A PROJECT REPORT

ON

DESIGN AND CONSTRUCTION OF A SHORT WAVE SUPERHETERODYNE RADIO RECEIVER

BY

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CERTIFICATION

The piece of work on the design and construction of a superheterodyne short wave receiver has been approved on partial fulfillment of the requirement for the award of B. Engineering in electrical/Computer Engineering Technology, Federal University of Technology, Minna.

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External Examiner Sign_______________ Date_______________

DECLARATION

This work was entirely carried out by Abbas Abdulhafeez and has never been submitted to the university for award of Bachelor of Engineering Degree (B. ENGR.)

DEDICATION

This piece of work is dedicated to Almighty Allah who has given me the wisdom strength to carryout these assignment. Also it is dedicated to my beloved master **SHIEK UTHMAN NURAIN**, my beloved mother **HAJIA R. ABBAS** and my amiable anti **HAJIA HUSSEINA R. ABDUL**.

ACKNOLODGEMENTS

In the name of Allah, the most gracious the most merciful. I wish to first and foremost thank almighty Allah for sparing my life to witness the ceaseless end of this project.

I wish to acknowledge the support, encouragement and prayers from my beloved parents Alhaji M. Abbas, Hajia R. Abbas Abdu, my anti Hajia Husseina R. Abdu, my brother lawal, my sisters Ramatu and Jumai and also that of my beloved master sheik Uthman Nurain.

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Finally my sincere gratitude and appreciation goes to Idayat, Lukuman, Muinat who helped me out in typing of the project and all those who have contributed one way or the other to the success of this project.

ABSTRACT

The project as the title indicates is a design and construction of a short wave Superheterodyne radio receiver.

The project report starts by taking a general view of the importance of Communication, the place of radio receivers and the Superheterodyne short wave receiver.

Later it was followed by a precise study of the various stages of the Superheterodyne receiver and the design process.

The report went on with the design and construction processes of the receiver, showing the design calculations. In the design analysis, the circuitry was made as simple as possible to aid readability and understanding of the various stages of the system. It also shows the result obtained the problem encountered, conclusion and recommendation.

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CHAPTER ONE

1.0 INTRODUCTION

A short wave receiver is an Amplitude Modulation (AM) receiver, with a frequency range, of about 2MHZ to 30MHZ. The technology of the short wave receiver is based on the Superheterodyne technique, whose principle of operation involves two very close radio frequency signals, which are mixed together to produce a fixed, and strengthened lower frequency called the Intermediate Frequency (IF).

The Superheterodyne technique operates with maximum stability, selectivity, and sensitivity.

The basic block diagram of a short wave Superheterodyne radio receiver is shown in figure 1.0.

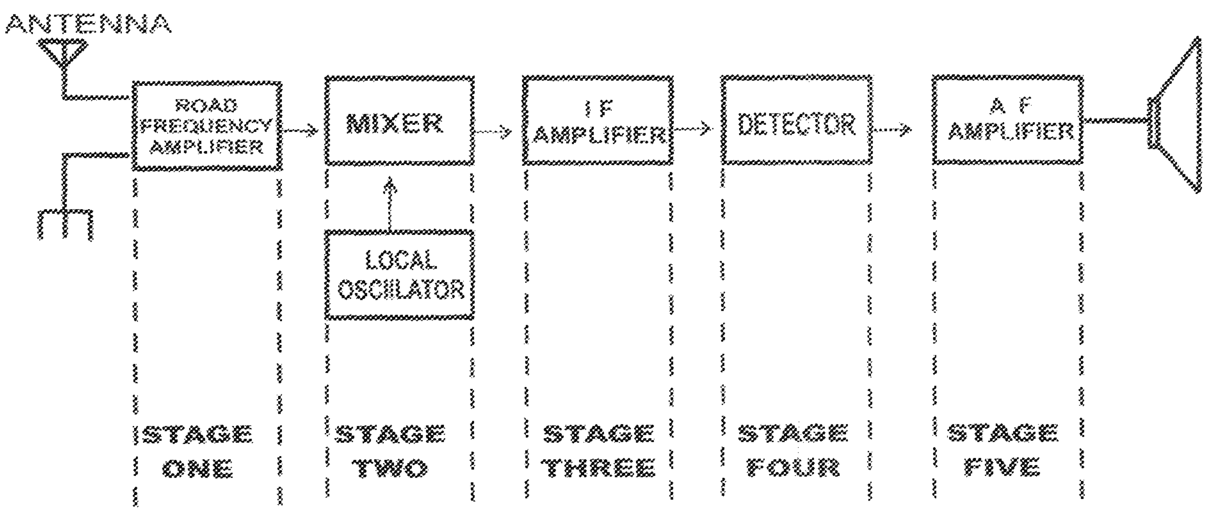


FIGURE 1.0 BLOCK DIAGRAM OF A SHORT WAVE RECEIVER (SUPERHETERODYNE)

The space contains a lot of radio radiation with numerous frequencies and each induces electric current in a free antenna. Therefore the turned radio frequency amplifier selects and amplifies the required frequency band signals from the various signals intercepted by the antenna.

The amplified RF signal is then coupled to the mixer stage, which beats together the two frequency signals. Firstly the amplified RF Signal of frequency F_{RF}, while the other is from a Local Oscillator Signal of frequency F_{LO}. The output of the mixer is the sum and difference signals of frequencies $F_{LO} \pm F_{RE}$.

The IF amplifier selects the difference frequency signal F_{IF}, which is also known as the intermediate frequency is normally 455KHZ for AM broadcasting receivers. The intermediate frequency amplifier is a turned type and allows only the intermediate frequency signal to go through while it rejects others. The amplifier also strengthens the frequency and passes it to the detector.

The AM Signal is detected using an envelope detector which demodulates the modulated frequency i.e. the audio Signal which is used to modulate the carrier wave in the amplitude modulation transmitted is then extracted from the wave and the radio frequency is filtered out.

The AF amplifier amplifies the AF Signal and sends it to the Speaker. The Superheterodyne receiver is also referred to as a "double-detection receiver with the mixer as the first detector and the envelope detector as the second.

1.1 LITERATURE REVIEW

The development of radio communication started with the discovery of the radio wave (the electromagnetic waves). The existence of radio wave was predicted long before they were actually discovered. James Clerk Maxwell made the prediction in 1864. The great English Mathematical Physicist. In 1885 a German Physicist Henrys Hertz (1871-1894) domesticated that the wave actually does exist and they travel through space.

An English Physicist Ernest Ruther Ford (1871-1937) succeeded in sending signal ¾ mile. Another basic principle of tuning, but the most successful of all the radio pioneer was G Markconi (1874-1937) an Italian, who went to England to work and he is the father of radio Communication.

In 1904 the first Vacuum tube was made by John Ambrose Fleming (1899-1943), an English Electrical Engineer. This tube was a diode, that is, it has two electrical parts. In 1906, an American inventor Lee De Forest (1837-1961) added a third part to Fleming Vacuum tube. This new Vacuum tube was called a Triode or Audio, it was much like the Vacuum tube used today.

The first radio broad cast was heard on Christmas Eve 1906. Radio operation on ship at sea suddenly playing them came the world, "If you have heard this programme write to R.A Fessenden at Brant Rock.

The modern Communication system is shown in fig1.1:

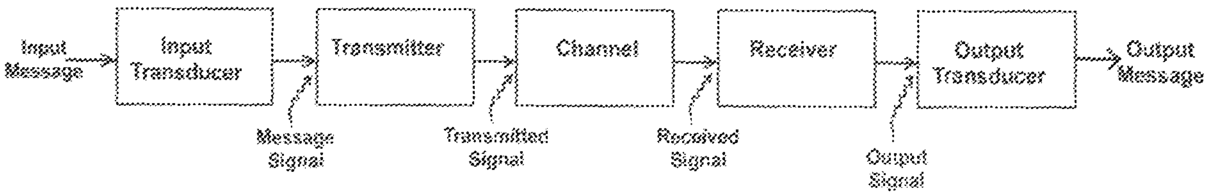


Fig 1.1Block Diagram of a modern communication system

The input transducer: the input message which may be analogue or digital, most be converted from its original form into an electrical signal to enable it to be processed by the necessary electrical/electronic equipment.

The transmitter: The transmitter couples the message to the channel. It is at the transmitter that, if necessary a carrier wave is modulated by the message signal. Modulation means modification of one of the parameters (amplitude, frequency or phase) of the carrier wave, usually of much higher frequency than that of the message signal. The parameter to be modified or modulated varies from one system to another, depending on the system requirements.

Channel: This is the medium through which the transmitted signal gets to the receiver. It may have many different forms, ranging from the ground, through underground or overhead cables, to sky and space, therefore, the transmitter can be either hard or non-wire (wireless to the receiver). A common characteristic of all channel is that the Signal passing through tem undergoes denigration which may result in noise or interference, fading, multiple transmission path, filtering etc.

Receiver: Basically, the receiver in a Communication system extracts and processes the desired Signal from the various signal received at the Channel output. The processing function includes conversion of the selected signal to a form suitable for the output transducer. This includes detection or demodulation, and amplification (of voltage and/or power) if the received signal level is low.

It may also be necessary or desired to delay the received signal. A good receiver should be able to select "well" the desired signal and reject "well" any unwanted signal.

Output transducer: This is an element or device that convets the electrical output signal of the receiver into the form desired by the user. For example a loud speaker converts electrical signal to sound waves for the user to hear. Among other common transducers are Cathode-ray-tubes(CRT), Tele typewriters, meters (analogue or digital) and oscilloscopes.

1.2 THE AIMS AND OBJECTIVES

The aim and objectives of this project is to design and construct a short wave superheterodyne radio receiver of frequency range from about 2MHZ to 22MHZ.

CHAPTER TWO

2.0 THEORY

2.1 CONSTRUCTION OF AN A M WAVE:

Amplitude modulation occurs if the amplitude of the carrier is varied with the modulating signal. Using the modulating and the unmodulated carrier waves as shown in Fig. 2.1(a) and Fig. 2.1(b) respectively, the A M wave represented by Fig. 2.1(c) is obtained by "Superimposing" the modulating signal on the carrier. Hence, the modulating signal forms an "envelop" to the A M wave provided the modulation depth is less than unity. It should be noted that the frequency of the AM wave is the same as that of the unmodulated carrier (i.e. Fc); it is only the carrier instantaneous that varies with the variation of the modulating signal.

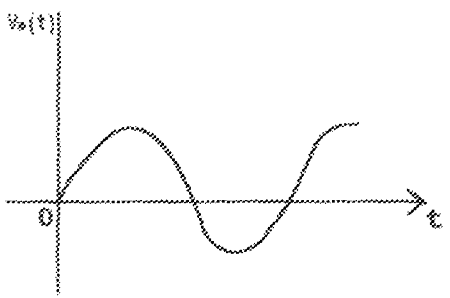


Fig 2.1a Modulating Signal

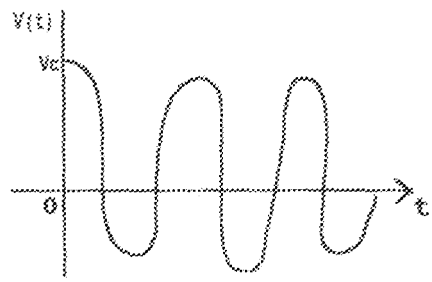


Fig 2.1b Carrier Signal

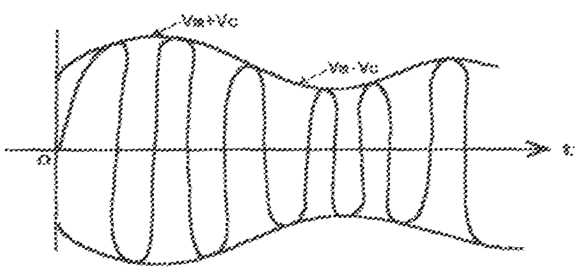


Fig 2.1c Am Wave

FIG 2.1 AM WAVE SIGNAL

The frequency Spectrum of an AM wave is given by $V_{AM}(t)$

$= V_c (1+m.Cos\omega_m t) Cos\omega_c t.$

$= V_c Cos\omega_c t + mV_c cos\ \omega_m t\ Cos\ w_c t.$

$= V_c Cos\omega_c t + ½\ mV_c cos\ (W_c - w_m) + ½m\ V_c\ Cos\ (W_c+w_m)t$

Where m = modulation depth.

This indicates that an AM wave consist of the following components.

i. A carrier frequency with amplitude V_c,

ii. A lower side-frequency F_c-F_m with amplitude ½mV_c and

iii. An Upper side frequency F_c+f_m with amplitude ½mV_c.

2.2 TRANSMISSION OF AN AM WAVE

The microphone converts the pure audio tone into the message signal, which is processed and filtered to make it occupy the required bandwidth. The modulating signal is superimposed on the carrier signal to form an envelope, which is, then transmitter using an AM transmitter through a channel to the receiver.

2.3 RADIO FREQUENCY STAGE

The radio frequency stage of a Supeheterodyne radio receiver must perform the following functions:-

1. It must couple the aerial to the receiver in an efficient manner.
2. It must suppress signals around or near the image and intermediate frequency.
3. At frequencies in excess of about 3mHz, it must provide gain.
4. It must operate linearly to avoid the production of cross modulation.

5. It should be selective enough to minimize the number of frequencies appearing at the input of the mixer that could result in inter modulation products lying within the pass-band of the IF amplifier.

At frequencies above 3MHz the noise picked up by an aerial is larger than the noise generated within the receiver. An RF amplifier will amplify the aerial noise as well as the signal and produce little, if any, improvement in the output signal to noise ratio. At higher frequencies the noise picked up by the aerial falls and the constant level receiver noise becomes predominant, the use of RF gain will then improve the output signal to noise ratio.

2.4 THE MIXER STAGE

The function of the mixer stage is to convert the wanted signal frequency into the intermediate frequency of the receiver. This process is carried out by mixing the signal frequency with the output of the local oscillator and selecting the resultant difference frequency.

The local oscillator must be capable of tuning to any frequency in the band to which the receiver is tuned plus the intermediate frequency i.e Fo = Fs + Fif. The ability of a receiver to remain tuned to a particular frequency without drifting depends upon the frequency stability of its local oscillator. In an AM broadcast receiver the demands made on the Oscillator in terms of frequency stability are not stringent since the receiver is tuned by air. High frequency communication receivers need greater frequency stability mainly because the channel Bandwidth is narrow. Receiver operating at one or more fixed frequencies can use a crystal oscillator, frequency charges involving crystal switching. When a receiver is to be turnover a band of frequencies an L-C Oscillator with automatic frequency control or a frequency synthesizer must be used.

2.5 INTERMEDIATE FREQUENCY AMPLIFIER

The purpose of the intermediate frequency (IF) amplifier in a Superheterodyne radio receiver is to provide most of the gain and the selectivity of the receiver. Most broadcast receivers utilize the impedance/frequency characteristic of single or double tuned circuits to obtain the required selectivity, but many receivers use ceramic fitter, particularly when an integrated circuit is used as the IF amplifier. Narrow band communication receivers must possess very good selectivity and very often employ one or more crystal fitters to obtain the necessary gain/frequency response.

The main factors to be considered when choosing the intermediate frequency for a Superheterodyne radio receiver are: -

a. The required IF band width

b. Interference Signal.

c. The required IF gain and stability and

d. The required adjacent channel selectivity.

The intermediate frequency should not lie within the tuning range of receiver, so that the radio frequency stage (RF) can include an IF trap to prevent IF interference. However, to simplify the design and construction of the IF amplifier, the intermediate frequency should be as low as possible.

2.6 DETECTION

The diode detector is universally used as the AM detector. The major disadvantages of the diode detector are lack of gain, low sensitivity and poor selectivity. And these are made up for in the IF amplifier. The advantage of using the diode detector is fidelity and it is also inexpensive, and simple to include in the design of Automatic gain control (AGC).

A simple circuit commonly found in domestic AM receiver for demodulation of AMDSB wave is the envelope detector whose circuit diagram is shown below:

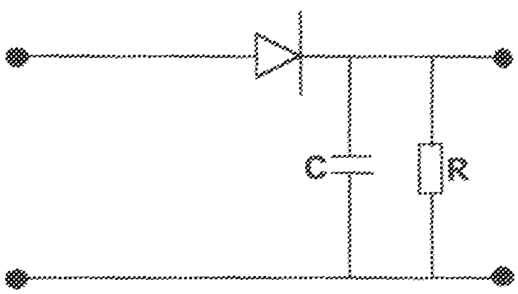


Fig 2.2a An Envelope Detector

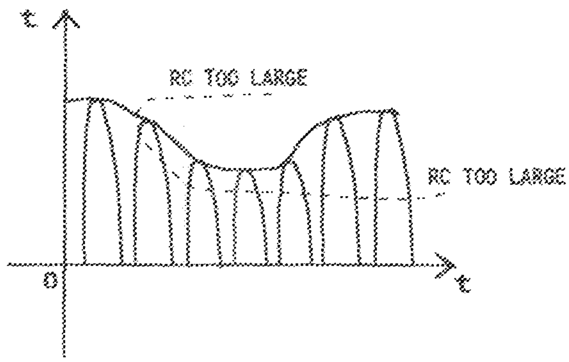


Fig 2.2b Rectifier Wave

The diode acts as a rectifier and the circuit behaves as a half-wave rectifier with capacitive fettering. As long as the modulation depth is less than unity (less than 100% modulation). The envelope of a received AMDSB signal approximate the message signal Vm (t). The fitter capacitor C, rapidly charges up during the period the AM signal reaches it peaks, the capacitor discharges through the load resistor, R. However, the discharging must neither be two slow to miss the next peak of the AM signal nor too rapid to deviate too much from the envelope. Therefore the time constraint of the filter network is governed by the inequality.

I/fc << R.C. << 1/w. Where w is the message signal bandwidth.

The envelope detector operates better with large carrier amplitude resulting in no distortion, with small carrier amplitudes, however, distortion of the envelope occurs since the diode operates in the non-linear region.

2.7 AUTOMATIC GAIN CONTROL

The field strength of the wanted signal at the aerial is not constant but fluctuates widely because of charges in propagation conditions. Automatic gain control (AGC) is applied to radio receiver to maintain the carrier level at the input of the detector at a more or less constant value even though the level at the aerial may very constantly. AGC ensures that the audio output of receiver varies only as a function of the modulation of the carrier and not with the carrier level itself.

The use of AGC also ensures that a large receiver gain can be made available for the reception of weak signals without overloading of the RF amplifier stages, with consequent distortions by strong signals. Further, a reasonable constant output level is obtained as the receiver is tuned from one station to another.

The automatic gain control systems are either of the simple or the delay type, for economic reasons the majority of broadcast receivers use simple AGC. In a simple AGC system, the AGC voltage is developed immediately a carrier voltage appears at the output of the IF amplifier. This means that the gian of the receiver is reduced below it maximum value when the wanted signal is weak and the full receiver gain is really wanted. This disadvantage of the simple AGC system can be over comed by arranging, that the AGC voltage will not be developed until the carrier wave is detected.

2.8 FILTERS

The term as used in communications system, is a frequency selective network designed to operate on an input signal to produce a desired output signal. That is, a filter passes signal of certain frequencies and blocks signals of other frequencies, the transmitted or passed signals having a certain range or ranges of frequencies, referred to as the band pass and the suppressed signals of other frequencies. The suppressed bands being referred to as the attenuation band or bands. The signals may be a continuous time entity that may be stated in time or frequency terms. The discrete time entities may also be stated in time or frequency terms.

Filters are usually categories according to their behaviour in the frequency, domain and are specified in terms of their magnitude or transfer response. Filters are classified as low pass, high pass, band pass, based on phase characteristics.

2.9 AUDIO FREQUENCY STAGE (AUDIO AMP)

The function of the Audio-frequency stage of a radio receiver is to develop sufficient audio frequency (A.F) power to operate the loud speaker or other receiving apparatus.

The A.F. stage will include a volume control and sometimes treble and base controls. The A.F stage may also include a muting facility. A sensitive receiver will produce a considerable output noise level when there is no input signal because there will then be no automatic gain control voltage developed to limit the gain of the receiver. The noise unavoidably present at the input terminal of the receiver then receives maximum amplification. The noise output can be considerable annoyance to the operator of receiver and to reduce or eliminate this annoyance a squelch circuit is filtted, which disconnects or severely attenuates, the gain of the A.F. amplifier whenever there is no input signal present.

2.10 SELECTIVITY AND SENSITIVITY

Selectivity is defined in radio receiver as the ability of a radio receiver to select the signal of a required radio station and reject the signals of unwanted adjacent stations. This is an important parameter in view of the great number of radio stations operating on or almost on the same frequencies, the higher the selectivity the lower the interference from the adjacent station.

Sensitivity of a radio receiver is its ability to pick up and reproduce weak signals and is determined by the value of high frequency voltage for normal output power. The lower the necessary input voltage for normal operation, the higher the sensitivity. For modern radio receiver's sensitivity values range from several microvolts to several multivolts. Higher Sensitivity can be assured achieved by increase the number of amplification stages which should however, be limited in order not to increase noise and distortion.

2.11 INTERFERENCE

No matter how complex or simple the design of a Superheterodyne radio receiver is, it is usually open to interference from unwanted signals. Some of the common interference sources include: -

Image channel interference: No matter what frequency a Superheterodyne receiver is tuned to, there is always another frequency that will also produce the intermediate frequency. The other frequency is known as the image frequency. The image signal has a frequency, Fm, such that the difference between it and the local oscillator, frequency is equal to the intermediate frequency F_{IF}.

The image signal is thus separated from the wanted signal by twice the intermediate frequency. The image signal must be prevented from reaching the mixer or it will produce an interference signal which, since it is at the interference frequency, cannot be filtered by the selectively of the IF amplifier. The RF stage most include a resonant circuit with sufficient selectivity to refit this image signal when tuned to the wanted signal frequency.

Another type of interference is the intermediate break, through this occur if a signal at the intermediate frequency is picked through, an aerial close to a river, it will interfere with the wanted signal. Such a signal must therefore be suppressed at the RF stage by an IF trap.

Another form is the co-channel interference, the Superheterodyne receiver is exposed to a number of other sources of interference, co-channel interference is due to another signal at the same frequency, and cannot be eliminated by the receiver itself. When it occurs, it is the result of unusual propagation conditions making it possible for transmission from a distance station to be picked up by the aerial. This form of interference can be reduced by operating the RF stage as linearly as possible.

Cross-modulation is another form of interference and is the transfer of the amplitude modulation of an unwanted carrier into the wanted carrier and is always the result of non-linearity in the characteristic of the FR amplifier or of the mixer. If the amplitude of the input signal is small, cross modulation will occur. The unwanted signal may be well outside the band pass of the IF amplifier once cross modulation has occurred.

Cross modulation is only present as long as the unwanted carrier producing effect exist at the aerial. And it can be minimized by linear operation of the IF stage and by increasing the selectivity of the RF stage, to reduce the number of large amplified signal entering the receiver.

2.12 NOISE

Noise is any unwanted or undesired signal interfering with the reception and processing of the desired signal. It can be classified into broad categories, depending on its source. Internal Noise is created by any of the passive or active devices found in the receiver while External Noise, on the other hand originates outside the receiver e.g. extra-terrestrial bodies, Atmospheric noise etc. Filters are used to reduce or eliminate the effect of noise in the receivers.

CHAPTER THREE

3.0 DESIGN AND CONSTRUCTION

The design of the superhetrodyne radio receiver involves the determination of value of the components that make up of the various stages of the receiver. In the design, the approximation of the calculated value is however inevitable, hence approximation of values have been used where necessary instead of calculated values.

The superhetrodyne principle calls for two district amplification and filtering sections prior to demodulation, as shown in fig 3.1

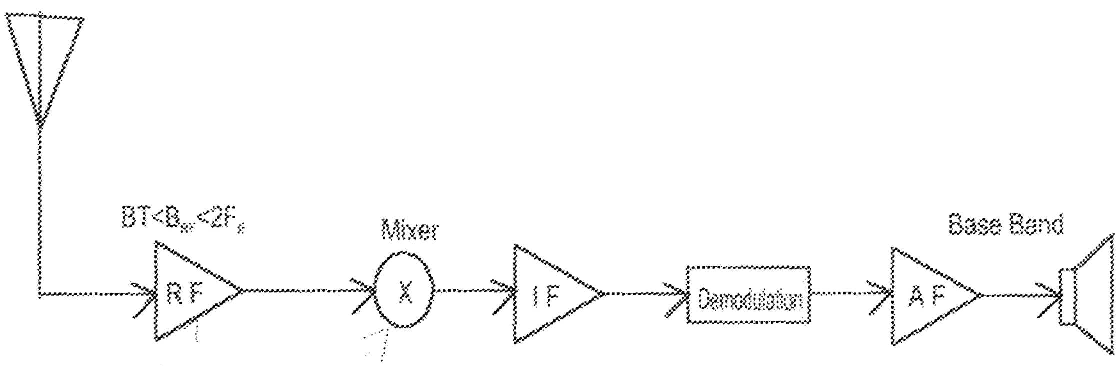


Fig 3.1

$F_{LO} = F_c + F_{IF}$

FIG 3.1 SHOWS THE VARIOUS AMPLIFICATION & FILTERING STAGES

The incoming signal X (t) is selected and amplified by the RF Section tuned to the desired carrier frequency F_C – This amplifier has a relatively broad bandwidth B_{RF} that partially passes adjacent-channel signals along with Xc(t). Next, a frequency converter comprised of a mixer and local oscillator translate the RF output into an intermediate frequency (F_{IF}) band at $F_{IF} < F_C$. The adjustable Lo frequency tracks with the RF tuning such that: $F_{LO} = FC + F_{IF}$

$F_{LO} = F_C - F_{IF}$

An IF input section with bandwidth $B_{IF} > BT$ removes the adjacent – channel signals. This section is a fixed band pass amplifier called the IF strip, which provides most of the gain. Finally the IF output goes to the demodulator for message recovery and base band amplification. To calculate the intermediate frequency (F_{IF}), assuming we have a radio frequency of $2MH_Z$ and local oscillator frequency (which is normally higher than the radio frequency) to be $2.455MH_Z$. The intermediate frequency

$$F_{IF} = F_{LO} - F_{RF}$$

$$F_{IF} = 2.455MH_Z - 2MH_Z$$

$$F_{IF} = 455KHZ$$

F_{IF} is normally 455KHZ for AM broadcasting receivers.

3.1 RECEIVING AERIAL

An antenna or aerial converts electromagnetic waves into high-frequency current. It couples the electromagnetic wave from the atmosphere to the input of the receiver.

3.2 TUNING CIRCUIT

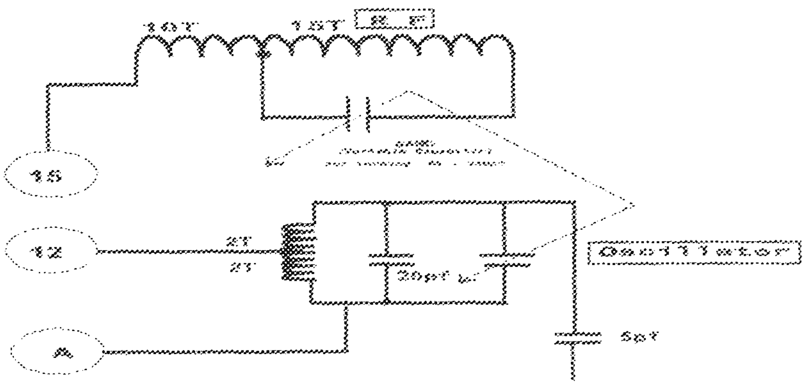


Fig 3.2

FIG 3.2 TUNING CIRCUIT

The RF signals picked by the receiving antenna are fed to the tuned input circuit of the receiver. Another signal F_{LO} that is generated from the Local Oscillator is gang tuned to select the required radio station and reject the unwanted ones. The ganging capacitors designated by the dotted lines have capacitance range 80- 350PF.

3.3 THE IF FILTERING CIRCUIT.

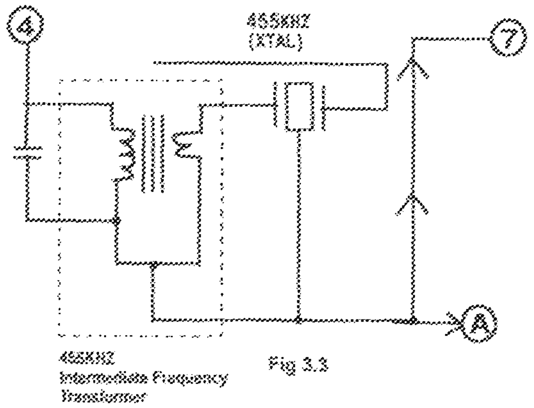


Fig. 3.3 The IF filtering Circuit .

The IF filtering circuit comprise of a tank circuit, an 455KH_Z intermediate frequency transformer and 455KH_Z IF crystal. The tank circuit consist of the following connected as shown above.

(i) Capacitor C_1 = 0.004NF.

(ii) Inductor L3 = 3.3MH, 20 turns.

(iii) inductor J2 = 2.2mH.

The tank circuit provides necessary selectivity and filter out unwanted signal. The transformer used was constructed locally by winding a coil of 33 turns on a ferrite rod. It increase the signal power of the selected IF signal high enough for modulation. The 455KZ IF Crystal was used to ensure that the IF frequency is fixed at maximum stability selectivity and sensitivity.

3.4 MIXER/DETECTOR CIRCUIT

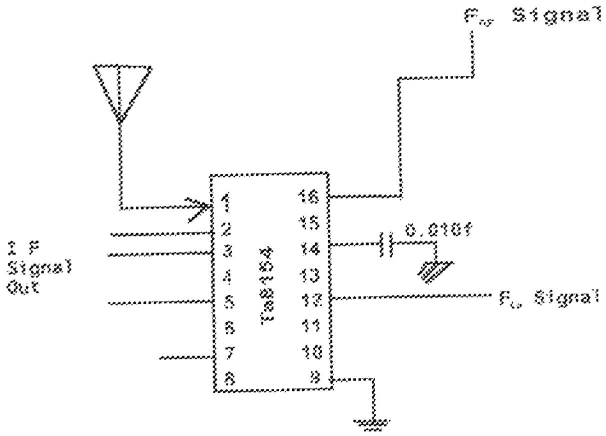


Fig. 3.4 Shows the pins configuration of the mixer (TA8164) IC

The amplified RF Signal is coupled to the input of the mixer. The mixer beats together two frequency signals. The first input to the mixer is the amplified F_{RF} through pin 1 and pin 16 while the other input is from a local oscillator signal of frequency F_{10} through pin 12 of the TA8164 IC as shown above. The intermediate frequency (F_{IF}) is developed at the output of the mixer as indicated in Fig. Above, from the pin configuration above, Pin 2, 3 and 5 give the output of the frequency converter. The amplified IF signal is fed into Pin 7 of the IC for demodulation. The function of the demodulator is to separate the modulating (message) signal from the IF signal. That is it converts an IF signal into a audio frequency AF signal by removing the carrier content of the amplified IF signal.

3.5 AUDIO FREQUENCY AMPLIFIER (AF AMPLIFIER)

The AF signal developed at the output of the detector is next amplified in the audio frequency amplifier. This will increase the signal power and gain of the AF signal before it is finally fed to the speaker. The AF amplifier finally boosts the low frequency signal to a level high enough to drive the loud speaker. In this design

LM386 IC is used as an audio amplifier. The LM386 is a power amplifier designed for use in low voltage consumer applications. The gain is increase by the connection of a capacitor between pins 1 and 8. The connections are shown in the circuit diagram below.

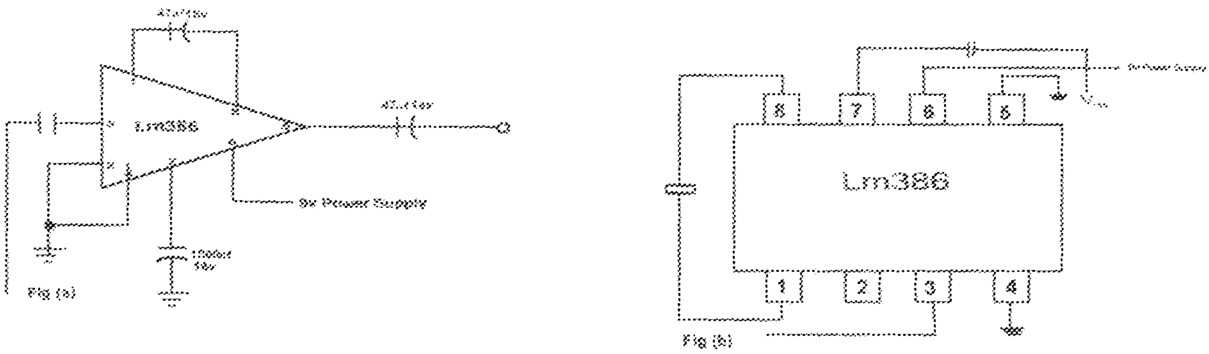


Fig. 3.5(a) & (b) illustrate the basic diagram of the LM386 IC and how it was connected respectively.

3.6 SPEAKER:

The amplified AF signal is fed to the loud speaker, which is a transducer. It converts low-frequency alternating current energy into sound wave energy (acoustic waves).

The loud speaker used in this design employs a moving coil (Electrodynamic) unit composed of the following parts: a cone, a front suspension, alloy mounting voice coil and a permanent magnet.

3.7 POWER SUPPLY UNIT

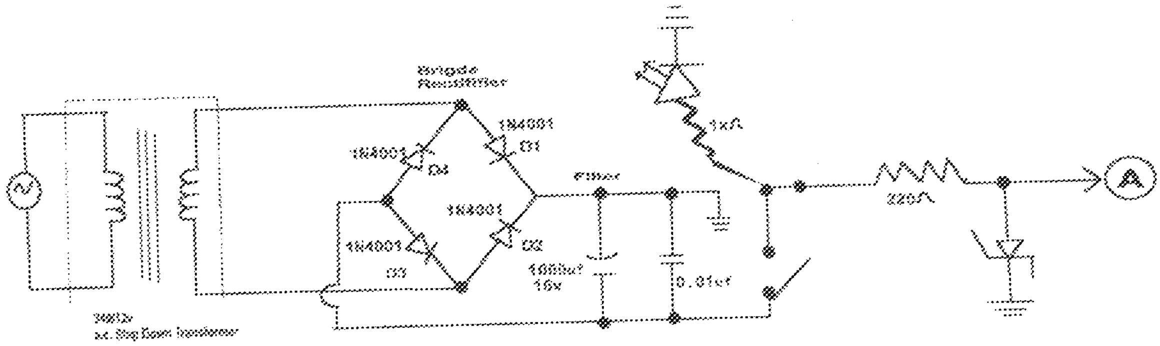


Fig.3.6 ***Regulated Power Supply***

Power Supply Unit is an electrical circuit that supplies the device with electrical energy. It can either be a battery or a rectified a.c as used in this project.

The Power Supply Unit consist of the main source, the 12V transformer, a bridge rectifier circuit a regulator circuit, a smoothing circuit for power regulation and an indication system consisting of a light emitting diode to indicate when on. The main source supplies the a.c. signal, which is then converted to d.c signal which is used to operate the constructed project.

A step-down transformer was used to step down the voltage from about 220V to 9V. The transformer voltage was chosen to be 12V (secondary) because given V peak = 12V, Vrms = $12/\sqrt{2}$ = 9V

And a fuse (1 AMP) was installed on the primary side of the transformer to protect against excessive current from the main source, which can damage the transformer and possibly the entire circuit connected. The input and output of the transformer may be considered.

Pin = P out

I_1V_1 = $I_2 V_2$

V_1 (r.m.s.) = 220v, V_2 (r.m.s.) = 9v.

I_2= 1A

$I_1 = \frac{I2\ V2}{} = \frac{1 \times 9}{} = 41mA$

V_1 = 220v

Thus at full load, a current of 41mA flows in the primary of the transformer. To calculate the fuse rating.

Fuse rating = I x allowance for current fuses x 2 (heating effect) x 2 (not to allow fuse to blow under abnormal full load).

= 41mA x 6 x 2 x 2 = 987mA.

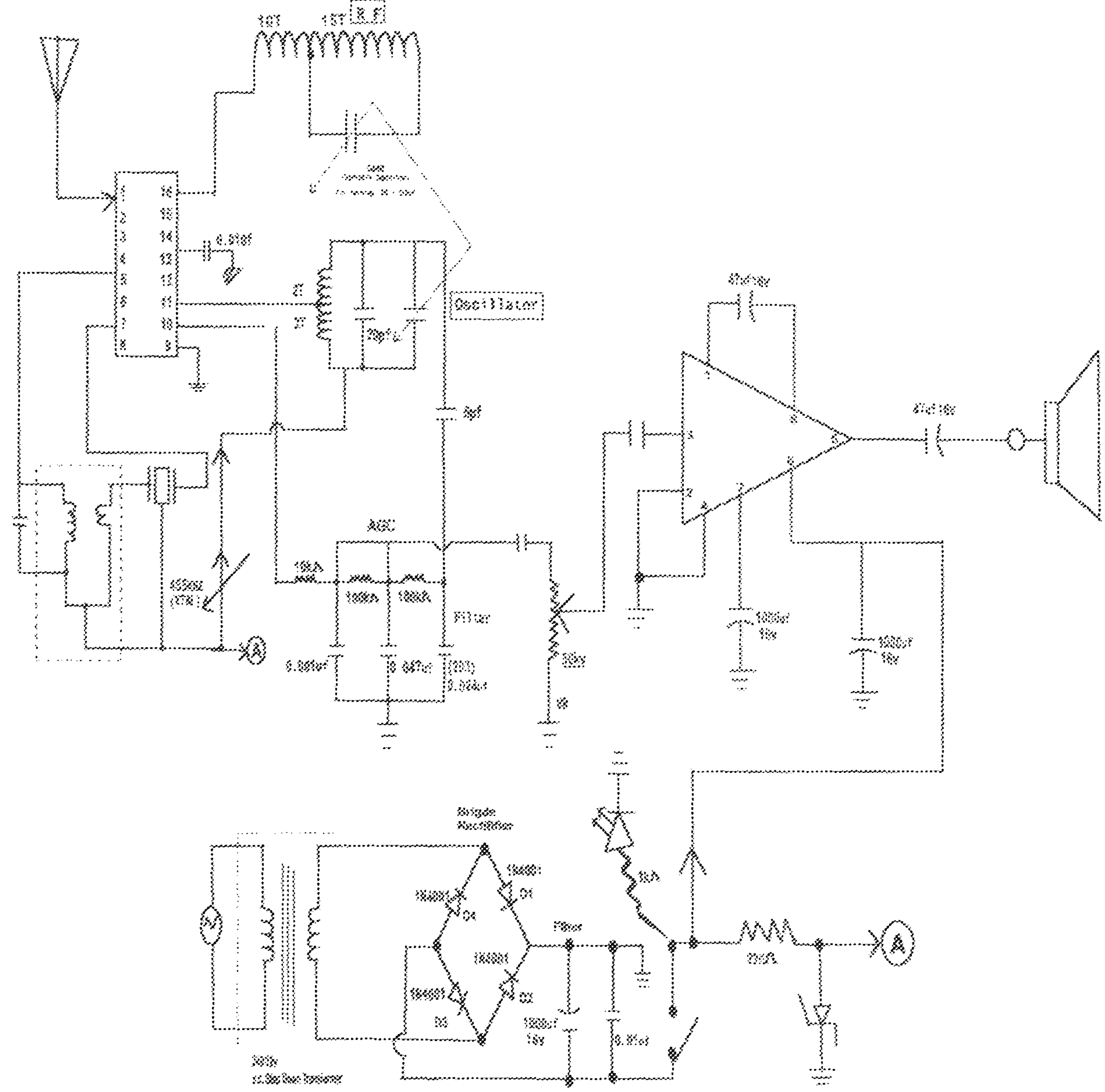
Therefore a fuse of current rating 1A was used.

As shown above a bridge (full wave) rectifier was used to convert an a.c. signal to a pulsating d.c signal. During the positive half-cycle of the input a.c. signal, diodes D1 and D3 conduct while diodes D2 and D4 are reversed biased. While during the negative half-cycle, diodes D2 and D4 conduct while D1 and D3 are reverse-biased.

The smoothing circuit is a filter network that reduces the ripples caused by the pulsation of the rectified signal. And the LED is used to indicate whether the circuit is open or closed.

3.8 CIRCUIT DIAGRAM

SHORT WAVE RECEIVER



CHAPTER FOUR

4.0 CIRCUIT CONSTRUCTION

The circuit construction started with metric layout of components on paper, which was checked and cross checked before transferring to the bread board according to the metric plan. From the breadboard the components were transferred into Vero board and all necessary interconnection lines were run. This was also cross-checked before final soldering.

During the soldering process, extra care was taken not to over heat the components, because it could led to loss of rating or total damaged to some of the components. They tools and equipment used during the construction include: Bread board, Vero board, soldering iron, soldering stand, solder, sponge, lead digital multimeter and the various components used.

Careful planning of the circuit wiring, minimized errors and made troubleshooting easier. The Vero board was scratched to provide a clear surface for good soldering and continuity on the Vero board necessary. The 8-pins IC socket that holds the LM 386 and the pins of TAX8164 were carefully mounted and soldered, breaking the continuity of the Vero board when necessary to connect other components.

The RF coil was constructed by carefully winding a very tinning wire round a ferrite rod while the ganged capacitor was mounted on the Vero board by drilling holes that connect the three legs of the gang, Capacitor and the nub for tuning. Also a hole was drill in the casing to fix the aerial.

4.1 TESTING/RESULTS

Each completed stage was tested and the waveform observed using an oscilloscope and the results obtained are:

At the input of the IF stage a distorted envelope like composite signal was observed. As shown in Fig. 4.1a

At the output of the IF stage (i.e. before the defection) a fine envelope signal was observed as shown in Fig. 4.1b

At the output of the detector diode, a rectified negative envelop have form was observed. As shown in Fig. 4.1c

At the detector stage output and AF output is distorted sinusoidal signal was observed, hence the inherent noise in the receiver output as shown in Fig.41c

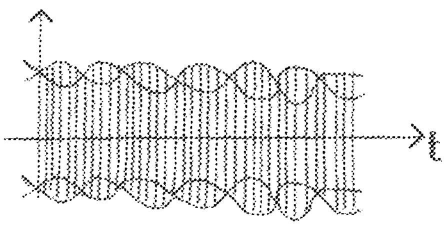


Fig 4.1.a Input to the I F Stage

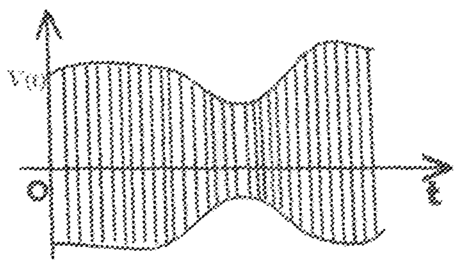


Fig 4.1.b output of the I F Stage

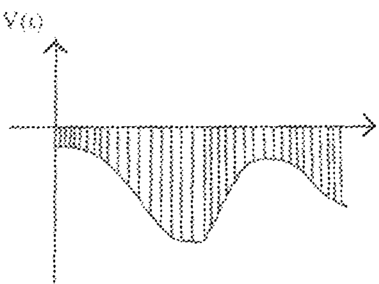


Fig 4.1.c Output of the Detector Stage

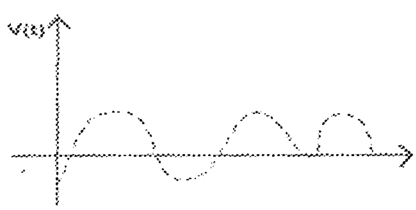


Fig 4.1.d After the Detector Stage and Filtering

Also, at the end of the construction, the project was tested and it receives various stations with minimal noise and high selectivity. The sensitivity was also high with a low level of distortion and the output power matched the input of the loudspeaker.

4.2 DISCUSSION OF RESULTS

From the results obtained, it can be deduced that the quality of reproduction of the receiver is determined mainly by the level of distortion introduced by a radio receiver. And from the graph obtained, the envelope signal observed at the output of the IF stage was because only the intermediate frequency (IF) ($455KH_z$) was allowed to pass. The distorted sinusoidal waveform observed at the output of the detector stage was due to noise and distortion was kept minimal by increasing the frequency-band pass of the receiver and detuning the resonant circuit from the carrier frequency. The system performed fairly to expectation through with some associated level of distortion in the output.

4.3 PRECAUTIONS TAKEN DURING THE CONSTRUCTION

The precautions taken during the construction are as follows: -

i. The breadboard was extensively used for the test construction.

ii. The Vero board was carefully checked and tested for continuity.

iii. Care must be taken during soldering of the components to avoid over heating.

iv. Off-target soldier splashes were carefully removed to avoid short-circuiting.

v. Re-checks were made more often to ascertain the right position of component and jumper wires.

vi. The power supply unit has normally put off from the circuit when mounting or removing component during the test construction and final construction.

vii. The polarities of capacitors (electrolytic) and the configuration of discrete components such as transition were ensured with multimeter before, they were finally soldered on the Vero board.

4.4 AREA OF FURTHER IMPROVEMENTS

i. The AM Oscillator could be increased to two, three or more to demarcate the ranges and improve turning.

ii. More than two IF stages can be cascaded together, this will effect increase the system's sensitivity.

iii. The power supply system could be made more stable with the provision of stable power supply from NEPA.

4.5 CASING

The casing of the system was based on the size of the fabricated components. The design was made to accommodate the speaker, length of fabricated components power supply unit and aerial.

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

The design and construction of a short wave (SW) Super heterodyne radio receiver was successful. It gave me an insight into quite a number of practical concepts in Electronics and Telecommunication Engineering. It enhanced my skills in handling electronic tools and components.

The design and construction was not without some problems as I spent a lot of time trying to adjust and re-adjust before I finally got a satisfactory gain. During the construction another problem encountered was the tracking of both the local oscillator and the radio frequency. Actually it was very difficult to keep the RF and local oscillator tuning exactly in step. Also after the design another problem encountered was how to get the components, although they are not expensive, but some components were not readily available and had to be substituted for.

The constructed short wave (SW) receiver was able to select radio stations (frequency band) out of the numerous modulated carriers reaching the receiving antenna and convert IF into an AF Signal. Definitely a short wave receiver would be of great use to engineers, reporters, pressmen, motorists, students, traders, laborers, students etc for receiving messages, information or signals from various stations transmitting within the short wave (SW) frequency band.

5.2 RECOMMENDATION

At the end of the construction the following recommendations were made:

i. A battery can compliment the power supply unit. This will give the receiver the chance to use the battery incase of power failure.

ii. Terminals of components and connecting leads used during the construction must be very short to avoid introduction of additional capacitance and inductance into the circuit.

iii. A push-pull power amplifier can be connected to the output of the audio amplifier IC used for a higher output power.

iv. Any student taking this type of project should have a good back ground in electronics communication, as this will help a lot.

v. And also it is very important for the department to provide necessary equipment for the electrical lab, to enhanced and aid students while carrying out this project and other practical.

5.3 REFERENCE

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