DESIGN AND CONSTRUCTION OF ELECTRONIC TV SIGNAL AMPLIFIER

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DEDICATION

This work is dedicated to the Almighty God, in whom I move, work and have my whole being. And to my parents, Gogol Chindaba, Esther Chindaba, Meshack Chindaba and Magret Zang

ATTESTATION/DECLARATION

I, CHINDABA GOLDIMA , declare that this work was done by me and has never been presented elsewhere for the award of a degree. I also hereby relinquished the copyright to the Federal University of Technology, Minna.

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Acknowledgement

I give glory to Almighty God, the Most High whom I owe so much thanks and appreciation for taking me to the place where I am now. The least I can say is Thank you Lord.

I passionately acknowledge the support of my able supervisor, Dr. E. N. Onwuka

I wish to express my profound appreciation to my Aunt, Esther Chindaba who single handedly put confidence in me and gave me all I need when I needed. If I could, I would pay you for all you have done for me but it is quantifiable. My profound gratitude goes to my parents, Gogol Chindaba and Magret Zang.

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ABSTRACT

This project is a design and construction of an electronic Television (TV) signal amplifier. It is useful in areas where TV signal reception is particularly poor such that ordinary TV Antenna cannot receive clear picture signal. The circuit consists mainly of the antenna section, power section, clipper, filter, and the amplification units.

The device was tested with TV sets and performance was found to be appreciable in comparism to ordinary antenna. It is small and compact for portability and easy handling; also, it is highly cost effective.

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TV Antenna & Reception Glossary

Here's the meaning of the technical terms I used.

Attenuator: A device used to reduce deliberately the level/strength of over-strong signals, to prevent overloading.

Balun: A BALanced-to-UNbalanced transformer, used to ensure a correctly matching connection between an antenna and a cable, or between a cable and a TV receiver. This is important for the best reception quality.

Diplexer: A device used to combine the signals from two receiving antennas, so they can be fed down a single cable to the receiver.

Some diplexers can combine VHF signals and some UHF signals, while others can combine both.

Directional antenna: An antenna which is much more sensitive to radio waves coming from one direction (its 'front') than from the opposite direction (its 'back').

Direct path: The path via which radio waves travel directly from the TV station tower to a receiving antenna.

EMI: Electromagnetic interference — what happens when radio frequency signals from other sources interfere with reception. Visual

symptoms include coloured lines across the picture, horizontal bands of noise specks, and so on.

Fringe area: At a significant distance from the TV transmitting towers, the signal strength has deteriorated to a level where a high gain

antenna must be used to get acceptable reception quality. This is known as 'fringe area reception'.

Front-to-back ratio: The sensitivity of a receiving antenna to signals arriving directly from its front, compared with its sensitivity to

signals arriving directly from the back. Also known as 'directionality'.

Ghosting: Pale extra images on the TV screen and to the right of the main image, caused by the reception of signals reflected from

buildings or other structures, in addition to (and arriving slightly after) the direct path signals.

High gain antenna: An antenna which has particularly high sensitivity to signals arriving from directly in front.

Line-of-sight reception: The ideal situation, where there's a clear visual path from the TV station tower to your antenna.

Multipath reception: When the signals from a TV station are reaching your TV antenna by two or more paths — i.e., one or more reflected paths as well as the main direct path. This can result in ghosting.

Notch filter: A small tuneable device which can be used to prevent interfering signals from reaching the antenna input of your TV set,

to minimise EMI. It's tuned to 'notch out' or reject the interfering signal, while allowing all other signals to pass through.

Reflected path: An indirect path by which TV signals can reach your antenna, after being reflected from a building or bridge, etc.

Snow: Visible noise specks on the TV screen, due to low signal strength. Also called 'pepper and salt'.

Splitter: A device used to divide up the signal from a receiving antenna, in order to drive a number of outlets and TV sets.

VHF: Very high frequencies, as used by Australian TV channels 0 - 12. (From 45 - 230MHz)

UHF: Ultra high frequencies, as used by Australian TV channels 27 - 69. (From 526 - 820MHz)

UHF translator: A transmitter operating on a UHF channel, which rebroadcasts the signal from a TV station to enhance reception.

CHAPTER ONE

INTRODUCTION

Communication represents a large part of the electronic industry. When television became practical, people could sit in the comfort of their rooms and see as well as hear a play or a news broadcast. as far back as 1927,Radio Engineers had known that pictures, as well as sounds, could be sent by waves [1],but technical problems slowed down their progress. Television did not begin on a large scale until the late 1940's [1]. Then it quickly became one of the world's most popular forms of communication and entertainment [1].

Television reaches millions of people. By a flick of a switch , viewers can enjoy a concert, a football game, a play or comedy as well as news broadcast [3]. News event can be seen as they happen in real time [2].Because of the importance of television, the need for proper reception of sound and images arises. Due to geographical locations and distance, some settlements have poor television signal reception hence the need for a TV Signal Booster that will receive, amplify the weak signal for proper and quality imagery.

Electronic TV Signal Booster is a relatively simple circuit that is designed to amplify signals from 30 to 900 Megahertz, this includes VHF (30 – 300 MHz),UHF (300 – 3000 MHz)

TV viewers in areas of weak poor signal reception mount aerial or external Antennas on long poles to be able to an improved TV images. It is therefore very cumbersome and has so many associated problems, some of which are ;-

- The antenna must be align in the direction of the location of the TV transmitting stations and TV transmitting stations are not located not located in only one direction

,this implies that other stations not in the direction of alignment of the Antenna will not have good reception.

- When any part of the antenna is detached, say the coaxial cable connector, the whole pole must be detached from its anchor and brought down for repairs and that could be cumbersome. But thanks to electronic TV signal Booster that has completely solve such problems in that, it is an indoor equipment that does not need any particular positioning or alignment, it works in any position or direction.

In its simplest form, a TV Signal Booster uses a small whip antenna that feeds incoming RF to a pre-amplifier, whose output is then connected to the antenna input of a receiver. Unless specifically designed otherwise, all TV Signal Boosters are intended for receive-only operation, and thus should not be used with transceivers; transmitting into this Booster will probably destroy its active components

1.1 CIRCUIT DESCRIPTION

This is a small, broad band, signal amplifier which covers the frequencies from 40 to 900 MHz. These frequencies include TV in VHF and UHF and also the radio broadcasting frequencies in the 88 - 108 MHz FM band.

It is connected between the antenna and the input of your receiver and boosts the signals by up to 20 dB, thus making it possible to receive even the weakest signals.

The circuit is built around a single transistor a UHF low signal device, the BFW 92. This transistor can operate in frequencies as high as 1.6Ghz, and has a gain of 23dB. The signal from the antenna sector is applied to the input of the circuit and though C5 is fed to the base of the transistor. It is amplified and from the collector of the BFW92 through C2 and C1 is taken to the input of the TV receiver.

The circuit operates off a small 9v battery, which because of the very low power consumption of the circuit, is going to last for a very long time

The input of the circuit is at point 4 and ground and the output at point 1 and ground. The battery is connected using a battery clip or any other means at points 2(-) and 3(+), and is a miniature 9v one, for best performance and to avoid unwanted interference doing operation it is recommended to place the capacitor on the positive supply line, where it passes through

1.2 TECHNICAL SPECIFICATION

Frequency response 30 – 900MHz

Gain; 20dB

Maximum output level; 90mV

The circuit is built around a single transistor a UHF low signal device, the BFW 92. This transistor can operate in frequencies as high as 1.6Ghz, and has a gain of 23dB. The signal from the antenna sector is applied to the input of the circuit and though C5 is fed to the base of the transistor. It is amplified and from the collector of the BFW92 thorugh C2 and C1 is taken to the input of the TV receiver.

The circuit operates off a small 9v battery, which because of the very low power consumption of the circuit, is going to last for a very long time.

CHAPTER TWO

LITERATURE REVIEW /THEORETICAL BACKGROUND

Television is a division of Telecommunication which has to do with the transmission and reception of still and moving images by electronic device in real time. The scientific foundation for Television has been laid by the remarkable discoveries made in many countries.

The advent of the first motion picture projectors followed the invention of the incandescent lamp by A.N Ladygun of Russia in 1873 and accidental discovery of the property of selenium by W.Smith and L.Mary in the same year [l].These two discoveries enable electric energy to be converted to light and back. Basing himself on these two discoveries, J. Kery of the mission of moving images in 1875 was the first to propose that the image should be analyzed into elements in Kerry's system[3], all of the picture elements were to be transmitted in parallel and these calls for a great number of communication channels as many as there would be picture elements. The idea was obviously impractical, its limitations were avoided in what is known as sequential Television system using only one communication channel over which the picture elements are transmitted in turn. Systems based on this principle of transmission were proposed in a variety of designs by physiologist P.I Bakhetyer (1880), S. Bidwell of Britain (1881), and Seneca of France (1881)[3].

The details and techniques have of course changed but the basic principle of sequential transmission has survived. In 1884, N.Nipkow, a polish scientist working in Germany, invented his mechanical analyzer now known as the Nipkow disc[l], which

ushered in the era of mechanical TV was able to show something for the effort put into it in

1925 when J .L Bair in Britain and C.Jen Kins in the United States first demonstrated the Transmission of moving Silhouettter over a distance [3] ..

Since then, Television system has come of age and better means of transmission and the reception of the signal are sought for. Hence the introduction of TV signals Amplifier.

TV signals travel at the speed of light, 300000km/s in form of electromagnetic wave. These Waves are attenuated with distance. According to the inverse square law, the power level of the signal received a distance away from the point source diminishes fairly with the distance [7]. For example, at distance r from a point source, the power density is;

$$P_r = \frac{P_t}{4\pi r^2}$$

Where P_r is the power density at the point r, P_t is the total power at the transmitter.

The table below shows the various frequency band of the electromagnetic spectrum of which our frequency of operation is shown.

Table 2.1: Electromagnetic Spectrum

Frequency band	Classification	Application
3-30KHz	Very Low Frequency	Long range navigation, sonar
30-300KHz	Low Frequency or Long Wave(LF,LW)	Navigational aids, radio beacons
300-3000KHz	Medium Frequency orWave(MF/MW)	Maritime radio, direction finding, commercial AM Sound broadcasting, coast-guard communication
3-30MHz	High Frequency (HF) or Short Wave (SW)	Telephone, facsimile, AM-SW radio broadcasting, search and rescue, aircraft-to-warship & ship-to-coast communications
30-300MHz	Very High Frequency (VHF)	VHF-TV broadcast, FM radio, air traffic control, private aircraft, taxi cab, police, navigational aids
300-3000MHz	Ultra High frequency (UHF)	UHF-TV broadcast, radar, satellite communication, altimeters, navigational aids
3-30GHz	Super High Frequency (SHF)	Microwave link, land mobile communication, radar
30-300GHz	Extra High Frequency (EHF)	Railroad services, radar landing system, experimental

2.1 FACTORS THAT AFFECT TV SIGNAL RECEPTION

- Distance from the transmitters - the closer you are to the transmitters, the stronger the signals will be so a small antenna may be all that's needed. The farther away you are, the weaker the signals will be so a bigger antenna may be more appropriate.
- Topography - if there are obstructions such as building, hills, and trees between your location and the transmitters, then expect the signals to be blocked or reflected and impact the signal that reaches your antenna. If the blockage is significant, you may not even get any signal at all. For multipath plagued locations, directional antennas are best.

2.2 FACTORS THAT DETERMINE SIGNAL RECEPTION

- Height of TV Station Transmitting Tower
- Transmitter Power
- Transmitter frequency (TV channel)
- Height of Receiving Antenna
- Terrain between the Transmitter and receiving antenna.
- Obstacles between the transmitter and receiving antenna (tall buildings, water tower,etc.) An attic installation is obstructed.

2.2.1 Distance from the transmitters - the closer you are to the transmitters, the stronger the signals will be so a small antenna may be all that's needed. The farther away you are, the weaker the signals will be so a bigger antenna may be more appropriate.

2.2.2 Topography - if there are obstructions such as building, hills, and trees between your location and the transmitters, then expect the signals to be blocked or reflected and impact the signal that reaches your antenna. If the blockage is significant, you may not even get any signal at all. For multipath plagued locations, directional antennas are best VHF/UHF television and radio signals are normally limited to a maximum "deep fringe" reception service area of approximately 40 to100 miles (60--160 kilometers). However, providing favourable atmospheric conditions are present, television and radio signals can sometimes be received at hundreds or even thousands of miles outside their intended coverage area. These signals are received using a large outdoor antenna system connected to a sensitive TV or FM tuner and/or receiver while only a limited number of local stations can be normally received at satisfactory signal strengths in any given area, tuning into other channels may reveal weaker signals from adjacent areas. More consistently strong signals, especially those accentuated by unusual atmospheric conditions, can be achieved by improving the antenna system. The development of interest in Signal Booster arises after more distant signals are either intentionally or accidentally discovered, leading to a serious interest in improving the aerial and receiving installation for the purpose of actively seeking long-range television and radio reception.

The service area from a TV or FM radio transmitter extends to just beyond the optical horizon, at which point signals start to rapidly reduce in strength [4]. Viewers living in such a "deep fringe" reception area will notice that during certain conditions weak signals normally masked by noise increase in signal strength to allow quality reception. Such conditions are related to the current state of the troposphere.

2.3 TV RECEPTION BASICS

TV broadcasting uses Electromagnetic radiation or 'radio waves' — just like AM and FM radio broadcasting, shortwave broadcasting or even cellular mobile phones. The only difference is that the waves used for TV carry picture information as well as sound, and have frequencies in channels which are reserved for TV broadcasting in the VHF (very high Frequency) and UHF (ultra high frequency) bands. At the TV station's transmitter, the video (picture) and audio (sound) information from the studio is used to modulate the transmitter's VHF or UHF carrier signals, which are then fed up via cables to the Transmitting antennas at the top of the station's tower. The antennas are designed to radiate the signals as radio waves, as evenly as possible around the station's service area. As a result if you put up a receiving antenna in most parts of the receiving area, it should be able to pick up enough energy from the radiated waves to generate electrical signals which are strong enough to feed into the antenna input of your TV set, so that it can demodulate them to recreate that station's pictures and sound with excellent quality. That's the ideal, anyway. So why doesn't this always happen? There are quite a few reasons, and to understand them we need to know a bit more about radio waves — and in particular those with frequencies in the VHF and UHF bands. For a start, the waves which radiate away from the TV station's transmitting antennas travel most easily in dry air, and in paths that are very close to a straight line. The radio waves from each TV station radiate from its transmitting antenna evenly throughout the station's service area. As they do, they spread out and therefore get weaker with distance At these frequencies, radio waves do become much weaker passing through solid objects like earth, rock, buildings or a lot of foliage. They also become weaker passing through water — such as heavy rain. So if you and your TV antenna are down in a gully, or behind a hill or some large buildings, or in a dense forest, the signals that reach your antenna might well be weakened enough to cause poor reception. This can also happen during a heavy downpour, even if you do have a clear 'line of sight' reception path but are more than about 30km from the transmitter. It's true that low-band VHF signals do 'bend' to some extent around hills and large buildings, so that you can often get reasonable reception in the upper 'shadow' area behind them. However further down in a valley, reception may be very poor.

The screen shown in the figure below shows the kind of reception produced by weak signal strength.

Weak television signal

Normal Picture Progressively Weaker Signal

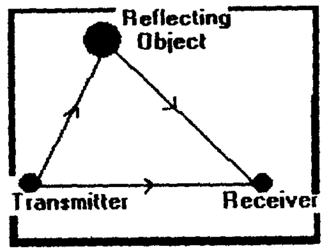
As we can see the picture becomes 'snowy' and covered in specks of coloured noise, often called 'pepper and salt'. There's a loss in picture detail and colour saturation, and in severe cases the picture may lose colour altogether.

We'll discuss how you can tackle this sort of problem later. At present, let's look at what else can go wrong apart from the signals becoming too weak for good reception.

Multipath reception: Ghosts in many ways is a much more common problem in multipath reception, where signals from the same station can reach your antenna by two or more distinct paths which differ significantly in length. This is shown in the diagram below, "Ghosting"

Normal Picture

An example of Ghosting"



Why Ghosting Occurs

This can happen because VHF and UHF radio waves can be reflected by large buildings or metal structures (like bridges), hills and cliff faces, and even reasonable sized bodies of water like that in a reservoir, lake or bay. The waves being reflected by these objects isn't in itself a problem. In fact sometimes reflected signals can be strong enough for good reception, if you're in a location behind a hill or some large buildings where the direct-path signals are themselves too weak. The real problem with reflected signals is when they reach your receiving antenna along with the direct-path signals, because when t Waves travel in air at virtually the same speed as light.

As you might know this is very fast, but still quite finite. In fact it's very close to 300,000km/s (kilometers per second).So if your receiving antenna is say 10km from a station's transmitting tower — line of sight — its signals will actually be taking 10/300,000 or 33micro seconds (33millionths of a second) to reach it. Not that you'll be aware of this tiny delay, of course. In itself it's not of any importance, either.

But this finite speed does become important when reflected signals from the same station can also reach your antenna — say by reflection from a building. Because these reflected signals also travel at 300,000km/s, but clearly they're traveling along a longer path to get to your antenna. This means that they'll take slightly longer to get there, arriving just after the signals which come via the direct path (which is also clearly the shortest path). As a result, the set will be receiving a mixture of two distinct versions of the station's signal. So instead of getting just one picture on the screen, you'll have two — the main one (from the direct path) and a weaker one (from the reflected path). The weaker one will be shifted to the right, because of the way the TV set 'paints' the picture Lines from left to right. The second picture is usually less distinct and more weakly coloured, because it's from a weaker signal. But although these extra 'ghost' images may be fainter and more weakly coloured, they can still be quite distracting and seriously degrade the clarity of your main picture. That's why they're regarded as a reception Problem. It can be surprisingly difficult to track down the exact source of the reflected signal that's producing a ghost. However you can at least work out one important point from a careful inspection of the TV screen: how much further the reflected signal is travelling, compared with the direct path signal. You do this by carefully measuring how far the ghost image is to the right of the main image, as a proportion of total picture width.

Now let's look briefly at the third main cause of reception problems: electromagnetic interference (EMI), also known as radio frequency interference (RFI).Like multipath reception, EMI is another example of reception of the signals from your TV station(s) being disturbed by other signals picked up by your antenna. But instead of the extra signals being reflected and delayed versions of the main signal, in this case they're from a different source of radio waves altogether. They might be coming from an industrial heater or welder; or a medical diathermy machine; or a nearby computer; or sparking from a big motor drive system (for lifts or elevators), power tools or appliance motors; or from corona discharge from high-voltage power lines; or radiation from a commercial two-way radio transmitter, CB or amateur radio transmitter. They might even be from an FM station or another TV transmitter on either the same channel as your local station or an adjoining channel, whose signals are still able to reach your antenna with sufficient strength to cause interference.EMI from FM broadcasting transmitters, industrial heaters, diathermy machines and computers tends to cause moving coloured lines or patterns superimposed on the picture, and again disturbing its clarity. Some signals from radio transmitters and similar sources of EMI can also produce audible interference, if they're strong enough. This takes the form of beat tones or 'whistles', or garbled and distorted speech, along with the TV programme sound. EMI from 'noise' sources like sparking motors or corona discharge from power lines tends to produce horizontal lines or bands of 'sparkling' noise superimposed on the picture. The noise bands are often fairly fixed in position vertically, but they may move slowly up or down. Sometimes the noise from computers can behave this way too.

Interference from another TV station on the same channel is easy to recognise: like ghosting it manifests as another picture on the screen, but in this case it's not the same picture shifted to the right, but a different picture altogether. In almost every case it's not fixed in position either — instead it moves slowly from left to right or vice-versa. Before we leave EMI problems, there is one kind of interference which we haven't mentioned as yet. That's the kind that's due to signal overload: situations where one or more of the TV signals reaching your set from the antenna are simply too strong. This can cause the radio receiver part of the TV set to distort the signals itself, and make them interfere with each other as a result. The symptoms of overload can be negative and unstable pictures, picture 'tearing', lines and patterns across the picture (very similar to other kinds of EMI), other images moving across the picture you're trying to watch, and/or distorted sound. This is the problems you'll tend to get if you're very close to one TV station's tower, or very near another high powered transmitter.

2.4 Tackling weak signals.

Now that we are aware of the various causes of poor TV reception and the signs to look for in diagnosing them, we can move forward to look at the best ways of tackling each problem. We'll start with weak signal reception, Let's say you're down in a valley, with a fair-sized hill blocking your antenna's view of a station's transmitter tower. Or you're effectively behind a collection of buildings, or a small forest of trees, which will give much the same result: weak signals. How do you go about improving reception in this kind of situation? Well, the first thing to do is make sure you have a good outside antenna — at least for the reception of that particular station. It should also be as high off the ground as you can mount it, because this will generally allow it to find stronger signals. That's why you see TV antennas in rural 'fringe areas' up on high masts. But our TV Signal Booster is aimed at eliminating all those complexities. But what exactly is a good TV Signal Booster? Basically one that has a high gain — or in other words, one that is designed to be particularly good at sensing the presence of passing radio waves and to cause another source of alternative signals is UHF repeaters and translators — 'relay stations' which are used to make the signals from stations available in areas with known reception problems. So if you still can't get acceptable reception of a station on its usual frequency channel, try looking for the same signal on another channel in the UHF band. As a result if you can't get a station's main signal at acceptable strength, you may still be able to get good reception via a UHF translator's signal.

2.4.1Expelling ghosts:

The most promising way of tackling poor TV reception due to weak signals, then, is to get a high gain Booster— but what if the problem is ghosts instead?

Surprising though it may seem, a high gain Booster is still the best way of tackling this type of problem too.

2.4.2Repelling EMI:

Now let's consider the various kinds of TV reception problem cause by EMI, and how you can go about solving them — or at least minimising them. Again, if the EMI from the source of your interference is coming from a different direction to the TV station Signals, a high gain Booster will very likely let you reduce the amount of EMI picked upnwanted ghost images that upset picture clarity. If that doesn't solve the problem, we may need to try other approaches as well. For example if the interference is coming from a transmitter or noise source with a frequency outside the actual TV channel(s) we are trying to receive, it may be possible to reduce the EMI by using a rejection or notch filter, Connected 'inline' — i.e., series with the Booster cable. A notch filter is basically a tuned circuit, which can be adjusted to stop signals in a small range of frequencies from passing through — while allowing signals of all other frequencies to pass. So by adjusting the filter to 'reject' the signals from our source of EMI, they are prevented from interfering with the TV signals. If on the other hand the interference is coming from a transmitter of some kind with a frequency inside one of the channels we are trying to receive, a notch filter is not likely to be able to help. Instead we may have to use an inline attenuator — a device which lowers the level of all signals passing through it. The idea here is that by using an adjustable attenuator and carefully adjusting its degree of attenuation, we may be able to reduce the EMI signals to a level where they cause minimal disturbance to the receiver, while still leaving the TV station signals at a strength high enough to allow good noise-free reception.

2.5 Tackling overload:

As we saw earlier, one type of reception problem is due to overloading, where the TV signals interfere with each other in the 'front end' of the receiver itself, because one or more of the signals from the stations is/are too strong. The remedy in this kind of situation depends on whether the overloading is due to just one very strong signal (because you're very close to that transmitter), or more than one. If only one is too strong, the most likely solution will probably be to connect an inline notch filter, and adjust it to largely reject the over-strong signal. In severe cases, we might also need to fit a metal shield around the back of the TV set itself, connected to the 'ground' side of the set's antenna input. (The metal shield should be perforated, so that it doesn't block ventilation and make the set overheat.) Many notch filters allow you to adjust not only the tuning of the rejection notch, but its degree of rejection as well. This allows us to reduce the level of the over- strong signal just enough to prevent overloading. If our overloading is being caused by more than one over-strong signal, we may be able to fit additional notch filters and adjust each of them to throttle back one of the offending signals. Or if the signals are all too strong, we may be able to achieve the same result using an inline attenuator. In this case we'd adjust its degree of attenuation so that the signals are weakened just enough to prevent overloading, but still strong enough for good noise-free reception.

CHAPTER THREE

DESIGN AND IMPLEMENTATION

3.1 GENERAL DESCRIPTION

This is a small, broadband, small amplifier which covers the frequencies from 40 to 900MHz. These frequencies include TV in VHF bands.

It boosts the signals by up to 20db, thus making it possible to receive even the weakest signals.

3.2 TECHNICAL SPECIFICATION

Frequency response 40 – 90MHz

Gain; 20dB

Maximum output level; 90MV

Input – output impedence:75ohm

3.3 HOW IT WORKS

The circuit is built around a single transistor a UHF low signal device, the BFW 92. This transistor can operate in frequencies as high as 1.6Ghz, and has a gain of 23dB. The signal from the antenna sector is applied to the input of the circuit and though C5is fed to the base of the transistor. It is amplified and from the collector of the BFW92 thorugh C2 and C1 is taken to the input of the TV receiver.

The circuit operates off a small 9v battery, which because of the very low power consumption of the circuit, is going to last for a very long time.

3.4 CONSTRUCTION

The input of the circuit is at point 4 and ground and the output at point 1 and ground. The battery is connected using a battery clip or any other means at points 2(-) and 3(+), and is a miniature 9v one, for best performance and to avoid unwanted interference doing operation it is recommended to place the capacitor on the positive supply line, where it passes through the metal box.

3.5 PARTS

R1 = 120 ohm (brown, red, brown)

R2 = 1.5 kohm (brown, green, red)

R3 = 270 ohm (red, violet, brown)

R4 = 82 kohm (grey, red, orange)

C1,C5 = 100 PF (ceramic)

C2,C3 = 1nF (ceramic)

C4 = 2.2pF (ceramic)

D1,D2 = 1N4148 diode

Transistor = BFR90, BFR91, BFW92

Misc = PCB, 6pins, solder, 9v battery clip

L1,2: diameter:5mm

Wire thickness: 0.5 mm

Turns: 8

3.6 THE Q FACTOR

Quality of the components has to be taken into account. The Q factor is a measure of the energy stored to that which is lost in the component due to its resistive elements at low or high frequencies. Inductors store energy in the magnetic field surrounding the device. Capacitors store energy in the dielectric between its plates. The energy is stored kin one half of an a.c cycle and returned in the second half. Any energy lost in the cycle is associated with a dissipative resistance and this gives rise to the quality factor Q. Q as stated before is the ratio of maximum energy stored to the amount lost per a.c cycle. The quality factor determines the 3dB bandwidth of resonant circuits.

Conclusion: The higher the Q, the less energy is dissipated.

3.7 THE BLOCK DIAGRAM OF THE CIRCUIT

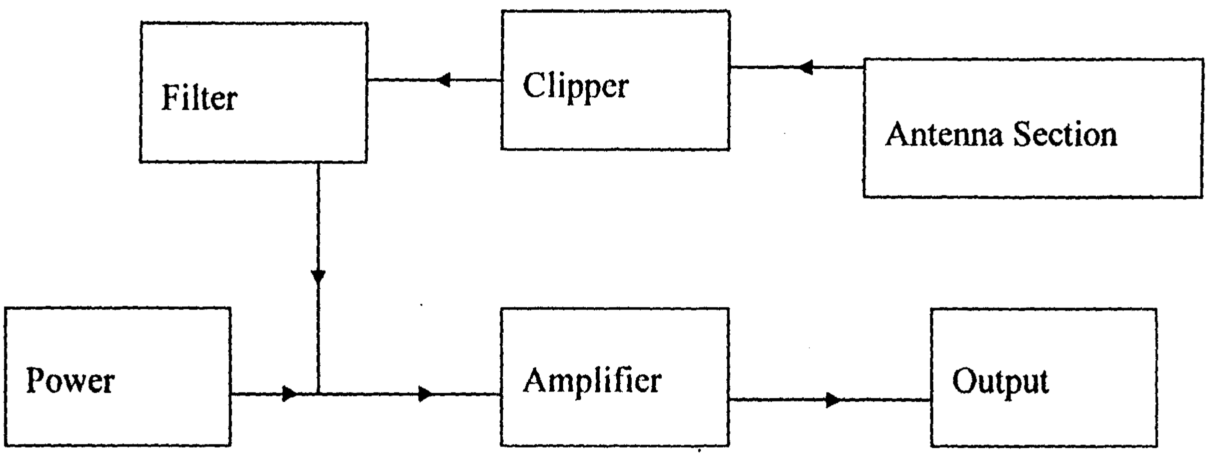


Figure 3.1 Circuit block diagram

From the block diagram of the circuit as shown above, we have the following sections, Which will be fully discussed or properly x- rayed.

3.8 ANTENNA

An antenna provides a transition from a guided wave on a transmission line to a free space wave and it provides for the collection of electromagnetic energy. In a transmitting system, a radio-frequency signal is developed, amplified, modulated and applied to the antenna. The RF currents flowing through the antenna produce electromagnetic waves that radiate into the atmosphere. After the transmitter amplifier the video signal to the required level, it sends the signal the Antenna.

To have adequate signal strength at the receiver, either the power transmitted must be extremely high or the efficiency of the transmitting and receiving antennas must be high because of the high losses in wave travel between the transmitter and the receiver.

All antennas have a gain factor expressed in decibels. Usually, this factor is relative to an isotopic radiator. An isotopic radiator radiates uniformly in all directions, as does a point source light. Al the power that the transmitter produces ideally is radiated by the antenna; however, this is not generally true in practice because there are losses in both the antenna and its associated feed line. The transmitted power is effectively multiplied by the antenna system gain, which is the sum of the line losses and the antenna gain (or loss for many small simple antennas). The gains in decibels directly add and maybe expressed as a numerical factor. The transmitter power and the antenna gain when multiplied equal the effective equal the effective radiated power (ERP).

The antenna being used for this system is a whip antenna. It is an antenna with adjusted length. If more range is needed, the length of the whip antenna can be increased. The diagram is shown in Fig. 2.1

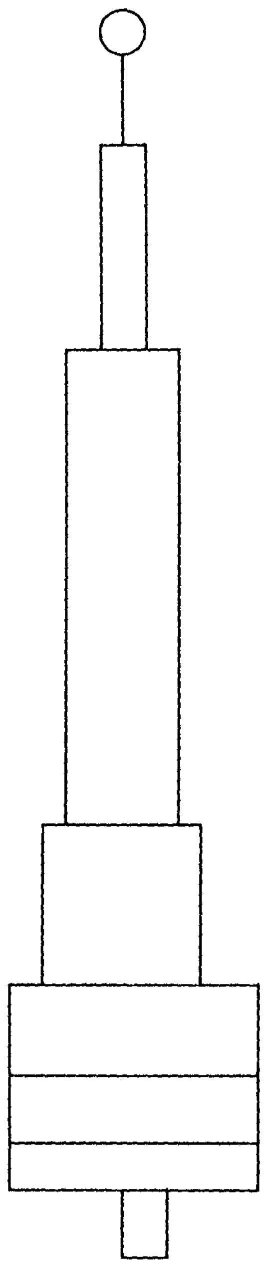


Fig 3.2:Collapsible Whip Antenna for Low Power Transmitters

For a whip antenna:

This design is for a whip operating at 500MHz.

It is recommended that the length of the antenna be l=0.05λ

l = antenna height (cm)

λ = wavelength

f = frequency (Hz)

v = speed of light = 3×10^8m/s

f = 500MHz

$$\pi = \frac{v}{f} = \frac{3\times10^8}{500\times10^6} = 0.6$$

l = 0.05λ = 0.05 (0.6) = 0.03m = 3cm

3.9 POWER SUPPLY STAGE

For the purpose of this design, power is supplied by an external 12 volt DC source. This is achieved using a 240V/12V converter, which converts the domestic supply mains voltage of 220V – 240V ac into the required 12volt DC voltage.

All stages in this project use 9V. The power supply stage is a linear power supply type and involves the use of a step down transformer, filter capacitor the voltage regulators; to give the various voltage levels. The power supply circuit diagram is shown in Fig. 3.3:

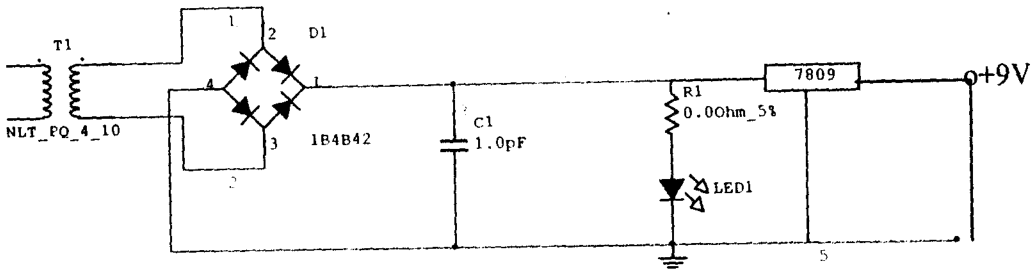


Fig 3.3 Circuit diagram of the Power supply unit

The rectifier is designed with four diodes to form a full wave bridge network. C1 is the filter capacitor and is inversely proportional toe the ripple gradient of the power supply. The ripple gradient is shown in fig 2.3

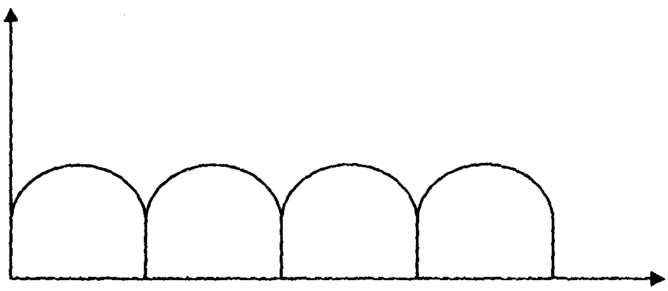


Fig 3.4 Ripple Gradient

Where dv is the ripple voltage for time dt, and dt is a dependent factor in power supply frequency. but Io = 1A for silicon diode, i.e

$$I = C\frac{dv}{dt} \rightarrow \frac{I}{C} = \frac{dv}{dt}$$ but Io = 1A for silicon diode, i.e

$$\frac{I}{C} = \frac{dv}{dt} = C = \frac{dt}{dv}$$

But dt = 10ms for 50Hz transformer.

& Vrms = 12V from the transformer

Vpeak = Vrms x √2 (i.e, rms x √2)

= 12 x √2

= 16.97V

Assuming ripple factor of 15%,

$$dv = \frac{15}{100} \times 16.97$$

$$= 2.55V$$

Therefore

$$C\frac{dt}{dv} = \frac{10ms}{2.55}$$

$$= 3.298mf$$

$$= 392\mu f$$

A preferred value of 330μf was used for the power supply stage.

But for the LED, $Vin = Vr + Vled$

$$= I_F + V_D$$

Where I_F = diode forward current = 15mA

v_d = voltage drop across diode = 1.7V

$$R = \frac{Vin - V_D}{I_F} = \frac{12 - 1.7}{15mA}$$

$$R = \frac{10.3 \times 1000}{15}$$

$$= 0.69Kohm$$

A preferred value of 1Kohm was used.

The voltage is regulated at approximately 9.4volts by the 9volt regulator, VRI (7809 voltage regulator).

3.1.0 CLIPPER

Clippers are circuits that clip the input waveforms at a particular level. Such circuits are applicable in radio receivers for communication circuits where noise pulses that rise well above the single amplitude are clipped down to the desired level. The circuits are also use in radars and computers. When it is desired to remove signal voltages above or below a specified voltage level. The diodes used for this purpose are mainly signal diodes; 1N4148

Circuit

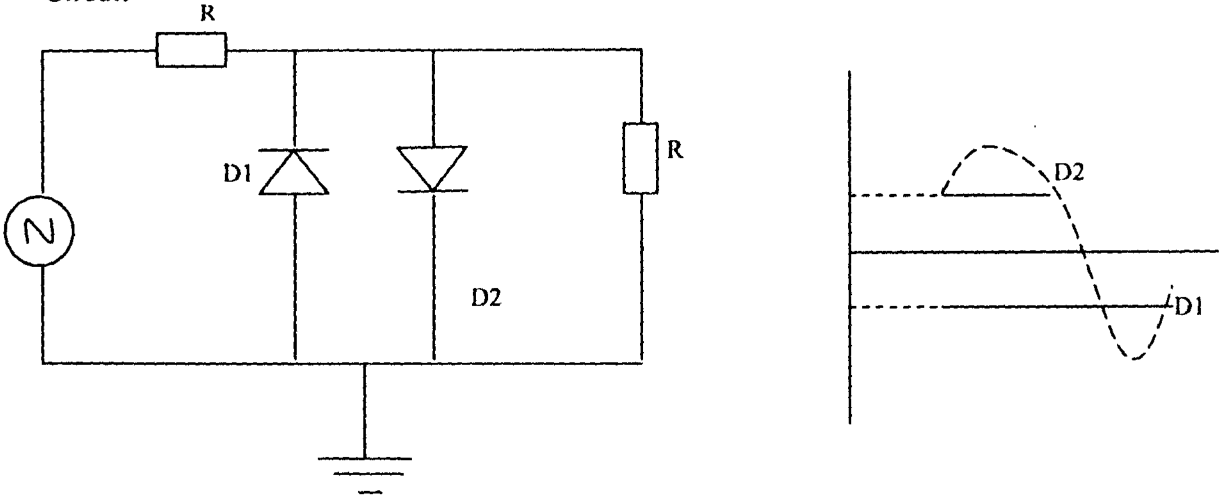


Fig 3.5 Clipper

From the figure above, it can be seen that the input signal is a sine wave but the output signal is more like a square wave. Sometimes a clipping circuit is used to change the shape of a signal. But the major work of clippers is to remove noise pulses exceed the clipping points; they will be clipped off or limited. The resulting signal will be noise – free than the original.Diode D2 clips the positive part of the signal (high frequency) from the antenna, is the signal voltage begins increasing, nothing happens at first, then when the signal voltages reaches a certain level depending on the diode for ordinary odes, the voltage level is 0.6V. D2 turns on and begins to conduct. Diodes have different barrier potentials so the clipping level depend largely on the various barrier potential of the dies when D2 forms an and begins to conduct, its resistance is much less than the resistance of D1, the signal voltage that is in excess of the barrier potential is dropped. Later, the negative alternation begins. As the signal first goes negatives nothing happens, when it reaches −0.6V, D1 turns on. As D1 conducts, the voltage in excess of −0.6V is dropped. The total amount swing is the difference between +0.6V and −0.6V or 1.2V peak- to – peak. Germanium diodes with barrier potential of 0.2V would turn on at 0.2V and drops any voltage in excess of 0.2V; it will produce a total swing of 0.4V peak – to – peak it used in a clipper circuit. The clipping points can be change to a higher value by using series diodes. Examine the figure below; it will require 0.6V + 0.6V, or 1.2V to turn on D3 and D4. Notice that the positive clipping point is now show n in the graph at +1.2V. In a similar fashion, D1 and D2 will turn on when the signal swings to −1.2V. The output signal in the figure has been limited to a total swing of 2.4V peak – to – peak.

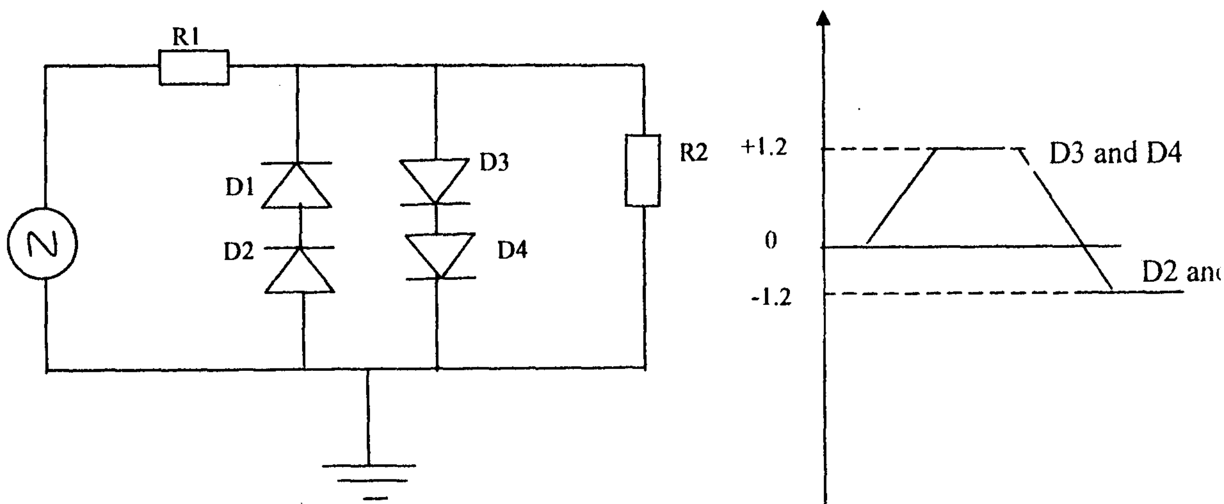


Fig 3.6 Clipping of higher threshold

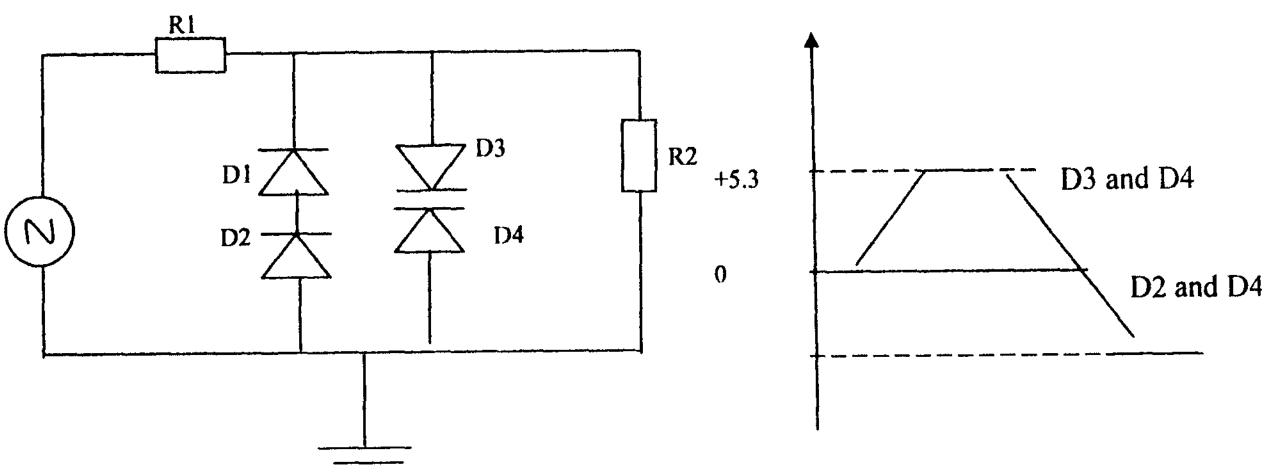


Fig 3.7 Clipping of higher threshold

3.1.1 FILTER

These are circuits in which a range of frequency is allowed, stopped or filtered ou. They may allow a rune of frequency to be accepted according to design. There are different types of filters in which designers work with some of which are

Low- pass filter

High – pass filter

Band – pass filter

Band - stop filter.

Low - pass filter: These are filters in which allow low frequency component of filters to pass. Frequencies above a certain level depending on the properties or values of the components use is regarded as high and therefore filtered out. They are useful in low frequency circuits. Mostly, it is the combination of inductive and capacitors that are used for this purpose. They arrangement or the low pass circuits is as follows

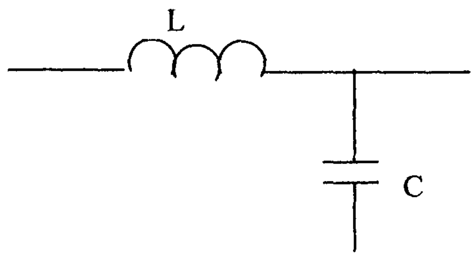


Fig 3.8 Low pass filter

The low – pass filter is possible due to the unique nature of the impedances of inductors and capacitors.

For and inductor, the impedance is proportional to the frequency, at low frequency, at high frequencies, the impedance of inductors become high either. I.e.

X_L = WL where w = 2πFL

Therefore when F is low, X_L is equally low. But the reverse is the case for capacitors; impedance of a capacitor is inversely proportional to the frequency, at high frequency, capacitive impedance will be low, at low frequency, capacitive impedance will be high.

$X_C = 1/WC$ where $w = 2\pi F$

$= 1/2\pi FC$

Looking at the diagram above or the low – pass filter circuit, the capacitor is connected to the ground, when low frequencies come in, the capacitor offers high impedance, as such the frequencies can not pass and be lost to the ground, but the inductor which is connected to the low frequency component of the signal and hence, does not impede the flow of the law frequencies. But at high frequency, capacitor offers least impedance compared to inductor, hence the high frequency components of the signal will pass through the capacitor not the inductor and will be lost by the ground

3.1.1.0 HIGH PASS FILTER

High pass filter circuits allow high frequency component of signals to pass and ground the low frequencies. It employs the unique impedances of inductors and capacitors as illustrated in the previous section.The circuit arrangement for high- pass filter is as follow

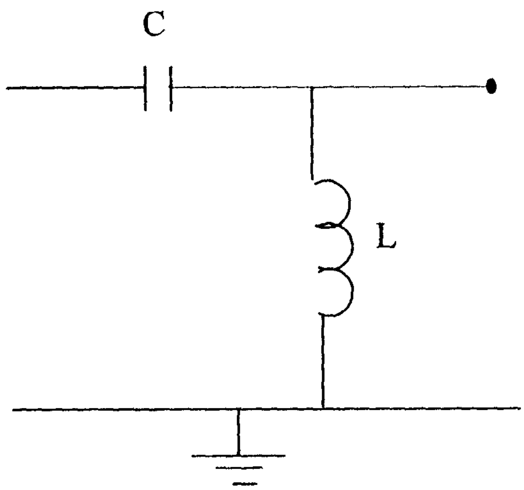


Fig 3.9 High pass filter

The low frequency component of the signal will follow the least impedance path which is through the inductor and will be lost to the ground.

Capacitor in the circuit will after least impedance to the high frequency component of the signal and hence allows its passage but blocks the low frequency components. Which will find an alternative route through the inductor and will be lost to the ground?

Band – pass filter allow a range of frequencies to pass while blocking all other frequencies outside the range.

But for this project, Band – pass filter is required because we are considering a range of frequencies 40MHz to 900MHz allowing a wide range of frequencies to pass, this includes the FM band, VHF band and the UHF band. The circuit is as shown below:

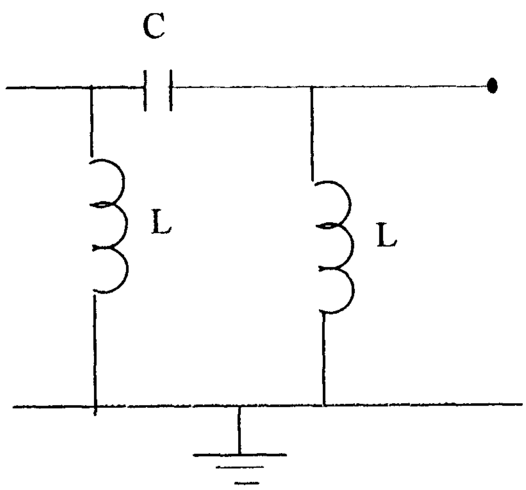


Fig 3.1.0 Band pass filter

The filter is called pie filter. It is used for band – passing. It allows only the range Frequencies chosen to pass, the value of the impedance can not be calculated directly because we are using a range of frequencies not just only one.

$X_C = 1/2\pi FC$ where F = 40 MHz – 900 MHz

$X_C = 2\pi FL$

3.1.2 AMPLIFIER

The amplifier is built around a high gain single transistor, a UHF low signal device, it boosts the signals by up to 20dB, thus making it possible to receive even the weakest signals. The Transistors type is NPN.

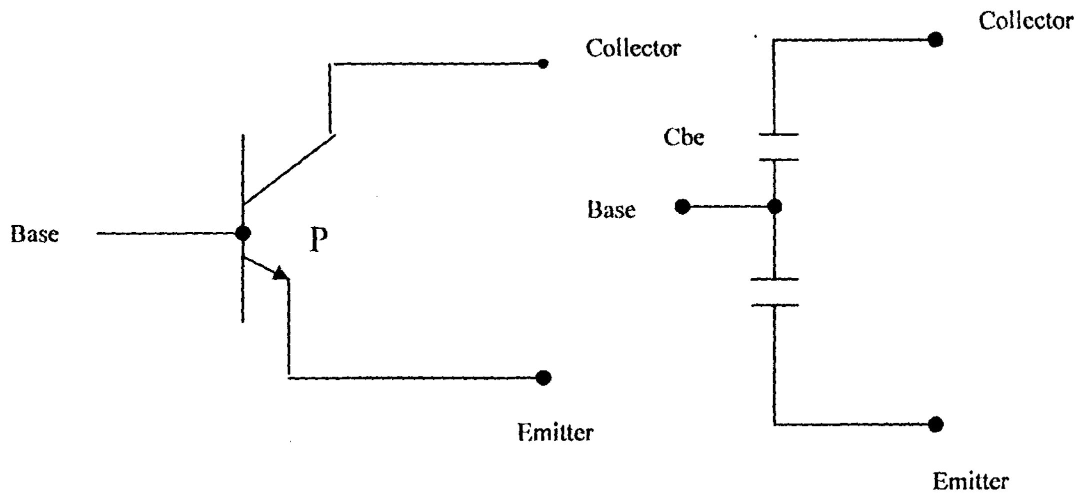


Fig 3.1.1 NPN JBT transistor

For the sake of this project, some of the characteristics of NPN JBT transistor will be looked into

- The bias current acts as a controlled flow source which steadily opens up the collector emitter channel enabling charge carriers to flow, this can be analogous to a sieves gate, the rate of flow is controlled by the current gain

  $\beta = I_C / I_B$

- Transistors are non- linear.especially when biased in the saturation region
- The input impedance drops as the biasing current being sinked to the collector increases.

- As the base current increases to allow more collector current through, the current gain β also increases.
- The collector – emitter voltage has a maximum valve that can be exceeded at an instant in time.

3.1.2.0 HIGH FREQUENCY RESPONSE

The most interesting property is the function capacitance from the base to emitter and base collector, because of heavier extrinsic doping and its forward biasing the depletion region.

The transistor is a common Emitter type. Resistors R2 and R4 and R34 are biasing resistors. C3 is a blocking Capacitor so also C2 is for dc blocking, the dc power is tapped and with resistor R3 to bias the collector side of the transistor.

Calculations;

C4 serves to block dc current for the Quiescent points from escaping to ground and at the same time present a slight resistance to the a.c RF signal. A small ohmic valve of 145 ohm can serve to prevent the a.c signal from escaping to ground.

Therefore, $145 = \frac{1}{2\pi fc}$

Where the operating frequency we are working with is 500mHz.

$$145 = \frac{1}{2\pi fc}$$

$$C4 = \frac{1}{2\pi \times 500 \times 10^{6} \times 145}$$

$$= 2.2 \text{ X}10^{-12}\text{F}$$

$$=2.2\text{PF}$$

$$5 = \text{IR}$$

R_2, R_3, R_4 are the biasing resistors. Capacitors C_2, C_3, C_4, and C_5 block the d.c current in the circuit provided by the 9Volts voltage source. We will be left with a circuit looking like this;

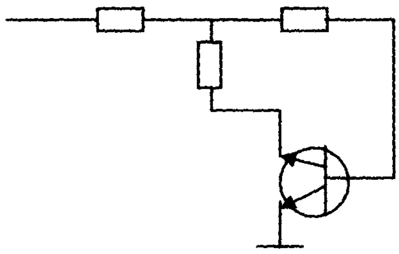


Fig3.1.2 Transistor biasing

Main collector Current = 1.5mA

Base emitter Voltage = 5V

Therefore, R_3, = (9 – 5)/15mA = 266.667ohm.

But a preferred valve of 27o oOhms was used.

Understanding of transistor action shows that, for transistor to be used for linear, amplifier, it must operate within its active region, not at saturation or cut off points.

A high base current takes the transistor to operate at cut off point.

For the purpose of this circuit, te transistor must operate at the active region. That means a small base current.

Base current of 0.6maaA will produce a collector Current of 15mA.

Total Current = (15+0.6) mA. R4 = 5/(15 – 0.6) = 15.6mA.

$R_4 = 5/(15.6 - 15) = 5/0.6 \times 10^{-3} = 83$Kohms

R_2 is a limiting resistor, it serves for protection. A valve of 1.5Kohm was chosen for this purpose to offer maximum protection to the circuit.

3.1.3 OUTPUT

The output is taken from the collector of the transistors via C2 and C1. C2 is a blocking capacitor that blocks every dc used for biasing of the transistor and allows an the high frequency ac signal to pass to the RF input of a TV. C1 is also a blocking capacitor to further block any form of dc that might find its way pass C2 because we only require the high frequency ac signal not he dc biasing voltage. Any low frequency signal will pass through R1 and L1 to be lost to the ground.

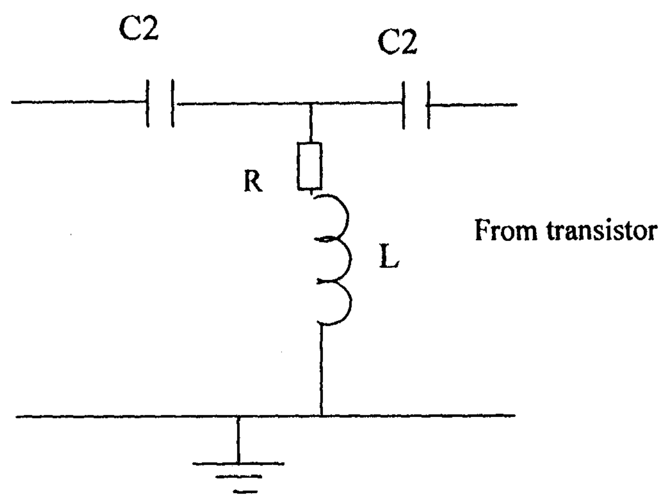


Fig 3.1.3

Is naturally smaller than the base – collectors. As the frequencies are increased, the two capacitances will drop. Because the capacitors are effectively in series, the smaller are dominate (base – collector capacitance). The capacitance is also influenced by the rate of change in base current magnitudes.

CIRCUIT DIAGRAM OF TV SIGNAL AMPLIFIER

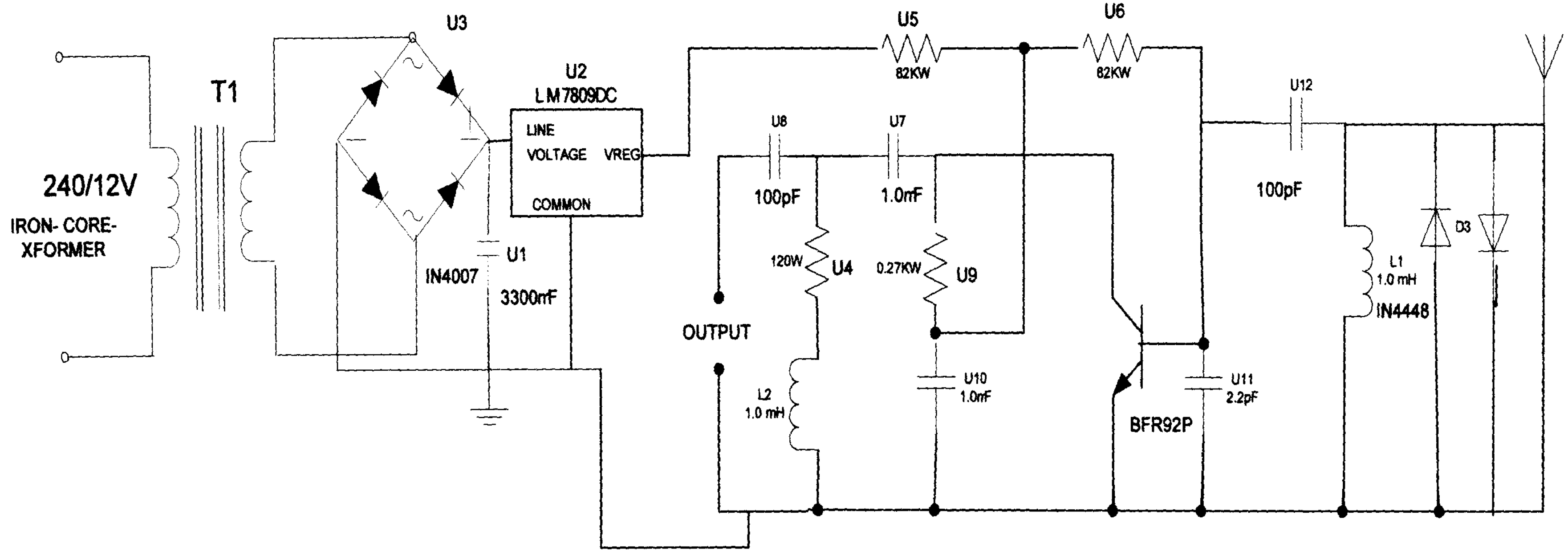


Fig 3.1.4 circuit diagram

CHAPTER FOUR

TEST, RESULTS, AND DISCUSSION

The following basic equipments were needed

1. A TV set
2. Short dipole style antenna
3. A 12volt DC power source

4.1 TEST

1. Tone a nearby TV set to free channel, automatic search or manual search to the channel that gives the best reception or any channel of choice.
2. The R5 potentiometer was adjusted for high gain. At high gain, the picture and sound gravity was at maximum.

4.2 RESULTS

Ordinary dipole style antenna was used on the television set then replaced by the TV signal amplifier and the difference in signal clarity was much. The TV signal amplifier gave a better reception than the ordinary dipole style antenna.

Also, the circuit was tested on different makes of TV sets such as Philips, Panasonic, Toshiba, Sony and sharp. The circuit shows a better reception with sharp TV set. This is without prejudice to any TV set manufacturing company; results could be different for other makes of TV signal amplifiers.

Also, the result obtained shows a better reception when the circuit was used with 14″ TV set than the bigger 17″ and 21″ TV sets. One would be tempted to conclude that what small size televisions lack in size is gain in signal clearity or god signal reception.

Problems Encountered

1. Working with small and fragile components was quite cumbersome and tiresome. Every little rough handling led to bent pins which were a little frustrating.
2. Working with high frequencies, (Radio Frequency) needs special care because long pins and rough soldering edges contributed to circuits stray capacitances, therefore, therefore, soldering was a bit hectic.
3. Getting the exact transistors in the market was almost impossible, even the replacements toward in data books were not easy.

4.3 PRECAUTIONS

1. I ensured all soldering points were well don.
2. I ensured correct orientations of all transistor flat sides
3. I ensured a proper power source of 12Volts supl7 to the circuit.

CHAPTER FIVE

CONCLUSION

In conclusion, a TV Signal Amplifier has been achieved; the aim of amplifying TV Signal without the use of Roof mounted external Antenna has been achieved.

It works better than existing ordinary internal dipole antenna. It is quite chip because the cause of production is small and components are easily obtainable in the market. Therefore, it is affordable.

Also, it is small and compact, which makes it useful in a world that places so much importance on miniturisation and portability.

There were a number of shortcomings in the implementation of the circuit in that the major component which is the transistor could not be obtain nearby, hence an equivalent was used. Also, since I dealt with high frequency which can be easily affected by stray capacitances, I encountered little problems as a result.

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