and power level (linear amplification must be used to prevent modulation distortion).This low-level method for AM is used in many Amateur Radio transceivers.

AM may also be generated at a low level, using analog methods described in the next section.

High-level generation

High-power AM transmitters (such as those used for AM broadcasting) are based on high-efficiency class-D and class-E power amplifier stages, modulated by varying the supply voltage.

Older designs (for broadcast and amateur radio) also generate AM by controlling the transmitter's final amplifier (generally a class-C, for efficiency) gain. The following types are for vacuum tube transmitters (but similar options are available with transistors)

- **Plate modulation:** In plate modulation, the plate voltage of the RF amplifier is modulated with the audio signal. The audio power requirement is 50 percent of the RF-carrier power.
- **Heising (constant-current) modulation:** RF amplifier plate voltage is fed through a "choke" (high-value inductor). The AM modulation tube plate is fed through the same inductor, so the modulator tube diverts current from the RF amplifier. The choke acts as a constant current source in the audio range. This system has a low power efficiency.
- **Control grid modulation:** The operating bias and gain of the final RF amplifier can be controlled by varying the voltage of the control grid. This method requires little audio power, but care must be taken to reduce distortion.
- **Clamp tube (screen grid) modulation:** The screen-grid bias may be controlled through a "clamp tube", which reduces voltage according to the modulation signal. It is difficult to approach 100-percent modulation while maintaining low distortion with this system.

CHAPTER 3

FREQUENCY MODULATION

3.1 Introduction

This chapter will introduce the student to the other forms of analog modulation—frequency modulation (FM) and phase modulation (PM)-both of which are commonly known as angle modulation. Both FM and PM are used extensively in communications systems. FM is used in radio broadcasting, for the transmission of the sound signal in standard (NTSC) TV, for private land-mobile radio systems, for direct-satellite broadcasting, and for cordless and cellular telephone systems, just to name a few common applications. PM by itself and in combination with AM is used extensively in modern data-communications systems. Angle modulation has a very important advantage over AM in its ability to provide increased immunity to noise. Angle-modulation systems typically require a larger bandwidth than AM systems, a necessary trade-off for its improved resistance to noise.

Topics covered in this chapter will include:

1.Theory of FM operation

2. Frequency deviation

3.Modulation index

4. Theory of PM operation

5. A comparison of FM and PM

6.Bessel functions

7.The spectrum of an angle-modulated signal

8.Signal bandwidth

9.Sideband power relations

10. Noise effects on FM

An Introduction to the Development of FM

This chapter will introduce the reader to the second analog form of modulation. This type of modulation scheme is known as angle modulation. Angle modulation can be further subdivided into two distinct types:

Frequency modulation (FM) and Phase modulation (PM).

The history and evolution of angle modulation basically revolves around one man, Major Edwin Armstrong. Armstrong, a radio pioneer who invented first the regenerative and then the superheterodyne receiver in the 1910s, worked on the principles of frequency and phase modulation starting in the 1920s. It was not until the 1930s, however, that he finally completed work on a practical technique for wideband frequencymodulation broadcasting. For further information, visit a Web site devoted to Armstrong's work As a historical footnote, it should be pointed out that at the turn of the last century, the very early Paulson arc transmitter actually used the simplest form of FM, frequency-shift keying (FSK), to transmit a wireless telegraph signal. With this type of wireless transmitter, a continuous electrical arc would have its fundamental output frequency altered by closing a telegraph key. When the key was closed, it would short out several turns of a tuning inductor, thus changing the transmitter output frequency. For this reason it was a form of FSK.

Despite Armstrong's efforts, the implementation of FM broadcasting was fought by RCA and NBC through 1945, only becoming popular in the United States during the late 1960s and early 1970s when technological advances reduced the cost of equipment and improved the quality of service. Many public-safety departments were early adopters of FM for their fleet communications. AMPS cellular-telephone service, an FM-based system, was introduced in the United States in 1983. Today FM is used for the legacy FM broadcast band, standard TV-broadcasting sound transmission, direct-satellite TV service, cordless telephones, and just about every type of business band and mobile-radio service. FM is capable of much more noise immunity than AM, and is now the most popular form of analog modulation.

3.2 Frequency Modulation

Frequency-Modulation Theory

We will start our discussion of angle modulation by first examining frequency modulation. The classic definition of FM is that the instantaneous output frequency of a transmitter is varied in accordance with the modulating signal. Recall that we can write an equation for a sine wave as follows:

$$e(t) = EP\sin(\omega t + \varphi) \quad 4.1$$

While amplitude modulation is achieved by varying EP , frequency modulation is realized by varying ω in accordance with the modulating signal or message. Notice that one can also vary φ to obtain another form of angle modulation known as phase modulation (PM). Later we will examine the relationship between FM and PM. See Figure for a time display of a typical FM signal.

An important concept in the understanding of FM is that of frequency deviation. The amount of frequency deviation a signal experiences is a measure of the change in transmitter output frequency from the rest frequency of the transmitter. The rest frequency of a transmitter is defined as the output frequency with no modulating signal applied. For a transmitter with linear modulation characteristics, the frequency deviation of the carrier is directly proportional to the amplitude of the applied modulating signal. Thus an FM transmitter is said to have a modulation sensitivity, represented by a constant, kf , of so many kHz/V,

$$kf = \text{frequency deviation}/V = kf kHz/V$$

For a single modulating tone of $eM(t) = eM \sin(\omega Mt)$, the amount of frequency deviation is given by

$$\delta(t) = kf \times eM(t)$$

where δ(t) is the instantaneous frequency deviation and eM(t) represents the modulating signal. The peak deviation is given by

$$\delta = kf \times EM \quad 4.2$$

where both δ and EM are peak values.

FM versus PM

Let us return to equation 4.1, repeated here:

$$e(t) = EPsin(\omega t + \varphi)$$

As previously mentioned, it is possible to vary both ω (FM) and φ (PM) in the above equation. Each term is part of the argument of the sine wave. So, what is the difference between varying one versus the other? A simple answer is that there is no difference, as either one will change the sine wave's frequency. However, closer inspection and the employment of more mathematical rigor reveal that there are some subtle differences between the two.

Due to the complex mathematics involved these differences will not be discussed here. Practically speaking, it is possible to obtain FM from PM, but most present-day FM systems do not generate FM by this method. This process of generating FM is known as indirect FM. If we compare the two forms of modulation in the time domain, we would observe that the FM waveand PM wave appear quite similar; however, their timing appears to be out of sync. Indeed, the FM wave has its maximum frequency deviation during the peaks of the input signal, while the PM wave has its maximum frequency deviation during zero crossings of the input signal. Without showing the phase relationship of the input wave to the modulated wave, it would be impossible to tell the difference between the two forms of angle modulation if one simlpy looked at the resulting modulated waveform.

3.3 The Subtle Difference between FM and PM

One way to tell the difference between FM and PM is to observe the following: If the instantaneous frequency of the signal is directly proportional to the amplitude of the input signal, it is FM. On the other hand, if the instantaneous phase of the signal is proportional to the amplitude of the
input signal, it is PM. This last statement, although correct, is unclear because the term instantaneous phase is undefined at present. Another way of expressing this last statement is to say that for PM, the transmitter output frequency is at the rest frequency when the input signal is at either its most positive or most negative voltage. The subtle difference between FM and PM is not really very important, for the vast majority of wireless angle

modulation transmitters use FM. That being the case, our comments will focus almost entirely on FM from this point on.

Mathematical Analysis of FM

As was done with AM, a mathematical analysis of a high-frequency sine wave, modulated by a single tone or frequency, will be used to yield information about the frequency components in an FM wave, FM power relations, and the bandwidth of an FM signal.

From the definition of frequency deviation, an equation can be written for the signal frequency of an FM wave as a function of time:

fsignal= fC+ kfeM(t) = fC+ kf

EM sinωMt 4.3 and substitution of δ = k

f× EM yields:fsignal= fC+ δ sinωMt

But what does this equation indicate? It seems to be saying that the frequency of the transmitter is varying with time. This brings up the same type of problem that was observed when we looked at a time display of AM and then performed a mathematical analysis in an attempt to determine its frequency content. With AM, the signal appeared to be a sine wave that's amplitude was changing with time. At the time, it was pointed out that asine wave, by definition, has a constant peak amplitude, and thus cannot have a peak amplitude that varies with time. What about the sine wave's frequency? It also must be a constant and cannot be varying with time. As was the case with AM, where it turned out that our modulated wave was actually the vector sum of three sine waves, a similar situation is true for FM. An FM wave will consist of three or more frequency components vectorially added together to give the appearance of a sine wave that's frequency is varying with time when displayed in the time domain. A somewhat complex mathematical analysis will yield an equation for the instantaneous voltage of an FM wave of the form shown here:

eFM(t) = ECsin(ωCt + mfsinωMt) 4.5

where EC is the rest-frequency peak amplitude, ωC and ωM represent the rest and modulating frequencies, and mf is the index of modulation. This equation represents a single low-frequency sine wave, fM, frequency modulating another high-frequency sine wave, fC. Note that this equation indicates that the argument of the sine wave is itself a sine wave.

3.4 Modulation index

As in other modulation indices, this quantity indicates by how much the modulated variable varies around its unmodulated level. It relates to variations in the carrier frequency:

$$h = \frac{\Delta f}{f_m} = \frac{f_\Delta |x_m(t)|}{f_m}$$

where $f_m$is the highest frequency component present in the modulating signal $x_m(t)$, and $\Delta f$is the peak frequency-deviation—i.e. the maximum deviation of the instantaneous frequency from the carrier frequency. If $h \ll 1$, the modulation is called *narrowband FM,* and its bandwidth is approximately $2f_m$.

If $h \gg 1$, the modulation is called *wideband FM* and its bandwidth is approximately $2f_\Delta$. While wideband FM uses more bandwidth, it can improve the signal- to noise ratio significantly; for example, doubling the value of Δf, while keeping $f_m$constant, results in an eight-fold improvement in the signal-to-noise ratio. (Compare this with Chirp spread spectrum, which uses extremely wide frequency deviations to achieve processing gains comparable to traditional, better-known spread-spectrum modes).

With a tone-modulated FM wave, if the modulation frequency is held constant and the modulation index is increased, the (non-negligible) bandwidth of the FM signal increases but the spacing between spectra remains the same; some spectral components decrease in strength as others increase. If the frequency deviation is held constant and the modulation frequency increased, the spacing between spectra increases.

Frequency modulation can be classified as narrowband if the change in the carrier frequency is about the same as the signal frequency, or as wideband if the change in the carrier frequency is much higher (modulation index >1) than the signal frequency. For example, narrowband FM is used for two wave radio systems such as Family Radio Service, in which the carrier is allowed to deviate only 2.5 kHz above and below the center frequency with speech signals of no more than 3.5 kHz bandwidth. Wideband FM is used for FM broadcasting, in which music and speech are transmitted with up to 75 kHz deviation from the center frequency and carry audio with up to a 20-kHz bandwidth.

3.5 Carson's rule

A rule of thumb, *Carson's rule* states that nearly all (~98 percent) of the power of a frequency-modulated signal lies within a bandwidth B_T of:

$$B_T = 2(\Delta f + f_m)$$

where Δf, as defined above, is the peak deviation of the instantaneous frequency $f(t)$ from the center carrier frequency f_c.

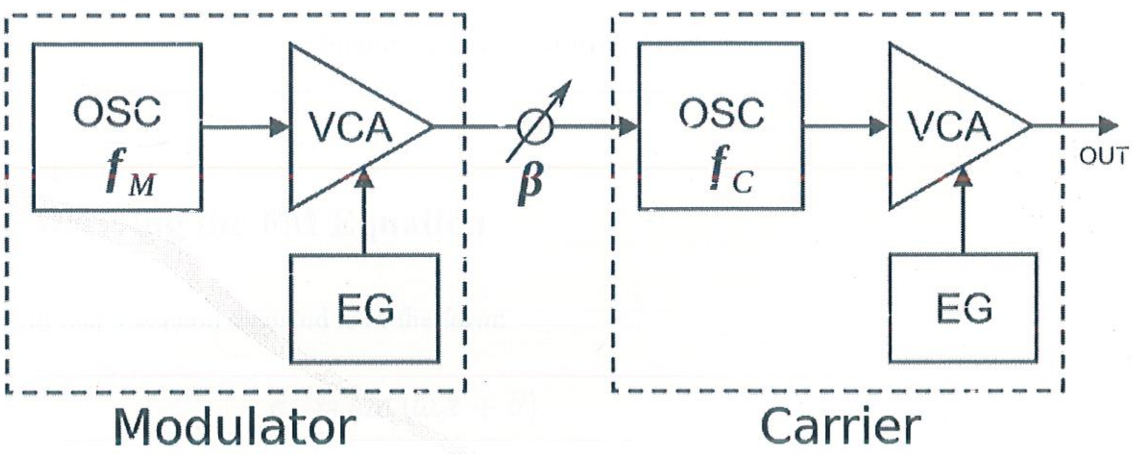

Figure 3.1 - Block Diagram

A 220 Hz carrier tone f_c modulated by a 440 Hz modulating tone f_m, with various choices of modulation index, β. The time domain signals are illustrated above, and the corresponding spectra are shown below (spectrum amplitudes in db).

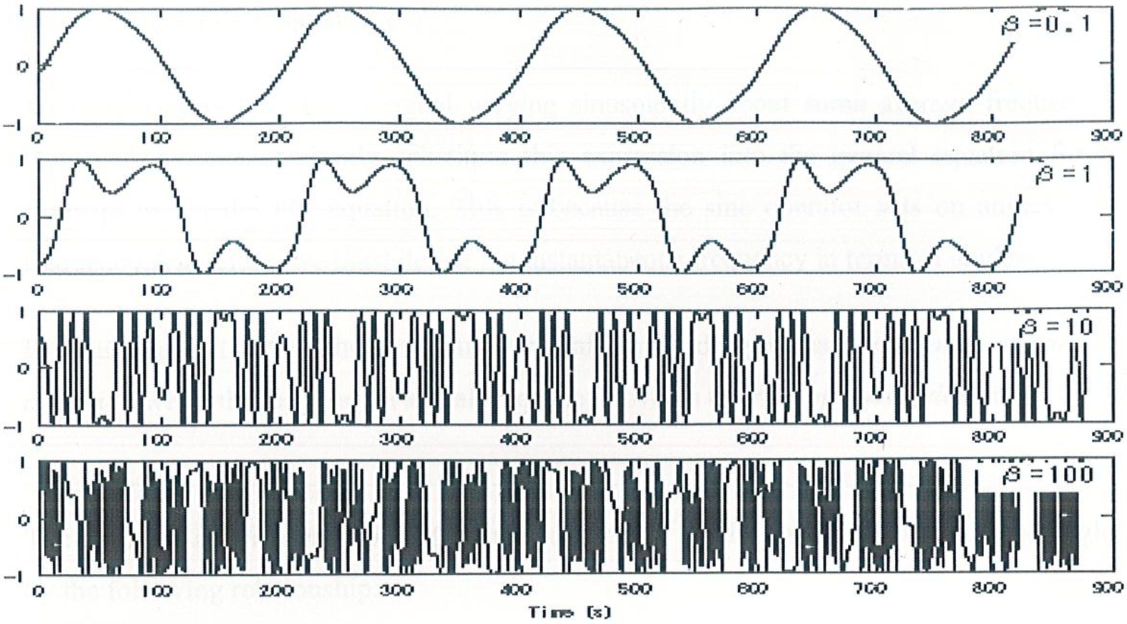

Figure 3.2 - Waveforms for each β

3.6 Deriving the FM Equation

Recall that a general sinusoid is of the form:

$$e_c = \sin(\omega_c t + \theta)$$

Frequency modulation involves deviating a carrier frequency by some amount. If a sine wave is used to deviate the carrier, the expression for the frequency at any instant would be:

$$\omega_i = \omega_c + \Delta\omega \sin(\omega_m t)$$

where:

ω_i =instantaneous frequency

ω_c =carrier frequency

$\Delta\omega$ =carrier deviation

ω_m =modulation frequency

This expression describes a signal varying sinusoidally about some average frequency. However, we cannot simply substitute this expression into the general equation for a sinusoid to get the FM equation. This is because the sine operator acts on angles, not frequency. Therefore, we must define the instantaneous frequency in terms of angles.

It should be noted that the modulation signal amplitude governs the *amount of carrier deviation* while the modulation signal frequency governs the *rate of carrier deviation*.

The term $\omega$is an *angular velocity* (radians per second) and is related to frequency and angle by the following relationship:

$$\omega = 2\pi f = \frac{d\theta}{dt}$$

To find the angle, we must integrate $\omega$with respect to time:

$$\int \omega dt = \theta$$

We can now find the instantaneous angle associated with the instantaneous frequency:

$$\theta = \int \omega_i dt = \int (\omega_c + \Delta\omega \sin(\omega_m t))dt = \omega_c t - \frac{\Delta\omega}{\omega_m}\cos(\omega_m t) = \omega_c t - \frac{\Delta f}{f_m}\cos(\omega_m t)$$

This angle can now be substituted into the general carrier signal to define FM:

$$e_{fm} = \sin\left(\omega_c t - \frac{\Delta f}{f_m}\cos(\omega_m t)\right)$$

The *FM modulation index* is defined as the ratio of the carrier deviation to modulation frequency:

$$m_{fm} = \frac{\Delta f}{f_m}$$

Consequently, the FM equation is often written as:

$$e_{fm} = \sin\left(\omega_c t - m_{fm}\cos\left(\omega_m t\right)\right)$$

3.6.1 FM Transmission Power

The equation for the transmitted power in a sinusoid is a fundamental equation.Since the value of the amplitude of the sine wave in FM does not change, the transmitted power is a constant. As a general rule, for a sinusoid with a constant amplitude, the transmitted power can be found as follows:

$$P(t) = \frac{A^2}{2R_L}$$

Where A is the amplitude of the sine wave, and R_L is the resistance of the load. In a normalized system, we set R_L to 1.The Bessel coefficients can be used to determine the power in the carrier and any side frequency:

$$P_T = P_C\left(J_0^2 + 2\left(J_1^2 + J_2^2 + J_3^2 + \cdots\right)\right)$$

P_C is the power in the unmodulated carrier.

$P_T$is the total power and is by definition equal to the unmodulated carrier power.As the modulation index varies, the individual Bessel coefficients change and power is redistributed from the carrier to the side frequencies.

3.7 FM Transmitter

FM Transmitters can be easily implemented using a VCO (see why we discussed Voltage Controlled Oscillators, in the first section?), because a VCO converts an input voltage (our input signal) to a frequency (our modulated output).

Signal ----->|VCO|-----> FM Signal

3.8 FM Receiver

Any angle modulation receiver needs to have several components:

1. A limiter, to remove abnormal amplitude values
2. Bandpass filter, to separate the out-of-band noise.
3. A Discriminator, to change a frequency back to a voltage
4. A lowpass filter, to remove noise added by the discriminator.

A discriminator is essentially a differentiator in line with an envelope detector:

FM ---->|Differentiator|---->|Envelope Filter|----> Signal

Also, you can add in a blocking capacitor to remove any DC components of the signal, if needed.

CHAPTER 4

RADIO FREQUENCY WAVES

4.1 Introduction

Radio frequency (RF) is a rate of oscillation in the range of about 3 kHz to 300 GHz, which corresponds to the frequency of radio waves, and the alternating currents which carry radio signals. RF usually refers to electrical rather than mechanical oscillations, although mechanical RF systems do exist.

To begin, it is helpful to understand what are radio waves and how they move (propagate) from A to B. Since we all know a bit about water waves, they can serve as a beginning point. Consider a pebble dropped onto the calm surface of a pond. As the pebble breaks the tension of the water surface, it pushes aside (disturbs) the surface water around it, which then collapses back upon itself as the pebble sinks below. Because the surface tension acts as a sticky coupling between adjacent water molecules, any motion in one area will disturb nearby areas as well, and these will then disturb others beyond, and so forth, as illustrated in the 2-dimensional .

After the pebble breaks the surface, the disturbance propagates radially outward from the point of impact as a surface wave. This illustrates the fundamental definition of all wave motion:

For the propagation and interception of radio waves, a transmitter and receiver are employed. A radio wave acts as a carrier of information-bearing signals; the information may be encoded directly on the wave by periodically interrupting its transmission (as in dot-and-dash telegraphy) or impressed on it by a process called modulation. The actual information in a modulated signal is contained in its sidebands, or frequencies added to the carrier wave, rather than in the carrier wave itself. The two most common types of modulation used in radio are amplitude modulation (AM) and frequency modulation (FM). Frequency modulation minimizes noise and provides

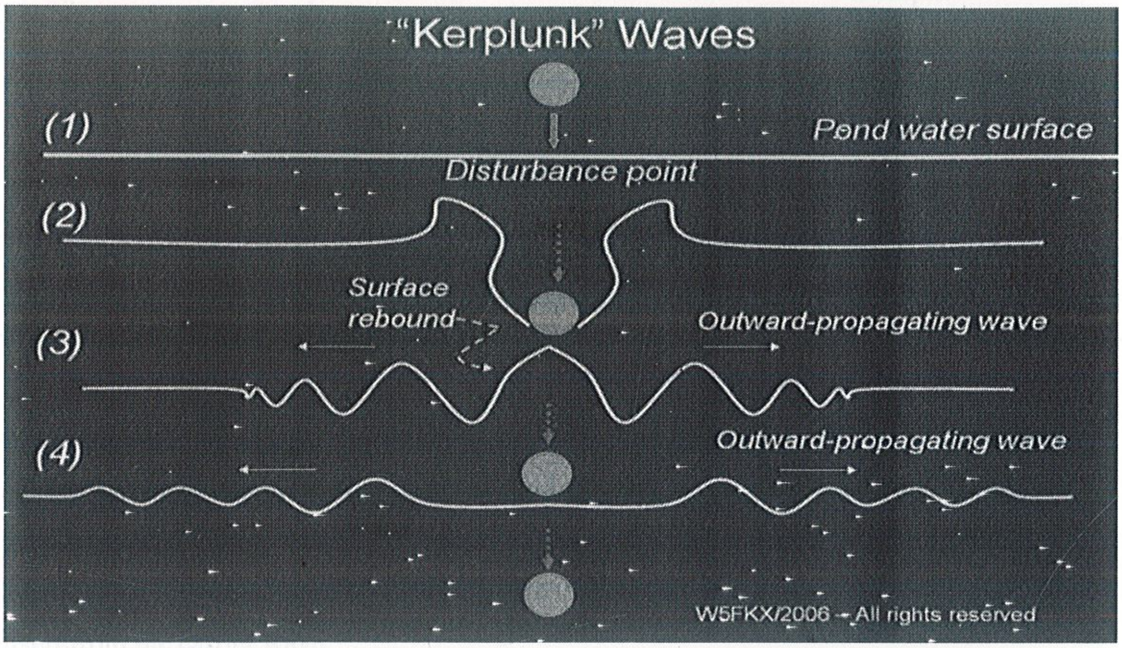

Figure 4.1 - Kerplunk Waves

greater fidelity than amplitude modulation, which is the older method of broadcasting. Both AM and FM are analog transmission systems, that is, they process sounds into continuously varying patterns of electrical signals which resemble sound waves. Digital radio uses a transmission system in which the signals propagate as discrete voltage pulses, that is, as patterns of numbers; before transmission, an analog audio signal is converted into a digital signal, which may be transmitted in the AM or FM frequency range. A digital radio broadcast offers compact-disc-quality reception and reproduction on the FM band and FM-quality reception and reproduction on the AM band.

In its most common form, radio is used for the transmission of sounds (voice and music) and pictures (television). The sounds and images are converted into electrical signals by a microphone (sounds) or video camera (images), amplified, and used to modulate a carrier wave that has been generated by an oscillator circuit in a transmitter. The modulated carrier is also amplified, then applied to an antenna that converts the electrical signals to electromagnetic waves for radiation into space. Such waves radiate at the speed of light and are transmitted not only by line of sight but also by deflection from the ionosphere.

Receiving antennas intercept part of this radiation, change it back to the form of electrical signals, and feed it to a receiver. The most efficient and most common circuit for radio-frequency selection and amplification used in radio receivers is the superheterodyne. In that system, incoming signals are mixed with a signal from a local oscillator to produce intermediate frequencies (IF) that are equal to the arithmetical sum and difference of the incoming and local frequencies. One of those frequencies is applied to an amplifier. Because the IF amplifier operates at a single frequency, namely the intermediate frequency, it can be built for optimum selectivity and gain. The tuning control on a radio receiver adjusts the local oscillator frequency. If the incoming signals are above the threshold of sensitivity of the receiver and if the receiver is tuned to the frequency of the signal, it will amplify the signal and feed it to circuits that demodulate it, i.e., separate the signal wave itself from the carrier wave.

There are certain differences between AM and FM receivers. In an AM transmission the carrier wave is constant in frequency and varies in amplitude (strength) according to the sounds present at the microphone; in FM the carrier is constant in amplitude and varies in frequency. Because the noise that affects radio signals is partly, but not completely, manifested in amplitude variations, wideband FM receivers are inherently less sensitive to noise. In an FM receiver, the limiter and discriminator stages are circuits that respond solely to changes in frequency. The other stages of the FM receiver are similar to those of the AM receiver but require more care in design and assembly to make full use of FM's advantages. FM is also used in television sound systems. In both radio and television receivers, once the basic signals have been separated from the carrier wave they are fed to a loudspeaker or a display device (usually a cathode-ray tube), where they are converted into sound and visual images, respectively.

4.2 Properties Of RF

Electric currents that oscillate at radio frequencies have special properties not shared by direct current or alternating current of lower frequencies. The energy in an RF current can radiate off a conductor into space as electromagnetic waves (radio waves); this is the basis of radio technology. RF current does not penetrate deeply into electrical conductors but flows along their surfaces; this is known as the skin effect. For this reason, when the human body comes in contact with high power RF currents it can cause superficial but serious burns called *RF burns*. RF current can easily ionize air, creating a conductive path through it. This property is exploited by "high frequency" units used in electric arc welding, which use currents at higher frequencies than power distribution uses. Another property is the ability to appear to flow through paths that contain insulating material, like the dielectric insulator of a capacitor. When conducted by an ordinary electric cable, RF current has a tendency to reflect from discontinuities in the cable such as connectors and travel back down the cable toward the source, causing a condition called standing waves, so RF current must be carried by specialized types of cable called transmission line.

4.3 Radio Communication

In order to receive radio signals an antenna must be used. However, since the antenna will pick up thousands of radio signals at a time, a radio tuner is necessary to *tune in* to a particular frequency (or frequency range). This is typically done via a resonator – in its simplest form, a circuit with a capacitor and an inductor forming a tuned circuit. The resonator amplifies oscillations within a particular frequency band, while reducing oscillations at other frequencies outside the band.

4.4 Frequency

Frequency	Wavelength	Designation	Abbreviation
3 - 30 Hz	10^5km-10^4km	Extremely low frequency	ELF
30 - 300 Hz	10^4km-10^3km	Super low frequency	SLF
300 - 3000 Hz	10^3km-100km	Ultra low frequency	ULF
3 - 30 kHz	100km-10km	Very low frequency	VLF
30 - 300 kHz	10km-1km	Low frequency	LF
300 kHz - 3 MHz	1km-100m	Medium frequency	MF
3 - 30 MHz	100m-10m	High frequency	HF
30 - 300 MHz	10m-1m	Very high frequency	VHF
300 MHz - 3 GHz	1m-10cm	Ultra high frequency	UHF

3 - 30 GHz	10cm-1cm	Super high frequency	SHF
30 - 300 GHz	1cm-1mm	Extremely high frequency	EHF

4.5 Radio Frequency Behaviour And Measurement

One of the key elements of managing a wireless LAN is understanding how radio frequency (RF) signals behave. Unlike signals that speed down a network cable with a minimum of outside interference, RF signals can be affected by the environment—walls, doors, street signs, and even the weather can have an impact on the signals. Understanding the unique

Frequency shift keying (FSK)

Phase shift keying (PSK)

4.5.1Radio Frequency Behavior and Measurement

May be reproduced without prior permission in writing from Course Technology. Some of the product names and company names have been used for identification purposes only and may be trademarks or registered trademarks of their respective manufactures and sellers. Behavior of RF signals and how this behavior can be measured is important for setting up and troubleshooting aWLAN.

4.6 RF Behavior

The behavior of an RF signal can be categorized by whether something adds power to the signal or takes power away from the signal. Known as gain and loss, these are now discussed in detail.

4.6.1 Gain

Gain is defined as the positive difference in amplitude between two signals. Gain is achieved by an **amplification** of the signal. Sometimes gain is used synonymously with amplification. However, gain is technically the measure of amplification. Gain can occur intentionally from an external power source that amplifies the signal, or unintentionally when an RF signal bounces off an object and combines with the original signal to amplify it.

4.6.2 Loss

Loss, also known as **attenuation**, is the negative difference in amplitude between signals. Like gain, loss can be either intentional or unintentional. Intentional lossmay be necessary to decrease the strength of the signal to comply with standards or to prevent it from interfering with other RF signals.More often, however, loss is unintentional. There are several factors that may result in RF
loss. These include:

■ *Absorption*—Certain types of materials can absorb the RF signal. This is known as **absorption**. The types of materials that will absorb an RF signal include concrete,wood, and asphalt.

■ *Reflection*—**Reflection** is the opposite of absorption. Instead of the signal being"soaked up," it is "bounced back." Reflection generally is caused by objects that are very large (in relation to the size of the **wavelength** of the signal, or the distance between successive amplitude peaks) and relatively smooth,such as walls,buildings, and the surface of the earth. Also, objects that are made out of metal will reflect a signal. These can include metal roofs, metal walls, and elevator shafts. A signal is generally weaker after it is reflected.

■ *Scattering*—Whereas reflection is caused by large and smooth objects, **scattering** is caused by small objects or rough surfaces. Objects that can cause scattering include foliage, rocks, and sand. Scattering can also occur when the RF signal comes in contact with elements in the air, such as rain or heavy dust particles.

■ *Refraction*—Over a long distance an RF signal may move through different atmospheric conditions. For example, it may start out in a relatively transparent condition, such as in bright sunshine, then go through a much denser condition, such as cold damp air. When an RF signal moves from one medium to another of a different density the signal actually bends instead of traveling in a straight line. This is known as **refraction**

.■ *Diffraction*—Unlike refraction, in which the medium through which the signal passes causes the RF signal to bend, **diffraction** is bending caused by an object in the path of the transmission.

■ *Voltage Standing Wave Ratio (VSWR)*—Unlike the previous examples in which external objects caused RF signal loss, **Voltage Standing Wave Ratio (VSWR)** is caused by the equipment itself. If one part of the equipment has different impedance than another part, the RF signal may be reflected back within the device itself. Not only does this cause a loss of signal strength, the reflected power can actually burn out the electronics of the device.

4.7 RF Measurement

Because RF signals can be affected by the environment, it is sometimes necessary to be able to calculate the gain or loss of the signal. For RF engineers the measurements must be very precise. For WLAN network managers, that same degree of precision is not always required; approximations can often be sufficient. However, gain and loss can be important when identifying WLAN transmission difficulties between mobile devices and the access point.

4.7.1 RF Math

RF power can be measured by two different units on two different scales. The first is on a linear scale using **milliwatts (mW)** or thousandths of a watt of power. Most linear scales have a reference that is fixed at zero, or the absence of what is being measured. The speedometer in a car is an example of a linear scale: when the needle is pointing to zero, the car is not moving.RF power (gain or loss) can be measured by the number of mWs that are being transmitted. However, linear scales do not reveal the relation to the whole. Consider an RF system that was experiencing a loss. Expressed on a linear scale, it can be said that the loss is 50 mW. However, this does not reveal what the loss is in relation to the whole. Is 50 mW a small loss or a large loss? If the total power transmission is 30,000,000 mW, then 50 mW is small, whereas if the total power transmission is only 100 mW, the loss is very large.

A second way to measure RF power is to use a relative scale. In a relative scale the reference point is the measurement itself, rather than being fixed at zero. A relative scale can reveal the gain or loss in power in relation to the whole. Considering the 50 mW loss above, a relative scale might indicate that half of the total power being transmitted is lost. Relative scales often use a logarithm to express the relationship of the measurement to the whole. A logarithm is the exponent to which the number 10 must be raised to reach a given value. For example, the logarithm (or "log") of the number 1,000 is 3 (103 = 1,000). The log is always the exponent.

The logarithm of a negative number or of zero is undefined and is not allowed. RF power gain and loss on a relative scale are measured in **decibels (dB)** instead of mW. This is because gain and loss are relative concepts and a decibel is a relative measurement. A basic rule of thumb in dealing with RF power gain and loss is known as the **10's and 3's Rules of RF Math**. The rules are:

- -3 dB—A loss of 3 decibels means that half of the power in mW has been lost.
- +3 dB—A gain of 3 decibels means that the power has been doubled in mW.
- -10 dB—A loss of 10 decibels means that 90 percent of the power has been lost in mW.
- +10 dB—A gain of 10 decibels indicates a tenfold increase in mW.

4.8 Antennas

One of the most important components of any wireless system is its antenna. Without antennas radio waves would be unable to travel long distances. In this section you explore how antennas work, their characteristics, and the various types of antennas.

4.8.1 Antenna Concepts

Radio waves are transmitted and received by using an **antenna**. An antenna is a copper wire or similar device that has one end up in the air and the other end connected to the ground or a grounded device. When transmitting, the radio waves are directed to strike this wire (the length of an antenna should be about 1⁄4 of the wavelength). This will set up electrical pressure (voltage) along the wire. This pressure will cause a small electrical current to flow up and down the wire. The voltage causes the electricity in the antenna to move back and forth at the same frequency as the radio waves. Broadcasting or sending out radio waves is accomplished by forcing the electricity in the antenna to move at the same frequency as the radio waves. An antenna moves back and forth in response to the radio signals reaching it.The motion causes a voltage that leads from the antenna into the receiver. This is seen in Figure . Although the Equivalent Isotropically Radiated Power (EIRP) is the measure of the total power radiated out by the antenna of a wireless system, the Federal Communications Commission (FCC) uses another term to describe everything in a wireless system *except* the antenna. As defined by the FCC, an **intentional radiator** is a device (minus the antenna) that is specifically designed to create and generate radio frequency signals. Just as the FCC regulates the overall power transmission of a wireless LAN, it also sets limits on the power that can be generated by an intentional radiator.

Sending antenna

Receiving antenna

Electrical current

Radio waves Radio waves

Electrical current

4.9 Characteristics of RF Antenna Transmissions

There are a variety of characteristics of RF antenna transmissions that play a role in properly designing and setting up a WLAN. These include polarization, wave propagation, multipath distortion, the Fresnel zone, and free space path loss.

4.9.1 Polarization

The orientation of the radio waves as they leave the antenna is known as **polarization.** Waves follow the plane of their electrical fields, and the electric field is parallel to the radiating elements (the antenna element is the metal part of the antenna that is doing the radiating). If the antenna is in a vertical position (perpendicular to the ground), then the polarization is said to be vertical; if it is in a horizontal position (parallel to the ground) the polarization is horizontal. Vertical polarization is typically used in wireless LANs with the dual antennas of access points pointing upward. Devices with antennas that are not polarized in the same way are not able to communicate with each other effectively. Receiving a horizontally polarized signal with a vertically polarized antenna (or vice versa) will reduce the amount of signal received. Polarization is typically referred to as being horizontal or vertical, but the actual polarization can be at any angle. Circular polarization is also possible.

4.9.2 Wave Propagation

Whereas polarization is the plane in which signals radiate ,**wave propagation** is the pattern of their dispersal. One type of wireless radio wave propagation is known as sky wave propagation. The RF waves bounce off of the earth's ionosphere from the sending antenna to the receiving antenna. Sky wave propagation does not require the antennas to be in a straight line with one another. Sky wave propagation is illustrated in Figure .The type of propagation associated with WLANs is called **RF line of sight (RF LOS)**. This follows the same principle as **visual line of sight**, in which the sending and receiving antennas must be in a relatively straight line with each other in order to send and receive the signals.

4.9.3 Multipath Distortion

Sky wave propagation signals, because they're pointing towards the sky, generally are not interfered with by other objects. However, because RF LOS propagation requires alignment of the sending and receiving antennas, ground-level objects can obstruct the signals. These obstructions do not necessarily completely block the signal, but can cause refraction or diffraction. These refracted or diffracted signals may still reach the receiving antenna but will arrive later than the signals that can move in a straight line without any obstructions. This is known as **multipath distortion**.

4.10 Licensed radio bands

When a national regulatory body (such as the FCC in the United States) allocates a frequency range to be used for a function, it can also specify how the frequency range can be used or shared.

To use licensed radio bands, a license must be obtained from a government agency. This requirement is true of all users of these radio spectrums. A few of the uses of licensed radio bands are as follows:

- **AM broadcast** (short wave between 1.711 MHz–30.0 MHz, medium wave between 520 kHz–1,610 kHz, and long wave between 148.5 kHz–283.5 kHz)
- **FM broadcast** (87.5 to 108.0 MHz)
- **Cellular phones** (840 MHz)

In the larger electromagnetic spectrum, which includes the radio spectrum, the licensing of infrared and X-ray spectrums also exists.

4.10.1 Unlicensed radio bands

When hearing the term *unlicensed,* you may think there are no laws or that unlicensed radio bands are like the Wild West and people can do as they like. However, that is not completely the case: You must follow several regulations that cover the use of the unlicensed radio bands.

The big difference between licensed and unlicensed bands is that the licensed bands are allowed to be used only by the company that licensed them, whereas the unlicensed bands are used by anyone who wants to use them.

Unlicensed radio bands have been allocated to certain users by the government, but to be able to use and broadcast on these bands, you do not need to have a license; you only need to create compliant devices that are to be used.

Regulations exist around these bands, so using unlicensed radio bands is not a free-for-all. In the United States, the FCC regulates all the electromagnetic spectrum, but it has set aside several ranges for public use.

Some of the types of unlicensed radio bands are as follows:

- **Industrial, Scientific, Medical (ISM):** This type includes several medical monitors and other devices that operate in the 900-MHZ, 2.4-GHz, and 5-GHz bands.
- **Unlicensed National Information Infrastructure (U-NII):** This type defines the specifications for the use of wireless devices such as WLAN access points and routers in the 5-GHz band.
- **Unlicensed Personal Communications Services (UPCS):** This type defines the specifications for devices operating in the 1.9-GHz band, where DECT6 cordless phones operate.

Wireless phone companies, such as Sprint and Rogers, have specific frequencies that only they are allowed to use by leasing them from the government. IEEE 802.11 networks have several choices of wireless bands that are available to them to use, without the requirement to lease the frequencies from the government.

The downside of the unlicensed frequencies or bands is that anyone else can use the same frequency ranges, which can cause interference for the signals you are trying to transmit.

So users of both licensed and unlicensed bands are required to follow a series of government regulations, but the unlicensed bands may be used by anyone who follows the guidelines and regulations. These guidelines cover issues like encroaching on neighboring frequencies and causing interference; so if everyone follows these rules, they will all be good neighbors, which is not always the case.

Some groups have helped to develop standards so that all users can be good neighbors with others who use those radio bands. These groups and standards bodies include the following:

- **FCC** (Federal **Communications Commission):** Manages and sets standards with regard to the spectrum use
- **IEEE (Institute of Electrical and Electronics Engineers):** A leading standards organization which publishes standards that are adopted across industries
- **Wi-Fi Alliance:** An organization that attempts to create a single standard for WLANs, thereby ensuring interoperability
- **ETSI (European Telecommunications Standards Institute):** Another standards organization that has contributed many worldwide standards
- **ITU-R (International Telecommunication Union, Radio communication Sector):** With the FCC, defines how WLANs should operate from a regulatory perspective, such as operating frequencies, antenna gain, and transmission power
- **WLANA (WLAN Association):** Provides information resources related to WLANs with regard to industry trends and usage. They are now defunct.

horizontal and vertical degrees. A type of antenna that normally has a 360-degree horizontal beam width could be remanufactured into a more focused beam width of 60 degrees. Generating the same power but with smaller beam width the RF waves will travel further

CHAPTER 5

IMPLEMENTATION

5.1 Introduction

We will discuss about implementation of our circuit. In our project we DVD Player and Television. Here output signal of DVD Player is transmitted and received to LCD other side. Here output of DVD Player is connected to Transmitter. Transmitter consist of two modulators one is FM and other is AM modulator. Transmitter is design such that video output of DVD Player is fed to AM modulator and audio output is fed to FM modulator. On the receiver side we have demodulator (both AM and FM)to demodulate signal .Analog output of demodulator is fed to LCD.

5.2 Transmitter

Video signal is fed to AM modulator and transmitted through antennae. Audio signal is fed to FM modulator and signals after passing through mixer Transmitted wirelessly through RF.

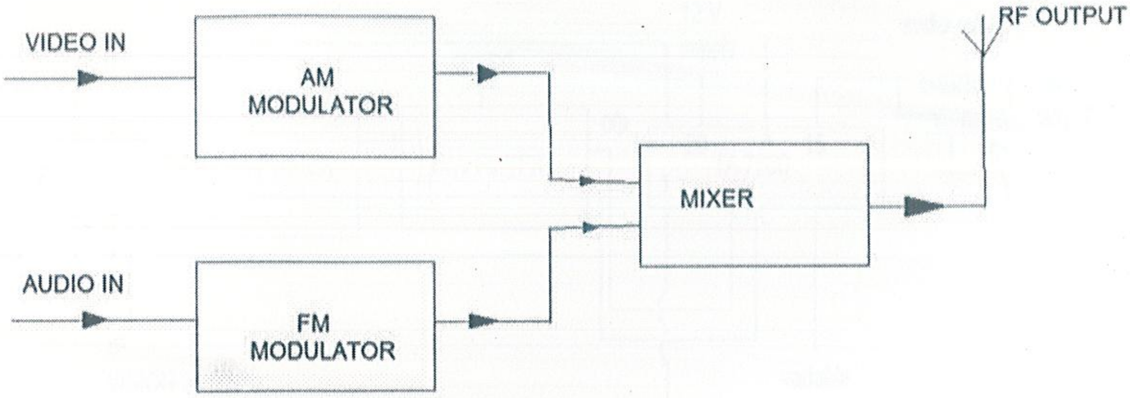

Figure 5.1 - Wireless RF transmitter

It requires two tuned circuits which are tuned to same frequencies. The frequencies of both tuned circuits are matched with each other and that with frequency of receiver.

5.3 Receiver

On the other side we have RF receiver .Signal after passing through receiver is fed to television. The block diagram is given below:-

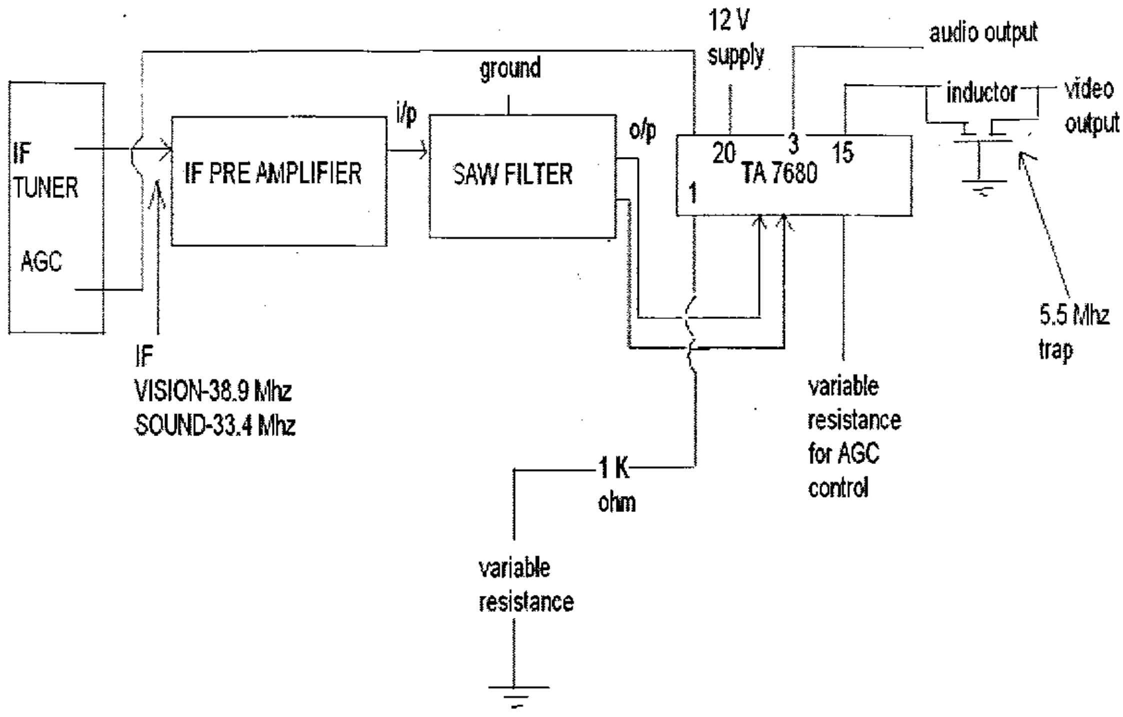

Figure 5.2 - Wireless RF Receiver

5.3.1 Radio Tuner

A **radio tuner** is a subsystem that receives radio broadcasts and converts them into audio-frequency signals which can be fed into an amplifier driving a loudspeaker. **FM tuner, AM tuner, Digital Audio Broadcasting DAB tuner**, etc. are types of radio tuner dealing with transmissions using different methods of modulation. The term *tuner* can mean either part of a radio receiver or standalone audio components that are part of an audio system, to be connected to a separate amplifier. The verb **tuning** in radio contexts means adjusting the radio receiver to receive the desired radio signal from a particular radio station.

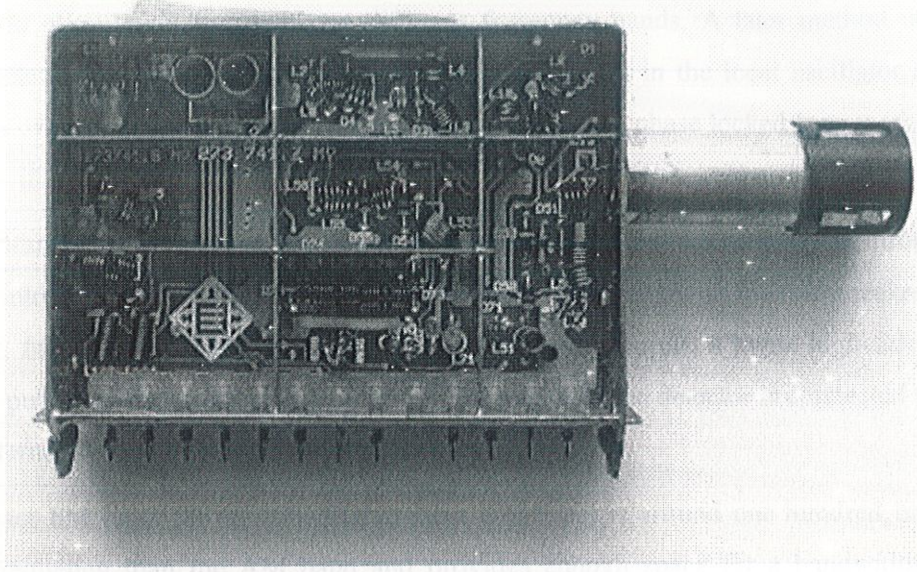

Figure 5.3 - Radio Tuner

Design

The simplest tuner consists of an inductor and capacitor connected in parallel, where the capacitor or inductor is made to be variable. This creates aresonant circuit which responds to an alternating current of one frequency. Combined with a detector, also known as a demodulator, (diode D-1, in the circuit), it becomes the simplest radio receiver, often called a crystal set.

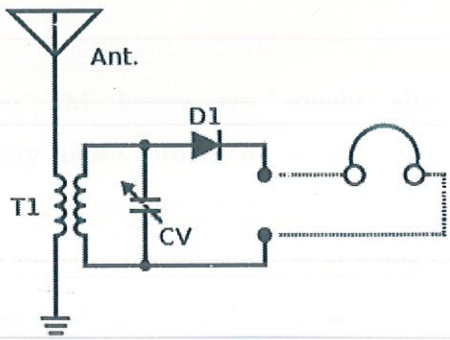

Figure 5.4 - Inductively Coupled Crystal Radio Receiver

Practical radio tuners use a superheterodyne receiver. Older models would realize manual tuning by means of mechanically operated ganged variable capacitors. Often several sections would be provided on a tuning capacitor, to tune several stages of the receiver in tandem, or to allow switching between different freqeuncy bands. A later method used a potentiometer supplying a variable voltage to varactor diodes in the local oscillator and tank circuits of front end tuner, for electronic tuning. Still later, phase locked loop methods were used, with microprocessor control.

In a self-contained radio receiver, the signal from the detector after the tuner is run through a volume control and to an amplifier stage. The amplifier feeds either an internal speaker or headphones. In a tuner component of an audio system (for example, a home high-fidelity system or a public address system in a building), the output of the detector is connected to a separate external system of amplifiers and speakers.

The broadcast FM band (88 to 108MHz in most countries) is around one hundred times higher in frequency than the AM band and provides enough space for a bandwidth of 50kHz. This bandwidth is sufficient to transmit both stereo channels with almost the full bandwidth of the human ear. Sometimes, additional subcarriers are used for unrelated audio or data transmissions. The left and right audio signals must be combined into a single signal which is applied to the modulation input of the transmitter; this is done by the addition of an inaudible subcarrier signal to the FM broadcast signal. FM stereo allows left and right channels to be transmitted. The availability of FM stereo, a quieter VHF broadcast band, and better fidelity lead to the specialization of FM broadcasting in music, tending to leave AM broadcasting with spoken-word material.

Restoration

Standalone audio stereo FM tuners are sought after for audiophile and TV/FM DX applications, especially those produced in the 1970s and early 1980s, when performance and manufacturing standards were among the highest. In many instances the tuner may be modified to improve performance. A growing hobby trend is the electronics specialists that buy, collect and restore these vintage FM or AM/FM audio tuners. The restoration usually begins with replacing the electrolytics (capacitors) that age over time. The tuner is outfitted with improved tolerance and better sounding upgraded parts. Prices have increased relative to the increasing demand for the older audio tuners. Those with the most value are the best sounding, most rare (collectible), the best DX capable (Distance Reception) and the known build quality of the component, as it left the factory.

AM/FM

Most of the top end audio tuner models were designed and manufactured to receive only the FM broadcast band. As FM became more popular, the limitations of AM became more apparent, and FM became the primary listening focus, especially for stereo and music broadcasting. The bulk of tuners made for the market, however, were AM/FM design, especially in the 1980s and 1990s. Few companies even manufacture dedicated FM or AM/FM tuners now, as these bands are most often included in a low cost chip for A/V systems, more as an afterthought, rather than designed for the critical FM listener. The FM aficionado must really look to the classic tuner models and either rebuild or upgrade the unit to satisfy demanding FM listeners. A few 1970s tuners feature now-deprecated Dolby noise reduction for FM broadcasts.

5.3.2 TV IF Tuner

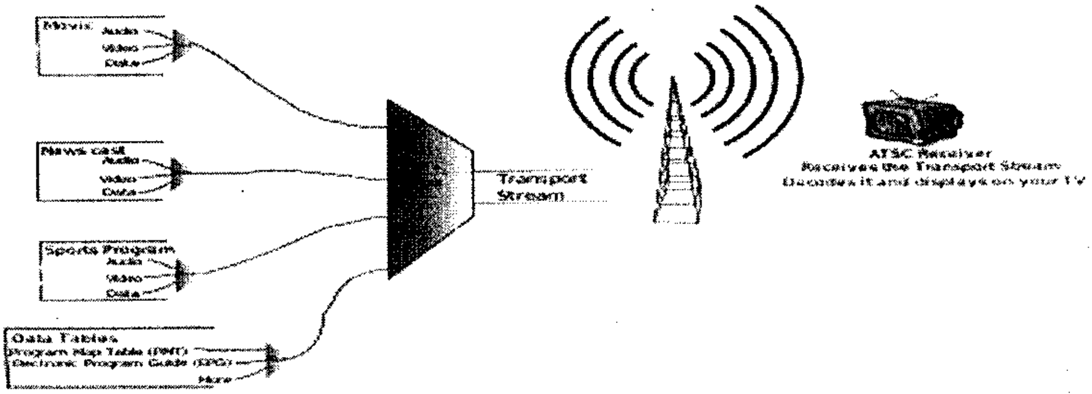

Figure 5.5 - IF Tuner

Multiple MPEG programs are combined then sent to a transmitting antenna. In the US broadcast digital TV system, an ATSC receiver then decodes the TS and displays it on a TV.

An ATSC (Advanced Television Systems Committee) tuner , often called an ATSC receiver or HDTV receiver is a type of television tuner that allows reception of digital television(DTV) television channels transmitted by television stations in North America, parts of Central America and South Korea that use ATSC standards. Such tuners may be integrated into a television set, VCR, digital video recorder (DVR), or set-top box that provides audio/video output connectors of various types.

How an ATSC Tuner Works

An ATSC tuner works by generating audio and video signals that are picked up from over-the-air broadcast television. ATSC tuners provide the following functions: selective tuning, demodulation, transport stream demultiplexing, decompression, error correction, analog-to-digital conversion, AV synchronization and media reformatting to fit the specific type of TV screen optimally.

Selective Tuning

Selective tuning is the process by which the radio frequency(RF) of the television channel is selected by a receiver from within a band of transmittedRF signals. The tuner usually performs the function of frequency-agile selection, along with rejection of unwanted out-of-band signals.

Demodulation

Demodulation means transforming the signal from the tuner into a usable signal that a TV set can use to produce quality images and sound without further consideration for the frequency at which it was transmitted. It is separation of a standard baseband signal from the RF carrier that was used to transmit it through the air (or down a coaxial cable or other long-distance medium.) ATSC as implemented in the US uses 8VSB modulation, which requires less power to transmit, as opposed to the also proposed COFDM modulatiion (used in European DVB-T, which is less prone to multipath distortion and therefore better received in mobile installations.

5.3.3 Preamplifier Stage

A **preamplifier** (preamp) is an electronic amplifier that prepares a small electrical signal for further amplification or processing. A preamplifier is often placed close to the sensor to reduce the effects of noise and interference. It is used to boost the signal strength to drive the cable to the main instrument without significantly degrading the signal-to-noise ratio(SNR). The noise performance of a preamplifier is critical; when the gain of the preamplifier is high, the SNR of the final signal is determined by the SNR of the input signal and the noise figure of the preamplifier.

In a home audio system, the term 'preamplifier' may sometimes be used to describe equipment which merely switches between different line level sources and applies a volume control, so that no actual amplification may be involved. In an audio system, the second amplifier is typically a power amplifier(power amp). The preamplifier provides voltage gain (e.g. from 10 millivolts to 1 volt) but no significant current gain. The power amplifier provides the higher current necessary to drive loudspeakers.

Preamplifiers may be:

- incorporated into the housing or chassis of the amplifier they feed
- in a separate housing
- mounted within or near the signal source, such as a turntable, microphone.

5.3.4 SAW Filter

SAW (surface acoustic wave) filters are electromechanical devices commonly used in radio frequency applications. Electrical signals are converted to a mechanical wave in a device constructed of a piezoelectric crystal or ceramic; this wave is delayed as it propagates across the device, before being converted back to an electrical signal by further electrodes. The delayed outputs are recombined to produce a direct analog implementation of a finite impulse response filter. This hybrid filtering technique is also found in an analog sampled filter. SAW filters are limited to frequencies up to 3 GHz.

5.3.4 Receiver

IC TA7680

Intenal circuit specification of IC are given below:-

TA7680AP FOR FET TUNER

TA768UP FOR NPN TUNER

PIF

Three Controlled IF Amplifier Stages

Video Demodulator Controlled by Picture Carrier

Black Noise and White Noise Inverter

Peak AGC

DC Amplifier for RF AGC Out

SIF

Three Differential IF Amplifier Stages

Phase Detector

DC Controlled Attenuator

Audio Amplifier Stage with NFB Terminal

FEATURES

PIF, SIF, ATT AUDIO DRIVER

2 Chip Color TV System is Possible with TA7644BP

PIF

High Gain, Wide Band IF Amplifier

AGC Characteristics with Excellent Stability

Excellent DG/DP Characteristics

Excellent S/N Characteristics Due to Delayed 3 Stages AGC Action

Negative Video Output Signal

Switch Off the Video Part with VTR SW

SIF

Excellent Limitter Characteristics

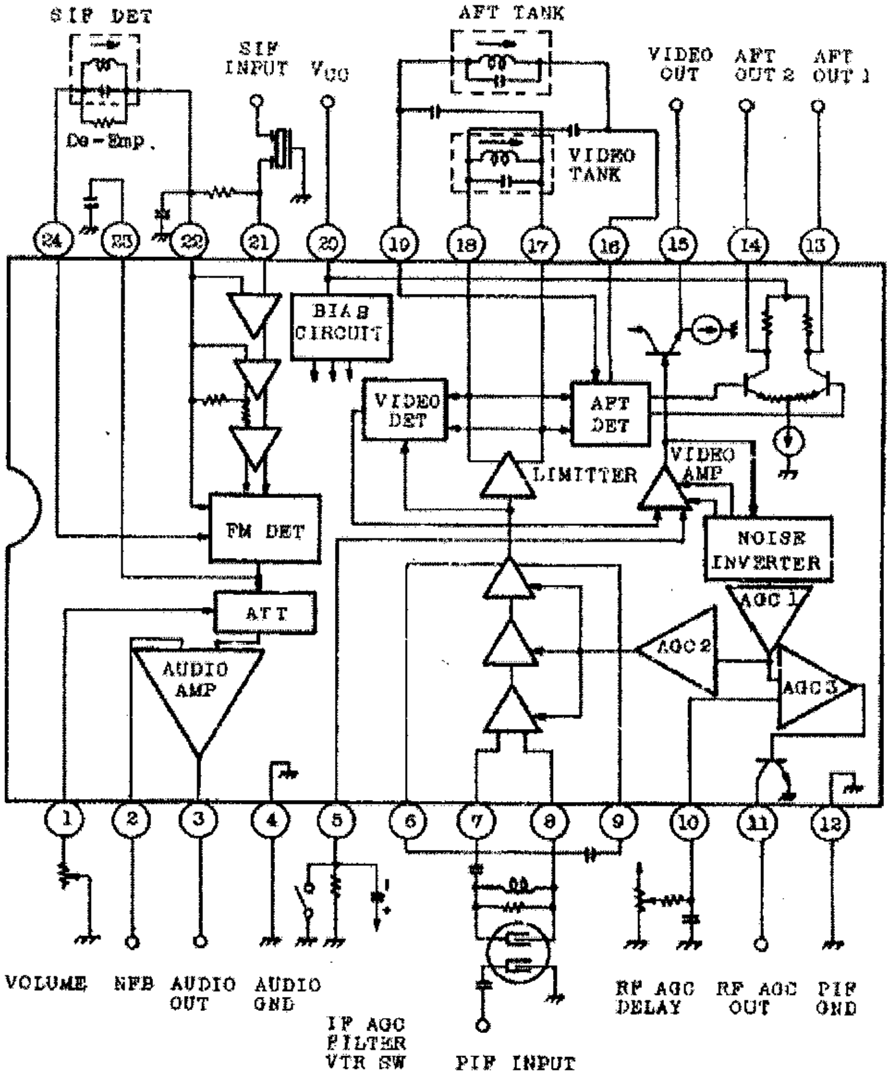

Figure 5.6 - Circuit Specification Of IC TA 7680

5.4 Execution

The transmitter parts were integrated and was checked thoroughly, connected with DVD Player. Receivers circuits was integrated on PCB board and connected with TELEVISION. And execution was done. Hence we get wireless audio and video transmission through RF waves. Output was checked on TELEVISION .Our Project was completed successfully.

5.5 Future Scope

1)This model can be used for human voice transmission for about 10m of range.

2)It can also be used for video transmission from CAMERA to TELEVISION wirelessly.

3)Person can research on digital transmission using digital modulation technique.

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