REPORT ON: - FM RECEIVER

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A comprehensive project report has been submitted in partial fulfillment of the requirements for the degree of

Bachelor of Technology

In

ELECTRONICS & COMMUNICATION ENGINEERING

Under the supervision of

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May, 2018

CERTIFICATE OF APPROVAL

This is to certify that the project titled "**FM RECEIVER**" carried out by

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for the partial fulfillment of the requirements for B.Tech degree in **Electronics and Communication Engineering** from **Maulana Abul Kalam Azad University of Technology, West Bengal**is absolutely based on his own work under the supervision of **Mr. ANINDYA BASU**. The contents of this thesis, in full or in parts, have not been submitted to any other Institute or University for the award of any degree or diploma.

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DECLARATION

"We Do hereby declare that this submission is our own work conformed to the norms and guidelines given in the Ethical Code of Conduct of the Institute and that, to the best of our knowledge and belief, it contains no material previously written by another neither person nor material (data, theoretical analysis, figures, and text) which has been accepted for the award of any other degree or diploma of the university or other institute of higher learning, except where due Acknowledgement has been made in the text."

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Place: Kolkata, West Bengal,

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Name of the Examiner Signature with Date

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ABSTRACT

A radio receiver is an electronic device that receives radio waves and converts the information carried by them to a usable form. An antenna is used to catch the desired frequency waves. The receiver uses electronic lters to separate the desired radio frequency signal from all the other signals picked up by the antenna, an electronic ampler to increase the power of the signal for further processing, and nally recovers the desired information through demodulation.

Of the radio waves, FM is the most popular one. Frequency modulation is widely used for FM radio broadcasting. It is also used in telemetry, radar, seismic prospecting, and monitoring newborns for seizures via EEG, two-way radio systems, music synthesis, magnetic tape-recording systems and some video-transmission systems. An advantage of frequency modulation is that it has a larger signal-to-noise ratio and therefore rejects radio frequency interference better than an equal power amplitude modulation (AM) signal

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LIST OF FIGURES

LIST OF SYMBOLS AND ABBREVIATIONS

2D	Two Dimensional
3D	Three Dimensional
AR	Axial Ratio
ARBW	Axial Ratio Bandwidth
BLIS	Blind Spot Information System
BSD	Blind Spot Detection
CMSA	Circular Micro strip Antenna
CP	Circular Polarization
CPU	Central Processing Unit
DOT	Department of Transportation
DSRC	Dedicated Short Range Communications
ETSI	European Telecommunications Standards Institute
FCC	Federal Communications Commission
FDTD	Finite Deference Time Domain
FEM	Finite Element Method
FNBW	First Null Beam width
GPS	Global Positioning System
GSM	Global System for Mobile Communications
HMSA	Hexagonal Micro strip Antenna
HPBW	Half Power Beam width
ICT	Information and Communication Technologies
ICVES	International Conference on Vehicular Electronics and Safety
IEEE	Institute of Electrical and Electronics Engineers
ITS	Intelligent Transport Systems
LP	Linear Polarization
LTE	Long-Term Evolution, a standard for wireless communication

MIC	Microwave Integrated Circuit
MIMO	Multiple Input Multiple Output
MMIC	Monolithic Microwave Integrated Circuit
MNM	Multiport Network Model
MOM	Method of Moments
MOTL	Microwave and Optical Technology Letters
MSA	Micro strip Antenna
OFDMA	Orthogonal Frequency-Division Multiple Access
OS	Operating System
PCS	Personal Communications Service
PIER	Progress In Electromagnetic Research
Q	Quality Factor
RAM	Random Access Memory
RL	Return Loss
RMSA	Rectangular Micro strip Antenna
RSU	Road Side Unit
SDT	Spectral Domain Technique
SVGA	Super Video Graphics Array
SWR	Standing Wave Ratio
TEM	Transverse Electromagnetic
TV	Television
UMTS	Universal Mobile Telecommunications System
V2H	Vehicle-to-Home
V2I	Vehicle-to-Infrastructure
V2M	Vehicle-to-Motorcycle
V2P	Vehicle-to-Pedestrian
V2V	Vehicle-to-Vehicle
VANET	Vehicular Ad Hoc Network

VLC	Visible Light Communication
VSWR	Voltage Standing Wave Ratio
Wi Max	Worldwide Interoperability for Microwave Access
WLAN	Wireless Local Area Network
NHTSA	National Highway Tar c Safety Administration
USA	United States of America

FM Receiver

1.1 Background of the project

A digital FM demodulator design can either be done in software or hardware. There are trade s between the two design approaches. Software is quicker to implement because you can write in high level languages such as C. However, if the design is done in software more clock cycles will be required to complete all the operations necessary since only one operation can happen per clock cycle. If the design is done in hardware many circuits can be running simultaneously synced by the same clock, resulting in a much faster design. However, the design will need to be done in a hardware description language such as VHSIC Hardware Description Language (VHDL) or Virology; this will require a more tedious design process. The FM demodulator design chosen for this project is done in hardware on a Diligent NEXYS FPGA board. The NEXYS FPGA board uses the Xilinx Sparten3 FPGA chip. FPGAs are Field Programmable Gate Arrays. That is, they contain programmable logic blocks that can be recon gored with a hardware description language. The hardware description language used is VHDL.

1.2 Motivation of Research

Owing to the excessive demands of multiple applications in single device and space constrain, implementation of a FM receiver for a multi-standard wireless system is very challenging task. The motivation underneath for the proposed research work comes from the need of compact, multiple frequencies, highly e client with large gain, low pro le FM receiver for wideband operation. Several designs are proposed using commercially available RF IC and that could be successfully implemented to make an ordable the superior technology for more common applications.

1.3 What is Modulation

A message carrying a signal has to get transmitted over a distance and for it to establish a reliable communication; it needs to take the help of a high frequency signal which should not an ect the original characteristics of the message signal. The characteristics of the message signal, if changed, the message contained in it also alters. Hence, it is a must to take care of the message signal. A high frequency signal can travel up to a longer distance, without getting an ected by external disturbances. We take the help of such high frequency signal which is called as a carrier signal to transmit our message signal. Such a process is simply called as Modulation. Modulation is the process of changing the parameters of the carrier signal, in accordance with the instantaneous values of the modulating signal.

1.4 Need for Modulation

Baseband signals are incompatible for direct transmission. For such a signal, to travel longer distances, its strength has to be increased by modulating with a high frequency carrier wave, which doesn’t an ect the parameters of the modulating signal.

1.5 Advantages of Modulation

The antenna used for transmission, had to be very large, if modulation was not introduced. The range of communication gets limited as the wave cannot travel a distance without getting distorted. Following are some of the advantages for implementing modulation in the communication systems.

1) Reduction of antenna size
2) No signal mixing
3) Increased communication range
4) Multiplexing of signals
5) Possibility of bandwidth adjustments
6) Improved reception quality

1.6 Signals in the Modulation Process

Following are the three types of signals in the modulation process.

1.7 Message or Modulating Signal

The signal which contains a message to be transmitted, is called as a message signal. It is a baseband signal, which has to undergo the process of modulation, to get transmitted. Hence, it is also called as the modulating signal.

1.8 Carrier Signal

The high frequency signal, which has a certain amplitude, frequency and phase but contains no information is called as a carrier signal. It is an empty signal and is used to carry the signal to the receiver after modulation.

1.9 Modulated Signal

The resultant signal after the process of modulation is called as a modulated signal. This signal is a combination of modulating signal and carrier signal.

1.10 Types of Modulation

There are many types of modulations. Depending upon the modulation techniques used, they are classi ed as

1.10.1 Continuous wave Modulation

In continuous wave modulation, a high frequency sine wave is used as a carrier wave. This is further divided into amplitude and angle modulation.

1) If the amplitude of the high frequency carrier wave is varied in accordance with the instantaneous amplitude of the modulating signal, then such a technique is called as Amplitude Modulation.

2) If the angle of the carrier wave is varied, in accordance with the instantaneous value of the modulating signal, then such a technique is called as Angle Modulation. Angle modulation is further divided into frequency modulation and phase modulation.

2.1) If the frequency of the carrier wave is varied, in accordance with the instantaneous value of the modulating signal, then such a technique is called as Frequency Modulation.

2.2) If the phase of the high frequency carrier wave is varied in accordance with the instantaneous value of the modulating signal, then such a technique is called as Phase Modulation.

1.10.2 Pulse Modulation

In Pulse modulation, a periodic sequence of rectangular pulses, is used as a carrier wave. This is further divided into analog and digital modulation.

In analog modulation technique, if the amplitude or duration or position of a pulse is varied in accordance with the instantaneous values of the baseband modulating signal, then such a technique is called as Pulse Amplitude Modulation (PAM) or Pulse Duration/Width Modulation (PDM/PWM), or Pulse Position Modulation (PPM). In digital modulation, the modulation technique used is Pulse Code Modulation (PCM) where the analog signal is converted into digital form of 1s and 0s. As the resultant is a coded pulse train, this is called as PCM. This is further developed as Delta Modulation (DM). These digital modulation techniques are discussed in our Digital Communications tutorial.

1.11 FM DEMODULATION

Demodulation should provide an output signal whose amplitude is dependent on the instantaneous carrier frequency deviation and whose frequency is dependent on the rate of the carrier frequency change.

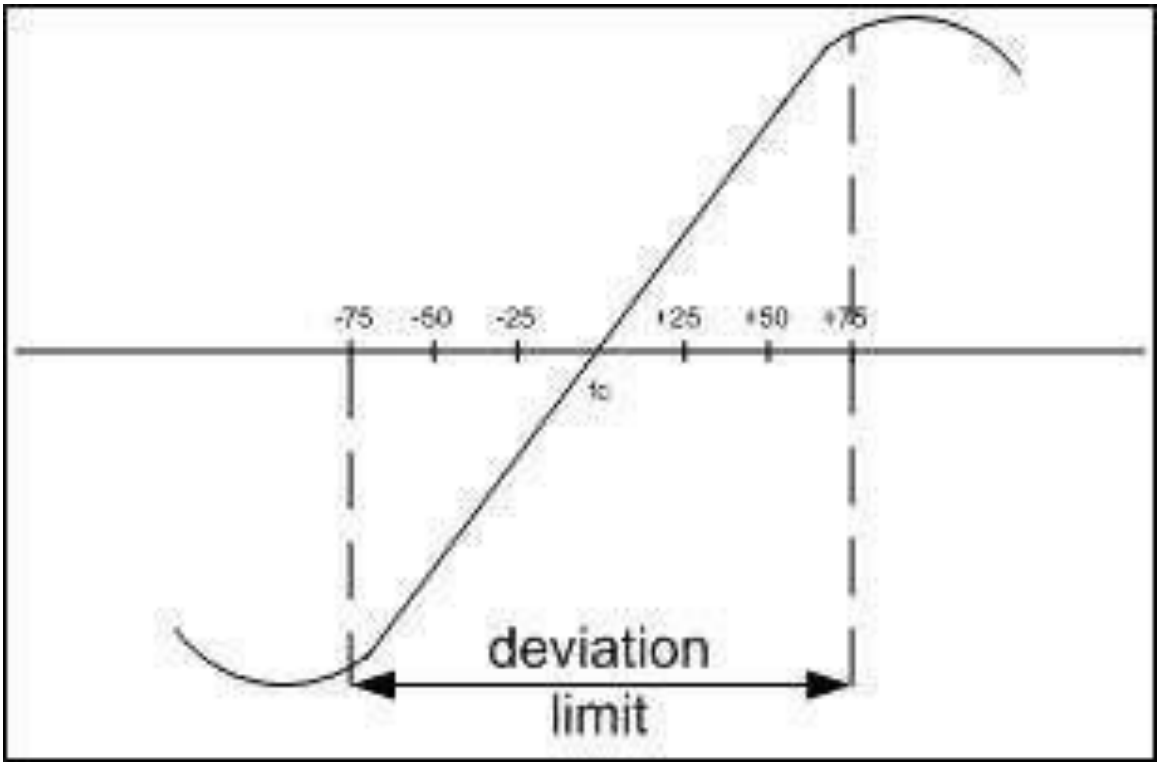

Figure 1.1: FM Characteristics curve

1.12 Slope Detector

1) Simplest form of tuned circuit frequency discriminator.

2) Single ended slope has the most nonlinear voltage versus frequency characteristics.

3) Seldom used

4) Convert FM to AMD

5) Demodulate AM envelope with conventional peak detectors

6) Circuit consist of a tuned circuit and an AM detector

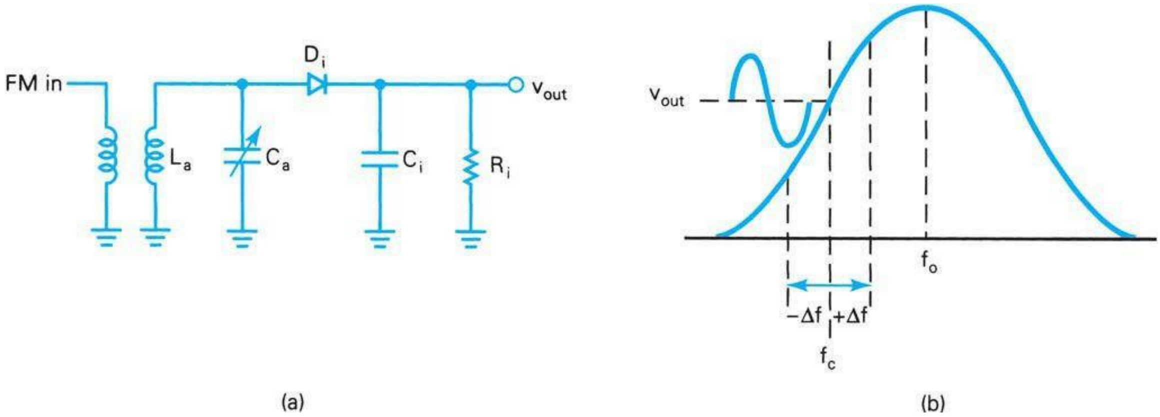

Figure 1.2: Slope detector (a) schematic diagram (b) voltage-versus-frequency curve.

1.13 Circuit Operation of Slope detector

1) La & Ca (tuned circuit) produce output voltage (amplitude varies) which is proportional to the input freq. (FM in) AM characteristic

2) Maximum output voltage occurs at resonant freq of tank circuit, fo and its output decrease proportionately as the input freq deviates below & above fo

3) IF center frequency (fc) falls in the center of the most linear portion of the voltage versus frequency curve (Figure 5.3(b))

4) When IF deviates above fc, output voltage increase and when IF deviated below fc, output voltage decrease.

5) The tuned circuit converts frequency variations to amplitude variations (FM to AM conversion).

6) Di, Ci and Ri simple peak detector that converts amplitude variations to output voltage (operate as AM Diode Detector) 7) output voltage varies at a rate equal to input frequency

8) Amplitude of output voltage depend on magnitude of freq changes

1.14 Balanced slope detector

1) Made up of single ended slope detector connected in parallel and fed 180o out of phase (Phase inversion).

2) The 2 tuned circuit perform the FM to AM conversions

3) At resonant freq, the resultant output voltage is 0 V.

4) As the IF deviates above the center freq, top tuned circuit produces higher voltage than the lower tank circuit (Vout) and vice versa.

5) Below gure shows the output versus frequency response curve.

6) Diode detector circuit (D1, R1, C1 & D2, R2, C2) recover the original signal.

Advantage: simple.

Disadvantages: poor linearity, di cult in tuning and lack of provisions for limiting.

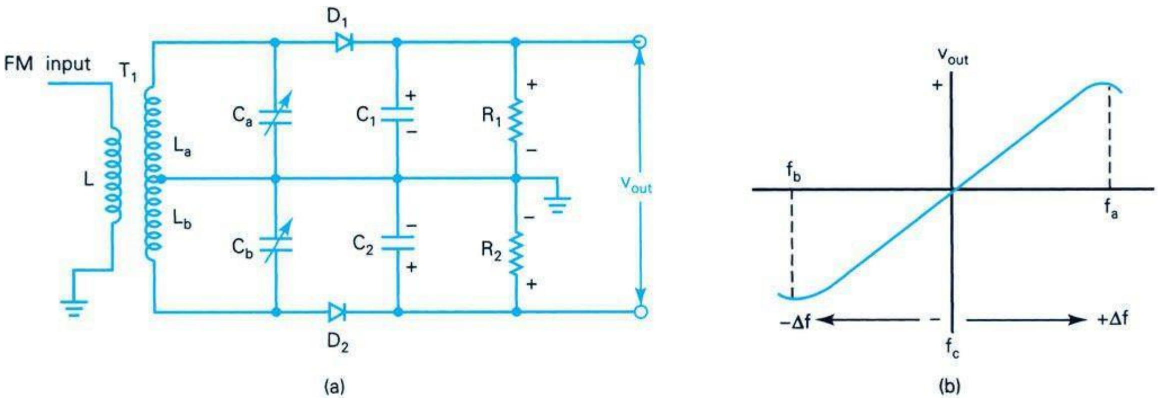

Figure 1.3: Balanced slope detector (a) schematic diagram (b) voltage-versus- frequency response curve.

1.15 Circuit Operation of Slope detector

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10) At resonant freq, the resultant output voltage is 0 V.

11) As the IF deviates above the center freq, top tuned circuit produces higher voltage than the lower tank circuit (V out) and vice versa.

12) Figure above shows the output versus frequency response curve.

13) Diode detector circuit (D1, R1, C1 & D2, R2, C2) recover the original signal.

Advantage: simple.

Disadvantages: poor linearity, dicult in tuning and lack of provisions for limiting.

1.16 Foster Seeley Discriminator

1) Also called phase shift discriminator (tuned-circuit frequency discriminator) operation very similar to the balanced slope detector.

2) Is tuned by injecting a frequency equal to the IF center frequency and tuning C0 for 0 volts out.

3) Output voltage is directly proportional to the magnitude and direction of the frequency deviation.

4) Output voltage-versus-frequency deviation curve is more linear than that of a slope detector because there is only one tank circuit, easier to tune.

5) For distortion less demodulation, the frequency deviation should be restricted to the linear portion of the secondary tuned circuit frequency response curve.

6) Responds to amplitude as well as frequency variations and, therefore, must be pre-ceded by a separate limiter circuit.

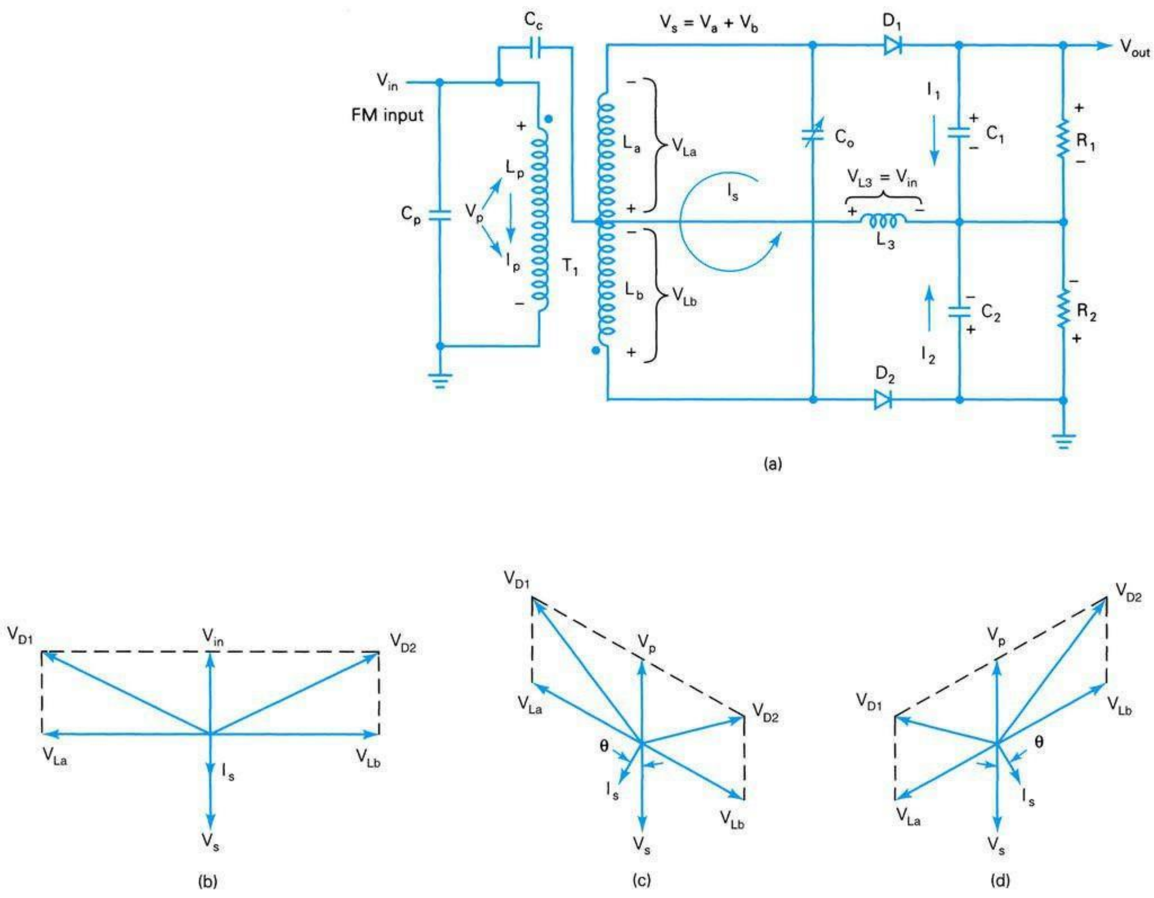


Figure 1.4: Foster Seeley discriminator (a) schematic diagram (b)vector diagram

1.17 Ratio detector

Advantage: relatively immune to amplitude variations in its input signal.

1) Figure below shows the schematic diagram for a ratio detector.

2) Same as the Foster Seeley discriminator but with 3 limiting changes.

3) D2 has been reversed current (Id) ow through the outermost loop of the circuit Shunt capacitor, Cs charges to approximately the peak voltage across the secondary winding of T1. The reactance of Cs is low, and Rs simply provides a dc path for diode current.

4) Therefore, the time constant for Rs and Cs is su ciently long so that rapid changes in the amplitude of the input signal due to thermal noise or other interfering signals are

shorted to ground and have no e ect on the average voltage across Cs.

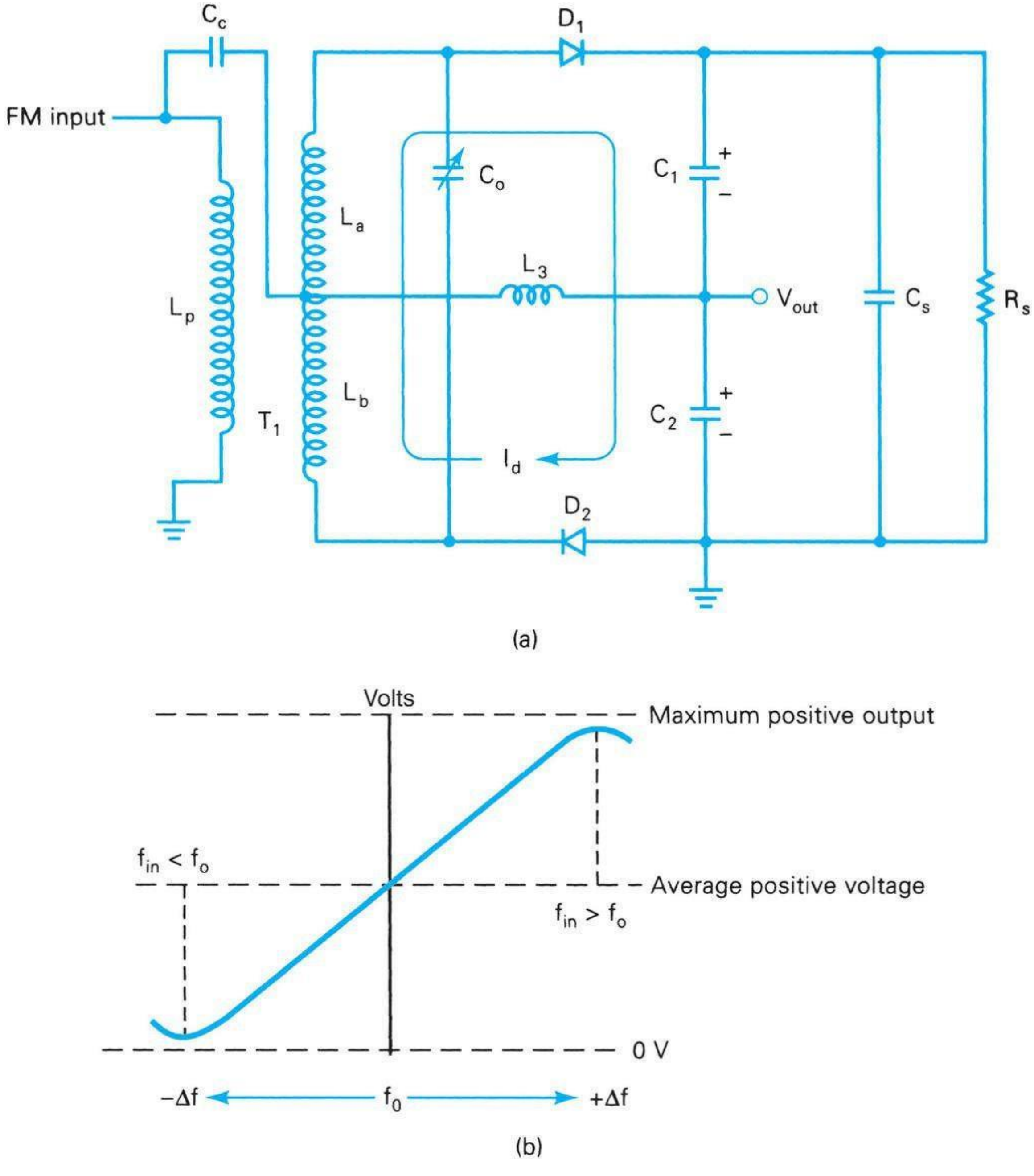


Figure 1.5: Ratio detector (a) schematic diagram ; (b) voltage-versus-frequency response curve

1) Consequently, C1 and C2 charge and discharge proportional to frequency changes in

The input signal and are relatively immune to amplitude variations.

2) Also, the output voltage from a ratio detector is taken with respect to ground, and for the diode polarities shown in Figure above, the average output voltage is positive.

3) At resonance, the output voltage is divided equally between C1 and C2 and redistributed as the input frequency is deviated above and below resonance.

4) Therefore, changes in Vout are due to the changing ratio of the voltage across C1 and C2, while the total voltage is clamped by Cs.

5) The Figure above shows the output frequency response curve for the ratio detector. It can be seen that at resonance, Vout is not equal to 0 V but, rather, to one-half of the voltage across the secondary windings of T1 . Because a ratio detector is relatively immune to amplitude variations, it is often selected over a discriminator.

However, a discriminator produces a more linear output voltage versus frequency response curve.

1.18 PHASE LOCKED LOOP (PLL)

1) FM demodulation can be accomplished quite simply with a phase locked loop (PLL).

2) PLL FM demodulator is probably the simplest and easiest to understand.

3) A PLL frequency demodulator requires no tuned circuits and automatically compensates for changes in the carrier frequency due to instability in the transmit oscillator.

4) Figure below shows the simple end block diagram for a PLL FM demodulator.

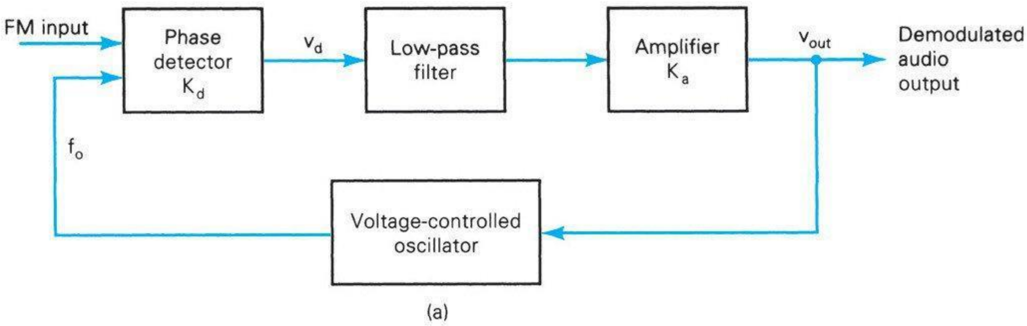


Figure 1.6: Block diagram for a PLL FM demodulator.

1) If the IF amplitude is saliently limited prior to reaching the PLL and the loop is properly compensated, the PLL loop gain is constant and equal to KV.

2) after frequency lock had occurred the VCO would track frequency changes in the input signal by maintaining a phase error at the input of the phase comparator.

3) Therefore, if the PLL input is a deviated FM signal and the VCO natural frequency is equal to the IF center frequency, the correction voltage produced at the output of the phase comparator and fed back to the input of the VCO is proportional to the frequency deviation and is, thus, the demodulated information signal.

4) Therefore, the demodulated signal can be taken directly from the output of the internal bu er and is mathematically.

5) Figure above shows a schematic diagram for an FM demodulator using the XR-2212. R0 and C0 are course adjustments for setting the VCO's free-running frequency. Rx is for

ne tuning, and RF and Rc set the internal op-amp voltage gain (Ka). The PLL closed-loop frequency response should be compensated to allow un attenuated demodulation of the entire information signal bandwidth.

6) The PLL op-amp provides voltage gain and current drive stability

7) PLL is the best frequency demodulator, because the ltering circuit removes noise and interference and its linear output reproduce the output signal.

1.19 FM receiver circuit explanation

Here is a simple FM receiver with minimum components for local FM reception. Transistor BF495 (T2), together with a 10k resistor (R1), coil L, 22pF variable capacitor (VC), and internal capacitances of transistor BF494 (T1), comprises the Colpit oscillator. The resonance frequency of this oscillator is set by trimmer VC to the frequency of the transmitting station that we wish to listen. That is, it has to be tuned between 88 and 108 MHz The information signal used in the transmitter to perform the modulation is extracted on resistor R1 and fed to the audio ampli er over a 220nF coupling capacitor (C1).

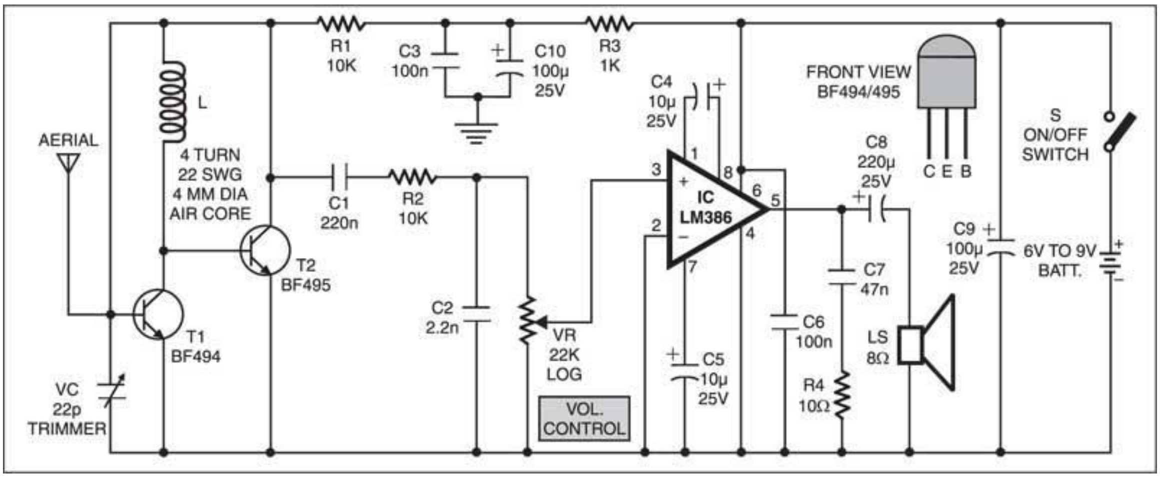


Figure 1.7: FM Receiver Circuit Diagram

You should be able to change the capacitance of the variable capacitor from a couple of Pico farads to about 20 pF. So, a 22pF trimmer is a good choice to be used as VC in the circuit. It is readily available in the market. If you are using some other capacitor that has a larger capacitance and are unable to receive the full FM bandwidth (88-108 MHz), try changing the value of VC. Its capacitance is to be determined experimentally.

The self-supporting coil L has four turns of 22 SWG enameled copper wire, with air core having 4mm internal diameter. It can be constructed on any cylindrical object, such as pencil or pen, having a diameter of 4 mm. When the required number of turns of the coil has reached, the coil is taken o the cylinder and stretched a little so that the turns don’t touch each other.

Capacitors C3 (100nF) and C10 (100F, 25V), together with R3 (1k), comprise a band-pass lter for very low frequencies, which is used to separate the low-frequency signal from the high-frequency signal in the receiver.

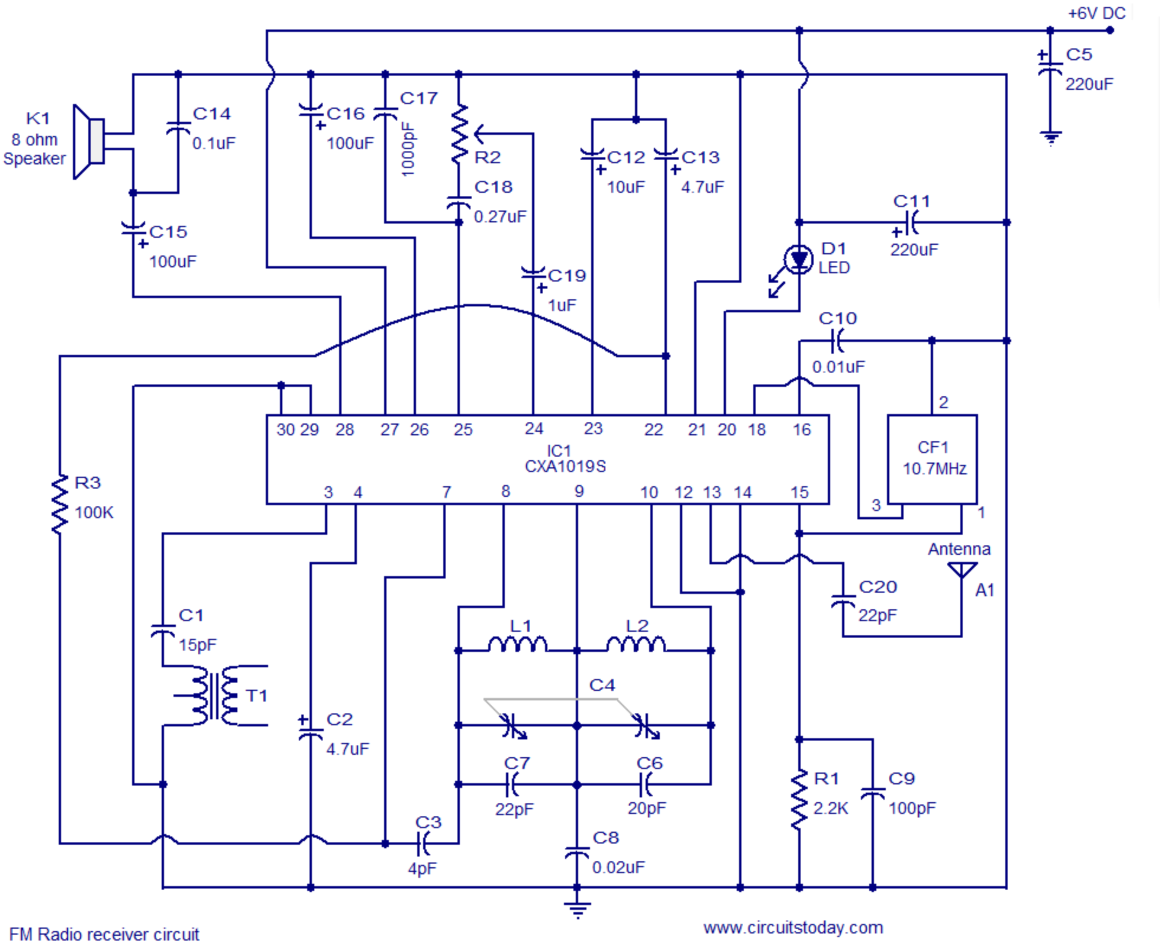
Antenna is a bit tricky you can use the telescopic antenna of any unused device. A good reception can also be obtained with a piece of isolated copper wire about 60 cm long. The optimum length of copper wire can be found experimentally.

The performance of this tiny receiver depends on several factors such as quality and turns of coil L, aerial type, and distance from FM transmitter. IC LM386 is an audio power amplifier designed for use in low-voltage consumer applications. It provides 1 to 2 watts, which is enough to drive any small-size speaker. The 22k volume control (VR) is a logarithmic potentiometer that is connected to pin 3 and the amplified output is obtained at pin 5 of IC LM386. The receiver can be operated o a 6V-9V battery.

CXA1019 FM receiver IC

A high quality FM receiver circuit based on CXA1019 IC is shown here. CXA1019 is a bipolar silicon monolithic FM/AM radio receiver IC from Sony. Built in circuitries inside the CXA1019 include RF amplifier, mixer, oscillator, IF amplifier, quadrature detection circuit, tuning LED driver electronic volume control, detector etc. FM section of the IC is only utilized in this circuit. The IC can be powered from anything between 3 to 7V DC and can drive an 8 ohm loudspeaker.

Circuit diagram



Circuit description

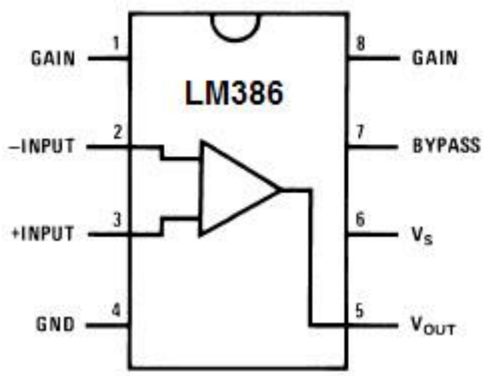
Inductors L1, L2 and capacitors C4, C6, C7 forms the tank circuit for the ICs built in oscillator section. The IF output available at pin 15 is grounded through resistor R1. C1 is the AC bypass capacitor for R1. Capacitor C16 is meant for ripple filtering. LED D1 is a tuning indicator. Output of the built-in detector stage (pin24) is coupled to the input (pin 25) of the built in AF amplifier stage through capacitor C19, POT R2 and capacitor C18. The POT R2 can be used as a volume control because it controls the input given to the audio amplifier stage. Capacitor C15 couples the audio output to the speaker and C14 is a noise bypass capacitor. C5 is just a power supply filter while C20 couples the antenna to the FM RF input (pin13) of the IC. The FM intermediate frequency output available at pin 15 is filtered using the 10MHz ceramic filter and applied to the FM intermediate frequency input pin18. Capacitor C2 is used for bypassing noise from the audio power amplifier section inside the IC. The output of this power amplifier section is around 500mW. Capacitor C1 and transformer T1 are related to the FM discriminator circuitry inside the IC. Resistor R3 is the feedback capacitor for the AGC section.

1.2.1 IC LM 386

LM386 is a low voltage audio amplifier and frequently used in battery powered music devices like radios, guitars, toys etc. **The gain range is 20 to 200**, gain is internally set to 20 (without using external component) but can be increased to 200 by using resistor and capacitor between PIN 1 and 8, or just with a capacitor. Voltage gain simply means that Voltage out is 200 times the Voltage IN. LM386 has a wide supply voltage range 4-12v. Below is the **Pin diagram of LM386**.

LM386 Pin Diagram

LM386 pin diagram consists of 8 pins where each pin has some function, such as



LM386 Pin Diagram

PIN 1 and 8: These are the gain control PINs, internally the gain is set to 20 but it can be increased up to 200 by using a capacitor between PIN 1 and 8. We have used 10uF **capacitor C1** to get the highest gain i.e. 200. Gain can be adjusted to any value between 20 to 200 by using proper capacitor.

Pin 2 and 3: These are the input PINs for sound signals. Pin 2 is the negative input terminal, connected to the ground. Pin 3 is the positive input terminal, in which sound signal is fed to be amplified. In our circuit it is connected to the positive terminal of the condenser mic with a **100k potentiometer RV1**. Potentiometer acts as volume control knob.

A **capacitor C5** of 0.1uF has also been used along with potentiometer, to remove the DC component of input signal and only allow audio (AC component) to be fed into LM386.

Pin 4 and 6: These are the power supply Pins of IC, Pin 6 for is +Vcc and Pin 4 is Ground. The circuit can be powered with voltage between 5-12v.

Pin 5: This is the output PIN, from which we get the amplified sound signal.

The output signal has both AC and DC component, and DC component is undesirable and can't be fed to Speaker. So to remove this DC component, a **capacitor C2** of 220uF has been used. This has the same function as Capacitor C5 (0.1uF) at input side.

Along with this capacitor, a **filter circuit** of **Capacitor C3** (.05uF) and **resistor R1** (10k) has been used at the output PIN 5. This filter also called the **"Zobel network"**, this electronic filter is used to remove the sudden High frequency oscillations or noise.

Pin 7: This is the bypass terminal. It can be left open or can be grounded using a capacitor for stability.

Gain Control of LM386

To make the LM386 a more versatile amplifier, two pins (1and 8) are provided for gain control. With pins 1 and 8 open the 1.35 kW resistors sets the gain of 20 (26 dB). If a capacitor is put from pin 1 to 8, bypassing the 1.35 kW resistors, the gain will go up to 200 (46 dB). If a resistor is placed in series with the capacitor, the gain can be set to any value from 20 to 200. Gain control can also be done by capacitive coupling a resistor (or FET) from pin 1 to ground. Additional external major components can be placed in parallel with the internal feedback resistors to tailor the gain and frequency response for individual applications.

For example, you can compensate poor speaker bass response by frequency shaping the feedback path. This is done with a series RC from pin 1 to 5 (paralleling the internal 15 kW resistor). For 6 dB effective bass booster 15 kW, the lowest value for good stable operation is R = 10 kW if pin 8 is open. If pins 1 and 8 are bypassed, then R as low as 2 kW can be used. This restriction is because the amplifier is only compensated for closed-loop gains greater than 9.

Features of LM386

- Operated on battery
- Minimum external parts
- Wide voltage range: 5v-18v
- 4ma current drain which is very low
- 20 to 200 voltage gain
- Input refers to the ground
- Output is self centered quiescent voltage
- Distortion is very low
- Available in 8 dip pin package

Applications of LM386

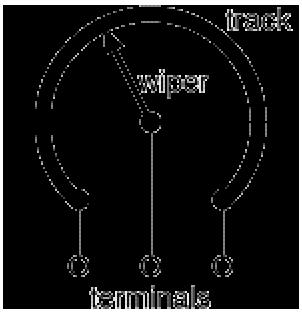
- In radio amplifiers, especially in AM and FM
- Portable audio players

1.2.2 Variable Resistor

A variable resistor is a device that is used to change the resistance according to our needs in an electronic circuit. It can be used as a three terminal as well as a two terminal device. Mostly they are used as a three terminal device. Variable resistors are mostly used for device calibration.

Working of Variable Resistor

As shown in the diagram below, a variable resistor consists of a track which provides the resistance path. Two terminals of the device are connected to both the ends of the track. The third terminal is connected to a wiper that decides the motion of the track. The motion of the wiper through the track helps in increasing and decreasing the resistance.



Variable Resistors Working

The track is usually made of a mixture of ceramic and metal or can be made of carbon as well. As a resistive material is needed, carbon film type variable resistors are mostly used. They find applications in radio receiver circuits, audio amplifier circuits and TV receivers. For applications of small resistances, the resistance track may just be a coil of wire. The track can be in both the rotary as well as straight versions. In a rotary track some of them may include a switch. The switch will have an operating shaft which can be easily moved in the axial direction with one of its ends moving from the body of variable resistor switch.

The rotary track resistor with has two applications. One is to change the resis tance. The switch mechanism is used for the electric contact and non-

Contact by on/off operation of the switch. There are switch mechanism variable resistors with annular cross-section which are used for the control of equipments.

Even more components are added onto this type of a variable resistor so as to make them compatible for complicated electronic circuits. A high-voltage variable resistor such as a focus pack is an example. This device is capable of producing a variable focus voltage as well as a screen voltage. It is also connected to a variable resistance circuit and also a fixed resistance circuit [bleeder resistor] to bring a change in the applied voltage. For this both the fixed and variable resistor are connected in series.

A track made in a straight path is called a slider. As the position of a slider cannot be seen or confirmed according to the adjustment of resistance, a stopping mechanism is usually included to prevent the hazards caused due to over rotation.

Variable Resistor Connection

A Variable Resistor is used as a rheostat when one end of the resistance is tracked and the wiper terminal is connected to the circuit and the other terminal of the resistance track remains open. In this case, the electrical resistance is connected between the track terminal and wiper terminal which depends upon the position of the wiper (slider) on the resistances track. A variable resistor can also be used as a potentiometer when both ends of the resistance track are connected to the input circuit and one of the said ends of resistance track and wiper terminal is connected to the output circuit.

In this case, all three terminals are in use. Sometimes, in electronics circuit, there may be a requirement of adaptable resistance, but this modification is required only once or very often. This is done by connecting preset resistors in the circuit. Preset resistor is one kind of variable resistor whose electrical resistance value can be adjusted by adjusting an adjustable screw attached to it.

Applications

- Voltage and Current Control Circuits
- Used as volume control knobs in radios
- Tuning or controlling circuits
- Analog input control knobs

1.2.3 Capacitor

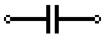
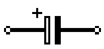
Capacitor is an electronic component that stores electric charge. The capacitor is made of 2 close conductors (usually plates) that are separated by a dielectric material. The plates accumulate electric charge when connected to power source. One plate accumulates positive charge and the other plate accumulates negative charge.

The capacitance is the amount of electric charge that is stored in the capacitor at voltage of 1 Volt.

The capacitance is measured in units of Farad (F).

The capacitor disconnects current in direct current (DC) circuits and short circuit in alternating current (AC) circuits

Capacitor symbols

Capacitor		
Polarized capacitor		
Variable capacitor		

Capacitance

The capacitance (C) of the capacitor is equal to the electric charge (Q) divided by the voltage (V):

$$C = \frac{Q}{V}$$

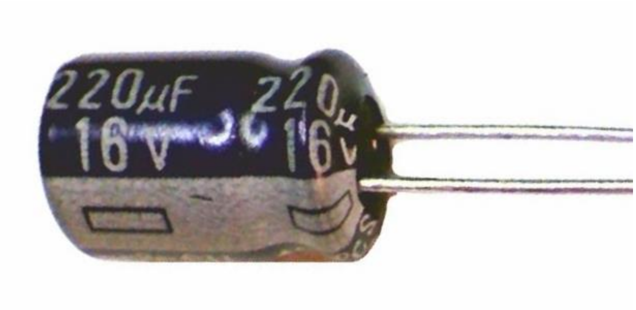
C is the capacitance in farad (F)

Q is the electric charge in coulombs (C) that is stored on the capacitor

V is the voltage between the capacitor's plates in volts (V)

220uF/25V Electrolytic Capacitor

A **capacitor** (originally known as a **condenser**) is a passive **two-terminal electrical component** used to store electrical energy temporarily in an electric field. The forms of practical capacitors vary widely, but all contain at least two electrical conductors (plates) separated by a dielectric

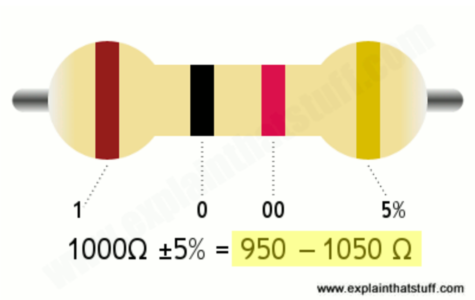


1.2.4 Resistor

A resistor is an electrical component that limits or regulates the flow of electrical current in an electronic circuit. Resistors can also be used to provide a specific voltage for an active device such as a transistor.

How resistors work

Resistor R2 (10k) has been used as a Pull up resistor to connect Condenser mic to the positive supply voltage, to provide the power to the mic. A suitable resistor should be used for proper working of mic, you can look up to datasheet for the value or use a variable resistor and set the proper value.



1.2.5 Loudspeaker

A Loudspeaker basically is a device able to convert or reproduce electrical signals or frequencies into corresponding music and/or speech vibrations in the air. These electrical signals, which are used to drive a loudspeaker, are always received from audio amplifiers.

How loudspeakers turn electricity into sound

How a loudspeaker works. When a fluctuating electric current flows through the coil (orange), it becomes a temporary electromagnet, attracted and repelled by the permanent magnet (blue/red). As the coil moves, it moves the cone (gray) back and forth, pumping sound waves into the air (light blue).

When things shake about, or vibrate, they make the sounds we can hear in the world around us. Sound is invisible most of the time, but sometimes you *can* actually see it! If you thump a kettle-drum with a stick, you can see the tight drum skin moving up and down very quickly for some time afterward—pumping sound waves into the air. Loudspeakers work in a similar way.

At the front of a loudspeaker, there is a fabric, plastic, paper, or lightweight metal **cone** (sometimes called a **diaphragm**) not unlike a drum skin (colored gray in our picture). The outer part of the cone is fastened to the outer part of the loudspeaker's circular metal rim. The inner part is fixed to an iron coil (sometimes called the **voice coil**, colored orange in the diagram) that sits just in front of a permanent magnet (sometimes called the **field magnet**, and colored yellow). When you hook up the loudspeaker to stereo, electrical signals feed through the speaker cables (red) into the coil. This turns the coil into a temporary magnet or **electromagnet**. As the electricity flows back and forth in the cables, the electromagnet either attracts or repels the permanent magnet. This moves the coil back and forward, pulling and pushing the loudspeaker cone. Like a drum skin vibrating back and forth, the moving cone pumps sounds out into the air.

1.2.6 Inductor

An **inductor**, also called a coil, chokes or reactor is a passive two-terminal electrical component that stores energy in a magnetic field when electric current flows through it. An **inductor** typically consists of an insulated wire wound into a coil around a core. The inductors required for RF circuits (antenna, tuner, amplifier etc).

1.2.7 Antenna

Captures the radio waves. Typically, the antenna is simply a length of wire. When this wire is exposed to radio waves, the waves induce a very small alternating current in the antenna

2.1.8 Transistor

A transistor **is a semiconductor device used to amplify or switch electronic signals and electrical power. It is composed of semiconductor material usually with at least three terminals for connection to an external circuit. A voltage or current applied to one pair of the transistor's terminals controls the current through another pair of terminals. Because the controlled (output) power can be higher than the controlling (input) power, a transistor can amplify a signal.**
Most transistors are made from very pure silicon or germanium, but certain other semiconductor materials can also be used. A transistor may have only one kind of charge carrier, in a field effect transistor, or may have two kinds of charge carriers in bipolar junction transistor devices. Compared with the vacuum tube, transistors are generally smaller, and require less power to operate. Certain vacuum tubes have advantages over transistors at very high operating frequencies or high operating voltages. Many types of transistors are made to standardized specifications by multiple manufacturers.

1.20 Circuit realization

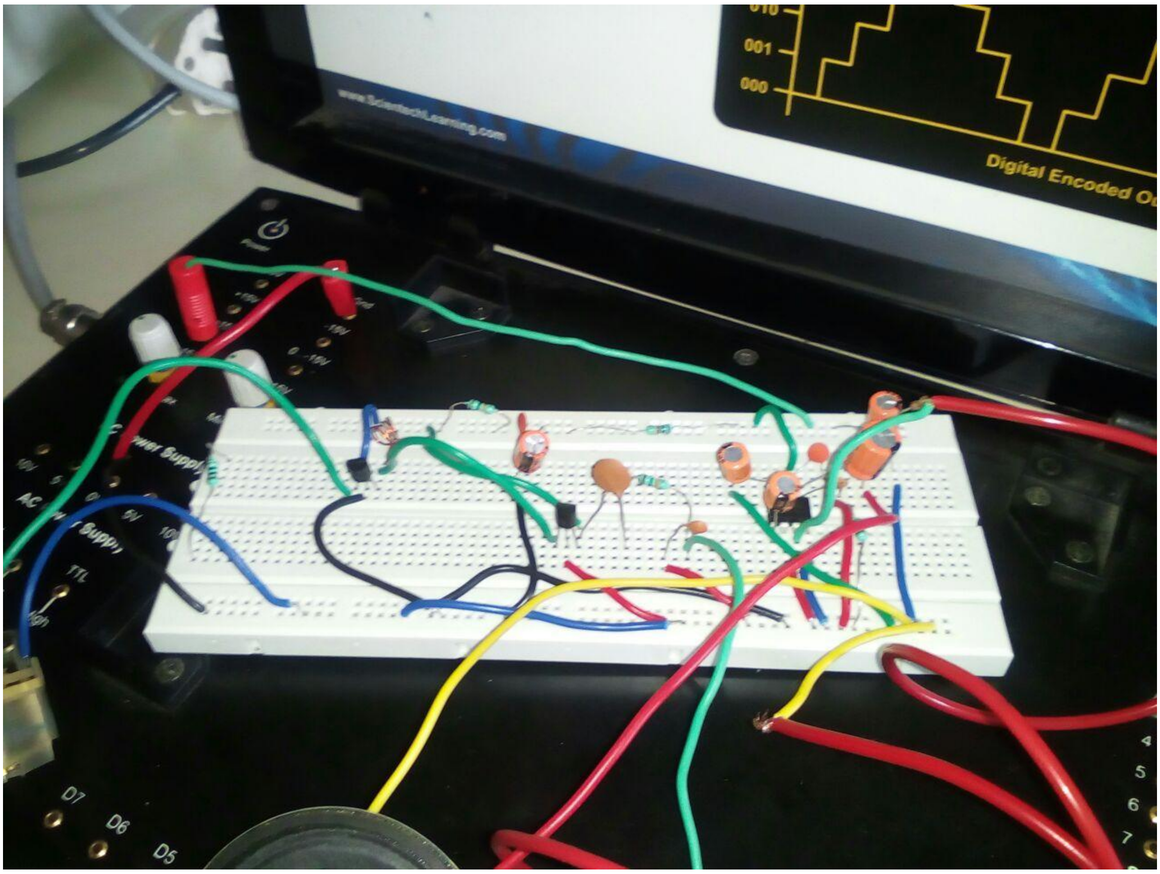


Figure 1.8: Construction of circuit 1

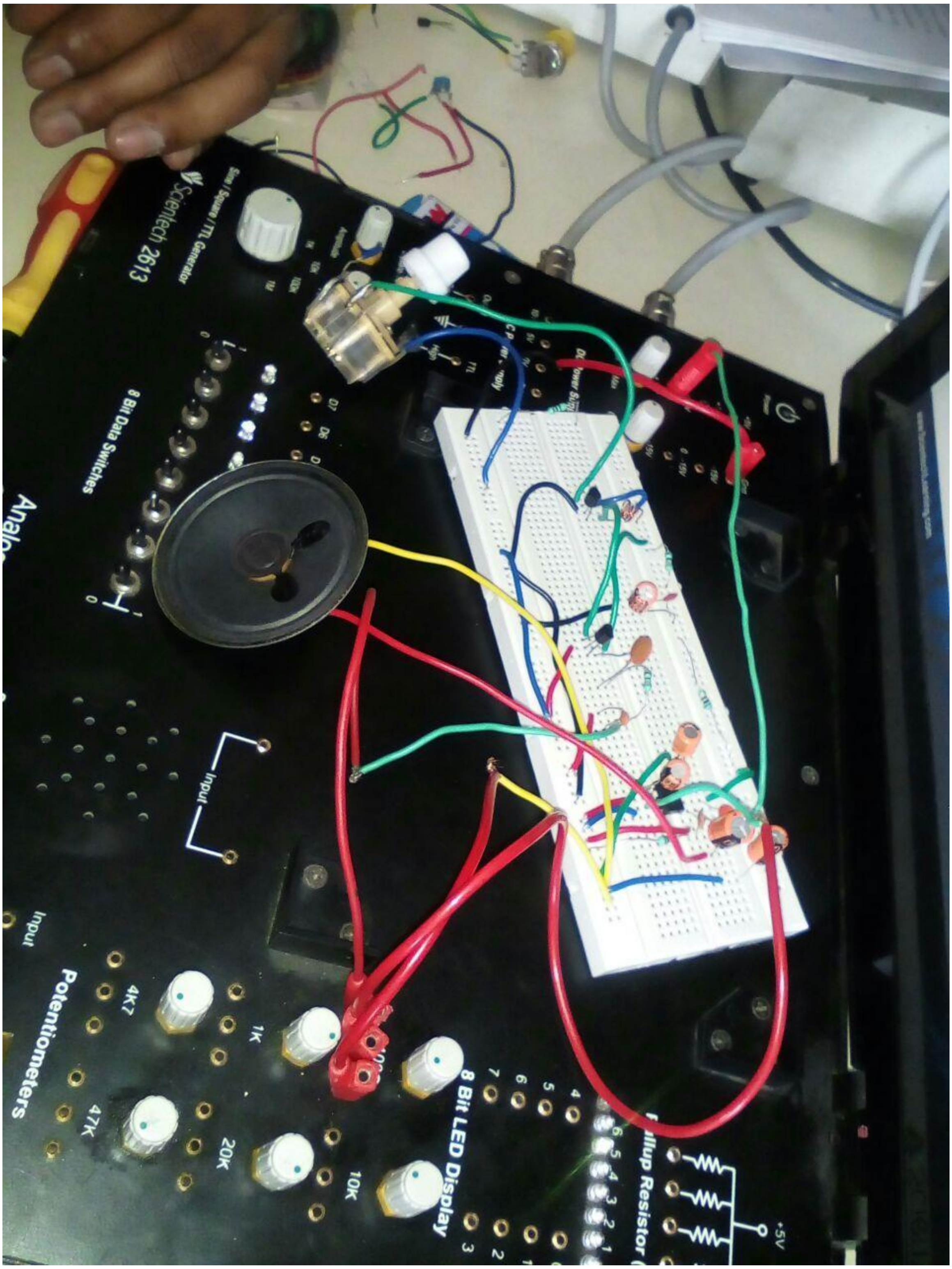


Figure 1.9: Construction of circuit 2

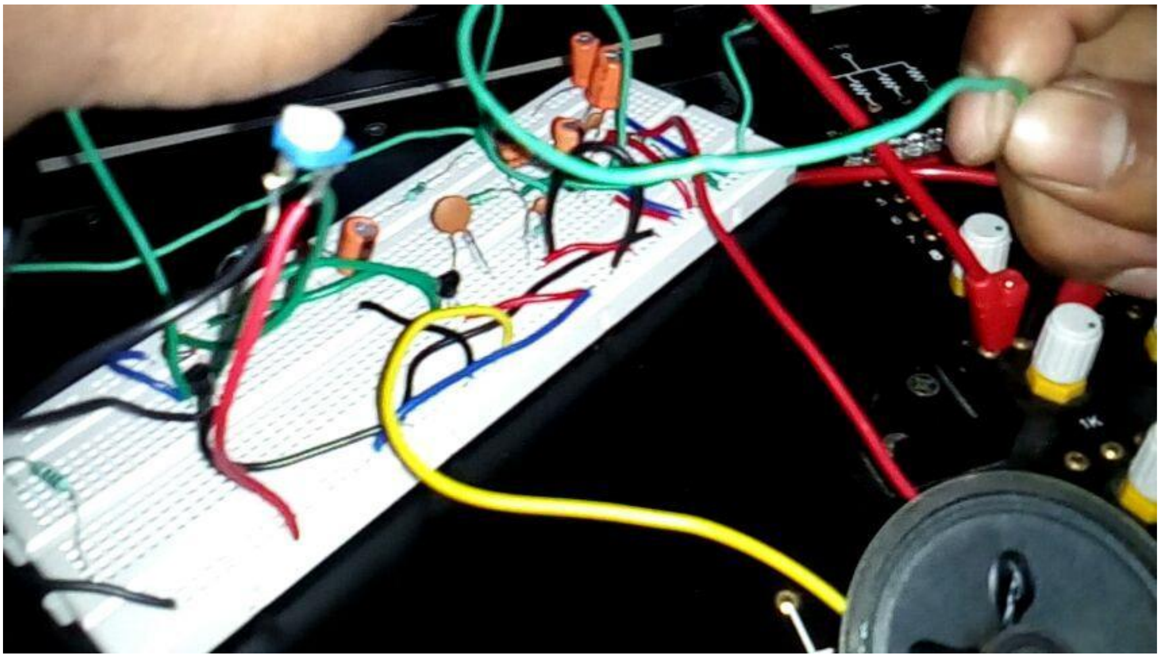


Figure 1.10: Construction of circuit 3

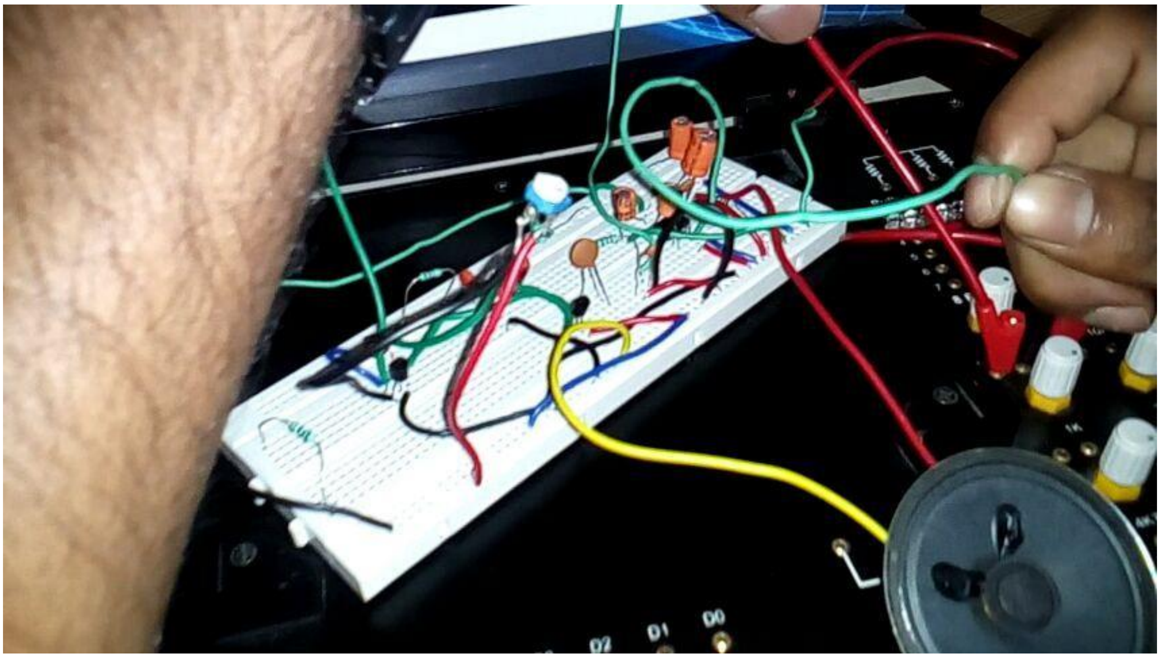


Figure 1.11: Construction of circuit 4

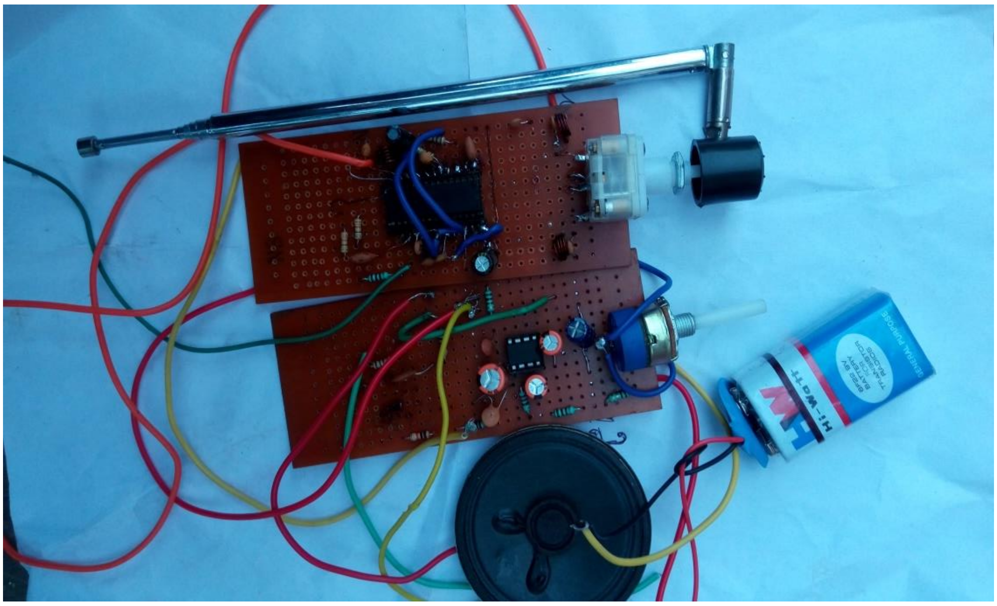


Figure 1.12: Main circuit

Conclusion

We therefore conclude that this project is indeed suitable for electronics engineering Students especially to students taking up FM Reception in their Electronic Communications Theory subject.
We Implemented FM Receiver part and Audio Amplifier Part respectively. At very beginning, while designing FM Receiver circuit,
We came across some particular problems, i.e. for using TRANSISTORS. After replacing TRANSISTORS with An IC, we obtain good response.
We have now seen an exact application of our lessons such as- Wireless Communication, FM modulation, Demodulation, Reception and also Amplifiers and more.
Being able to receive information by means of wireless FM communication is indeed fascinating.

We can hear the transmitted sound signal in the FM Receiver from the transmitter. The quality of sound of the receiver is good and there was less noise that can be observed in some frequency range.

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