DESIGN FOR VHF JAMMER (134-176MHZ) AGAINST IMPROVISED EXPLOSIVE DEVICES

By

Muhammed Suleman

Abid Mehmood Khattak

Muhammad Bilal Tamimy

Fahad Maqsood

Directing Staff

Major Syed Muhammad Ali Abidi

Submitted to the Faculty of Department of Electrical Engineering Military College of Signals, National University of Science and Technology, Islamabad in partial fulfillment for the requirements of a B.E Degree in Telecom Engineering

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CERTIFICATE OF CORRECTNESS AND APPROVAL

It is certified that the work contained in this thesis “Design For VHF Jammer (134-176 MHz) Against Improvised Explosive Devices”, was carried out by Muhammad Suleman, Abid Mehmood Khattak, Bilal Tamimy,Fahad Maqsood under the supervision of Major Syed Muhammad Ali Abidi for partial fulfillment of Degree of Bachelor of Telecommunication Engineering, is Correct and Approved.

Approved by

____

(Major Syed Muhammad Ali Abidi)

Project Directing Staff (DS)

Military College of Signals (MCS)

Dated-------- June 2012

ABSTRACT

DESIGN FOR VHF JAMMER(134-176MHZ) AGAINST IED'S

Military operation started in FATA areas since 2001 and the Pakistan army was attacked in 2002 for the first time and that too by an IED. Since then Pakistan army has seriously suffered a lot of casualties both in terms of soldiers and equipment.

FATA is considered to be the hub of the IEDs (improvised explosive devices) .This type of war in which we use the guerrilla tactics and the IED technique took birth after the Vietnam War. The remotely controlled IED especially used in Afghanistan and Iraq war. There was a study carried out to counter the IED. The idea of developing the jammers was employed to counter IED from 2007 onwards. The American and the European jammers are too costly so there was a need felt to develop a low cost jammer in VHF range.

Pakistan is going through severe social and security threat against national prosperity due to terrorist bombings activities. Terrorists often use remote control devices, such as walkie talkie phones that generally operate in the VHF band etc, for activation of remote control devices. The project will give an easy and low cost tool for jamming of VHF band remote control improvised explosives devices in a selective region of the VHF band range because the IEDs can be made in a large variety of shapes and sizes and some time there shape is in such a form that cannot be even expected, they can be on the roadsides, in garbage ,in cars, placed on animals etc.The project will provide the jamming of the IEDs by the best possible approach.VHF jammer between the range (136 to 176MHz)will transmits on the same frequencies as the targeted IEDs are operating on hence disrupting and jamming the communications and blocks the working of the IEDs .

The jammer will be able to jam/block the frequencies denying the terrorist to operate RC-IEDs and hence saves the IEDs from detonating and being explode.

DISSERTATION

No portion of the work presented in the dissertation has been submitted in support of another award or qualification either at this institution or elsewhere.

DEDICATION

To Almighty Allah, for whose greatness we don’t have enough words, To our parents and to the victims of the terrorism in Pakistan

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ABBREVIATION USED

AC	Alternating Current
DC	Direct Current
FATA	Federally Administered Tribal Areas
GSM	Global System for Mobile Communication
IED	Improvised Explosive Device
ISM	Industrial Scientific Medical
LC Circuit	Inductor Capacitor Circuit
RC	Remote Control
RC Circuit	Resistance Capacitor Circuit
RF	Radio Frequency
RX	Receiver
TX	Transmitter
VA	Voltage Amplifier
HF	High Frequency
UHF	Ultra High Frequency
VHF	Very High Frequency
WIMAX	Worldwide Interoperability for Microwave Access
WLL	Wireless Local Loop

Chapter: 1

INTRODUCTION

1.1 Problem Statement

Pakistan is facing a serious social and security threat against national harmony due to terrorist bombings. Terrorists often use remote control devices, operated by Walkie Talkie phones generally in the VHF (very high frequency) band for activation of remote control devices. The project will give an easy and low cost tool for jamming of VHF band remote control devices in a selective region. Terrorist have always been improvising their attack plans. The Improvised Explosive Devices is always concealed and difficult to detect and can easily be activated from an individual sitting at a far distance. The Improvised Explosive Devices is made using the normal daily usage things like booby traps and least expected things are used in making of Improvised Explosive Devices. The Improvised Explosive Devices is easy to manufacture (being cheap) difficult to counter and is very damaging.

1.2 Background

The war of IED started during the Vietnam War and it took full boom during Iraq and Afghanistan war. The major problem is the detection and the diffusion of the IED.The question arises “what is an IED??”.An improvised explosive device (IED), also known as a roadside bomb, is a homemade bomb constructed and deployed in ways other than in conventional military action. Some diagrams of IED shown in Figure 1-1 below

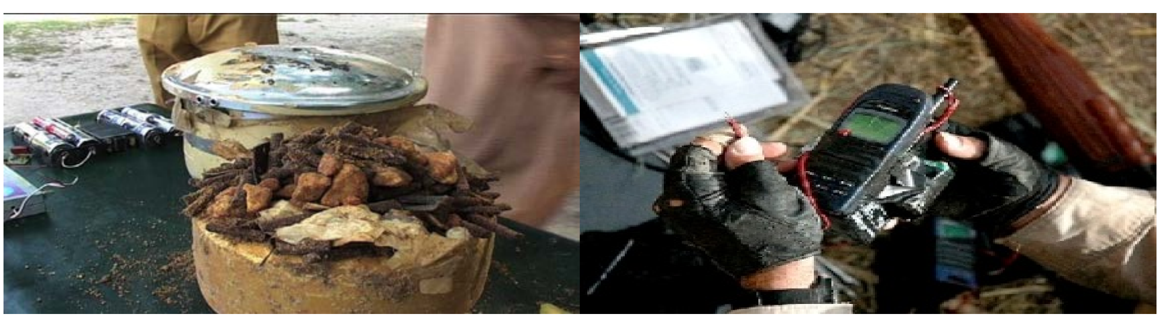


Figure 1-1 How IED's look like

The damage caused by these simple looking and easily manufactured IED is unbelievable. There is a huge number of casualties who are the victims of the IED both in military and civil. A brief chart showing the casualties in 2011 is shown in Table 1-1 below.

Table 1-1 Casualties in Pakistan in year 2011

Affected Department	killed	Injured
Civilians'	3456	6733
Police	154	143
Paramilitary forces	66	87
Army	654	268
Rangers	58	34
Frontier corps	223	42
Total	**4611**	**7307**

We can see that none of the department is safe from the danger of the IED. So there was a need felt to counter the IED technology. The terrorist have already moved to Walkie-talkie for the detonation of the IED just because of the reason that the mobile phone jammers are commercially and easily available .so there was an urgent need to undertake the idea of jammer in VHF range.

1.3 Solution

These IED can be blocked from detonating only by applying the vhf jammer so that the activating device which detonates the IED is blocked and hence the IED doesn’t explode. As there is only one way to stop the IED from the detonating. The best solution is the developing a VHF jammer which is low cost easy to use and provide a real time solution against the IED.A diagrammatic view of the jammer working is shown below.

The Figure 1-2 shows that the jammer has to block the two Walkie talkie set from communication.

Figure 1-2 Communication Jamming

1.4 Objectives

The research was concentrated on development of low cost VHF jammer prototype, which would have practical utilization in the field of defense and rescue. The objective is to implement the VHF jammer using best possible technique. The VHF jammer will be able to jam the frequencies denying the terrorist to operate RC-IEDs.An effective design for power supply is required which will generates the required input signal and Development of signal generator and power amplifier which will generate the signal of required output and also Designing and development of effective transmission medium and antenna which will transmit the required jamming signal at desired frequency.

1.5 Applications

The VHF jammer will mostly be used in FATA of Pakistan where the war on terror is going on. Mostly it will be used by military forces. The extremely strong jamming power ensures jamming and block VHF walkie-talkie, two way radio within 10 seconds. VHF jammer works in 24 hours 7 days. Figure 1-3 shows jammer immobilizing walkie talkie communication when activated at desired range to sets.

Figure 1-3 VHF Jammer Immobilizing Walkie Talkie

Fighting in highly volatile and dangerous FATA areas of Pakistan under IED threat imposes new demands on the successful completion of military objectives. In most scenario military convoys suffers heavily due to remotely controlled IED explosion. This prototype vhf jammer will offer a comprehensive solution to the military of the Pakistan to avoid the causalities.

1.6 Methodology

The project involves the development of comprehensive and mobile solution for IED exploded by VHF Walkie-talkie. The project includes development of a power supply phase, which generates the required 1watt/15 volts input for the signal generation phase. It also includes a power amplification stage which amplifies the generated signal. A transmission stage consisting of antennas for the transmit ion of the signal to the required frequency. The development of the project is carried out in four modules. The development has been shown in Figure 1-4 below.

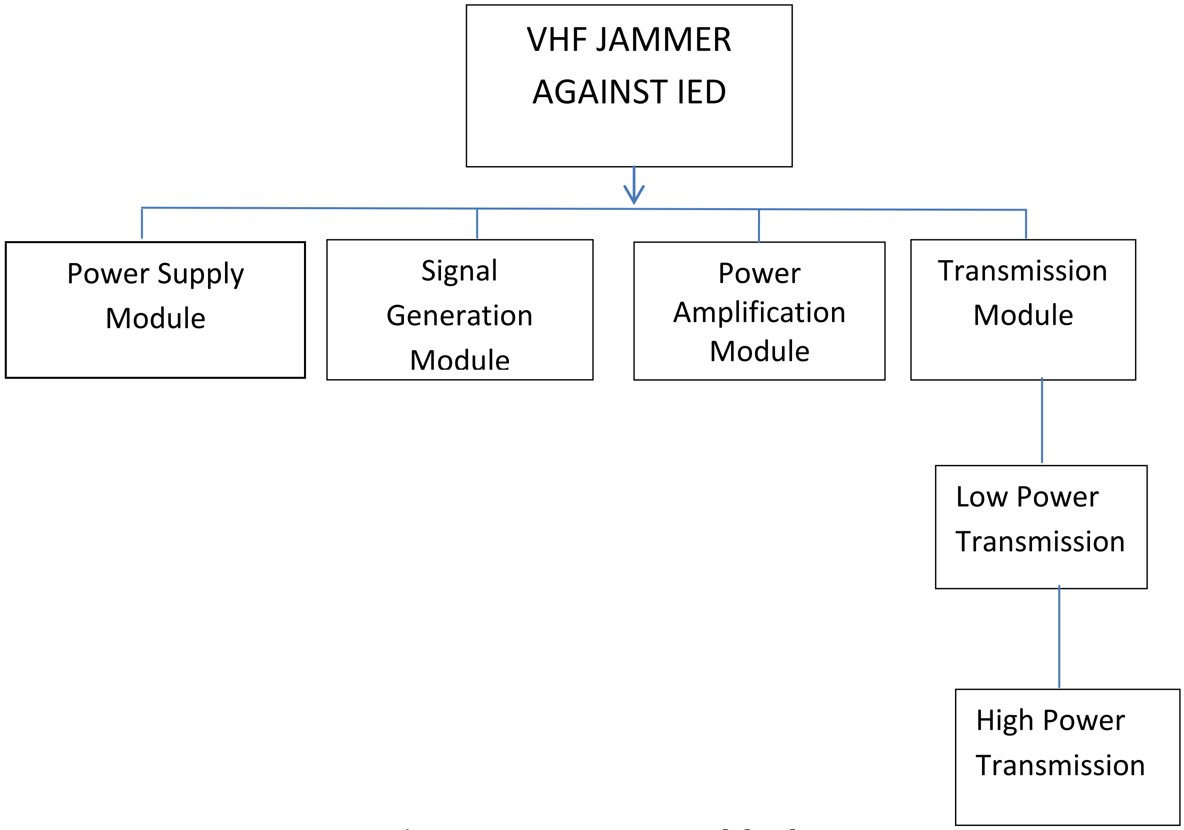


Figure 1-4 VHF Jammer Module Chart

Chapter: 2

LITERATURE REVIEW

2.1 Introduction

This chapter will emphasizes on the background study of the project, need and motivation and aim for the designing and development of the project . The objectives of the thesis and the outline are also presented to give an overview for the development and designing of the project.

Threat of RC-IED is endangering the world wide over and Pakistan is also facing these eminent threats which can be a dilemma on the integrity of the country. This increases the importance of jammer in the prevailing condition of Pakistan. Government all over the globe stand united against these RC-IED terrorist attacks and is trying their best to get a solution of this severe problem.

Because of the prevailing condition of the country Pakistan is facing a lot of causalities especially in remote areas because of the terrorist activities and most of them are by RC-IED, so there is severe need of the jammers which can stop the detonation of the IEDs because they are triggered by the remote control and if these remote controlled signal is jammed, many casualties can be saved.

2.2 Types of Jammer

The jammer is an electronic devices which are being used to stop the transferring of the data by using the wireless transmitter. Main difference between the jamming and the interface is that in jamming the communication is being blocked /disrupted intentionally and in the interface the disruption of the communication is done unintentionally because our device is operating in the same frequency as our target device is operating on hence the jamming is done.

A jamming device transmits on the same frequencies as that of target device hence disrupting/blocking the communications. Enough interference caused by these jammers electromagnetic waves will prevent communication that can be voice or the non voice between wireless media and the base tower. The jammer produces the interface on the effective EM spectrum of the target and scrambles the process of the communication.

The jammers are available at different sizes , shapes ,ranges and output depending upon the technology being employed and the cost of the jammer. Some Jammers are small in size, like hand-held sized device while others sizes can be large. Jammer will be able to jam the frequencies denying the terrorist to operate RC-IEDs .Jammers will interfere mostly with wireless themselves, while devices with greater radii may interfere direct with transmitter. The jammer is implemented by combining the different sections together i.e. power supply , noise generator ,noise amplification, radio frequency and the transmission section. The jammer is going to be powered through batteries as the jammers are mostly portable or they can be given AC supply if required. The jammer can be classified into different types depending upon the type of the frequency spectrum they are operating on.

HF jammer,VHF jammer, UHF jammers, GSM/mobile jammer, WIMAX JAMMER,WLL jammer, ISM jammer etc but the band that are more generally used for the IEDs are the VHF, UHF, GSM bands. That's why our prime focus of study for the IEDs jamming will be comprising on the one of the above mentioned important band.

VHF jammer operates in the frequency band ranging from (30-300MHz) they block the communication that is being carried out in this band.UHF jammers operates in the frequency band ranging from (300-450MHZ for IEDs mostly) hence utilizes this bands for IEDs jamming.GSM/mobile jammers operates on the frequency 900MHz and 1800MHz hence blocks the communication the cell phones as in these frequency the cell phones are operating in the Pakistan so that's why they are also called the cell phone jammers. Some jammers can cover more than one band of the frequency like the VHF/UHF both bands hence jamming the communication of the both of the bands .Some jammers are multiband jammers that blocks the communication of the all the bands like GSM,VHF,UHF etc hence disrupting the communication of all he bands. They have a more complex circuitry than the others because of the coverage of multiband.

2.3 Types of Jamming

There are different techniques that are being deployed in the jamming of the remote controlled improvises explosive devices. The jamming signal is being radiated on the reception of the target and hence blocks the targeted receiver with the help of noisy Jamming signal. There are two important technique for the jamming which are repeater technique and the noise technique. The technique that is mostly going to be deployed for jamming is noisy technique. The three categories of noise jamming technique are Barrage Jamming, Sweep Jamming, Spot Jamming. These Jamming techniques are discussed in detailed.

2.3.1 Barrage Jamming

Barrage jamming is also called active jamming. In barrage jamming continuously the transmission of jamming signal on single or more frequencies or the bandwidths of frequency programmed into the jammer system is carried out. Since each jammer is to operate with the multiple programmed frequencies, hence it will be able to counter for the multiple threats at a time. The band of the frequencies is being covered continuously for jamming without providing the jamming on the single frequency hence is effective in this way but there is a disadvantage of this type of the jamming technique because on this the power is not concentrated on the single frequency but on complete band and more power full jamming as like for single frequency is not done. This type of the jamming technique is being much more useful for the jamming of the remote controlled IEDs because there exact frequency of operation is not known and because in case of the IEDs there is a very small amount of time that is required for the triggering of the IED and we do not have much time to scan the whole band to check out that at which band the target is going to be operate. Different types of barrage jamming are given below

2.3.2 Base jamming

Base jamming is a modern type of the barrage jamming. In this the one of the many receivers of the target is jammed with its operating frequency and hence cutting of communication from others transmitters and receivers other works normally. In this type of jamming technique the target is the receiver set which is cut off from its base by a jammer and hence communication is disrupt.

2.3.3 Pulse jamming

In this barrage jamming technique noise pulse of varying rate ,duration and the amplitude is being produce and is being transmitted at the target receiver and also making difficult to detect the location of the jammer. They are mostly used for the jamming of the radar, teletypewriter, and data transmission system. Cover pulse jamming forms a short noise pulse on the reception of the signal thus covering with a noise block and blocking the communication. This types of the jamming is mostly effective for the aircrafts ,radars etc

2.3.4 Sweep jamming

In the sweep jamming the whole band of the operation of the jammer is being sweeped continuously and repeatedly. If the frequency at which the target communication is on if it is in the jamming band than it will be blocked .In this jamming techniques the power of the jamming signal is being switched from one to another frequency , because of the shifting of the power of signal between one to another frequency thus have an advantage of jamming the more number of frequencies in a quick time period. Sweep jamming do not interfere and disrupt at all the time all of the frequencies but some at a time and hence decreasing the effectiveness of this form of jamming technique .

2.3.5 Spot jamming

Spot jamming is very much effective if the frequency of the operation of the target receiver is known hence whole power of the jamming signal is being concentrated on this frequency . All of its power of jamming signal on single frequency hence very powerful while it has a big disadvantage if the frequency of operation of the target is not known or it has large frequency band and receiver frequency of the target is changing continuously than it will not be effective.

This problem can be catered by utilizing more number of jammers, each using this technique of jamming hence can cover more frequencies for jamming. A large number of resources are required that's why not an economical solution for this problem.

2.4 Components of Jammer

The general form of the jammer consists of following main components. Power supply, IF section (noise generation + low noise amplification) , and RF section. The power supply generate required power which is required for signal generation at noise generation and amplification stage and RF section transmit that required generated signal at desired frequency and higher output power then target set. Each component is discussed in detail below

2.4.1 Power Supply

The jammers takes its power from the source continuously , the jammer are mostly portable so batteries are being used for its operation and their values depends upon the requirement of the jammer. If the jammer is not portable than AC supply is being utilized and after that the transformers are being used to adjust the voltage according to the requirements of the jammer. After the conversion of voltage the bridge rectifier is used for the conversion of AC to DC voltages [2].

2.4.2 Noise Generator

The noise generator and low noise amplification are collectively called IF section. The noise signal is being generated at this portion of the jammer .Tuning circuit is also part of the noise generator. Noise generator controls the frequency at which the jammer broadcasts its signal by sending a particular voltage to the oscillator . the noisy signal that is being generated in this portion is being utilized by the low noise amplification stage of the jammer for the amplification of the noise. Signal is normally generated by the use of the 555/556 IC

2.4.3 Low Noise Amplification

The noise that is produced in the noise generator stage is being amplified here by the use of the operational amplifiers and also the comparators of the voltages. The noise is being amplified here to such a level that it is enough for the power amplification in the radio frequency section. The low noise is being amplified by the use of the LM386 IC Produces random electronic output in a specified frequency range to jam the signal.

2.4.4 RF Amplification (Gain Stage)

The work of RF section is to generate the carrier frequency and the power amplification of the signal. The power of the signal received from the low noise amplification stage is being amplified here to such a level so that this is enough for the jamming of the required target and ready to transfer to the transmission section. This is done by the use of the various radio frequency power transistors. It is very important part of the jammer and tells the quality ,range, stability of jammer. Different techniques and different types of transistor having different power rating and the specification can be deployed depending upon the range ,quality, requirements, budget etc The carrier of the RF jamming signal is also being generated over here by the use of the LC circuit and there specification can be varied according to the requirement of the jammer. There can be one or more stages of the RF section depending upon the requirement and technique utilized in the jammer

2.4.5 Transmission Section

The RF signal after the RF amplification stage is now ready for the transmission. This is done by the use of the antenna. The specification of the antenna its gain, directivity, radiation pattern depends upon the requirement of the jammer. Antennas can be Omni-directional, directional, sectored etc depending upon the requirement. The transmission section transmit the required generated signal at same frequency but higher output power than target set to jam communication

Chapter: 3

POWER SUPPLY

3.1 Introduction

A power supply is a device that is used to provides electrical power to one or more electric devices. It is a device which changes one form of electrical energy to another, though it can also refer to devices that is used to convert another form of energy (mechanical, chemical, solar) to electrical energy. All the power supplies must produce or covert energy it supplies to its load, along with any energy it consumes while performing that task, from an energy source. A power supply can be implemented as a discrete, stand-alone device or like an integral device which is hardwired to its load. The general diagram of the simple form of power supply is shown in Figure 3-1 below.

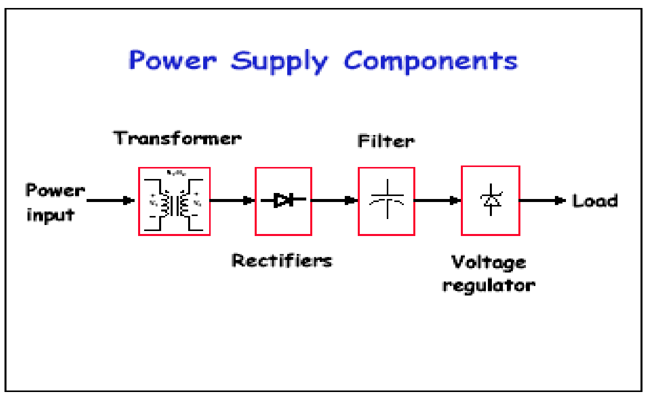


Figure 3-1Power supply components

power supply features includes, The amount of current or voltage it can supply to its load, Stability of its output current and voltage is under varying load conditions and How long it can supply energy without refueling. Power supplies are vastly used in electronics. Every electronic device e.g. computer,television,electronic circuits uses power supplies as its input voltage, so it is commonly used and it must be properly designed.

3.2 Types Of Power Supplies

There are three types of electronic power conversion devices used which are .DC/DC converter, AC/DC power supply, and DC/AC inverter. Everyone of these power conversion supplies has its own particular however we will only deal with the AC/DC power supply which are used in our project. A power supply converting AC line voltage to DC power must perform the functions[3].

Rectification is used to convert the incoming AC line voltage to DC voltage, Voltage transformation is used to supply the correct DC voltage level. Filtering Smoothes the ripple of the rectified DC voltage level. Regulation. Output voltage level is controlled by regulation to a constant value irrespective of load and temperature variations. Output voltage source is separated from input voltage source by shielding and isolation. Protections are provided against electrical surge or spike at output.

An ideal power supply is one that provide a constant and stable output voltage regardless of variations in the voltage, load current. Figure 3-2 below shows a general power supply. The Current I and voltage V relation is current increases and constant voltage is maintained and a point where voltage start decreasing and down slope is observed. The relation to change of voltage is ΔV/V. The peak to peak ripples voltage is ΔV which can be eliminated by using filters and capacitors of required values.

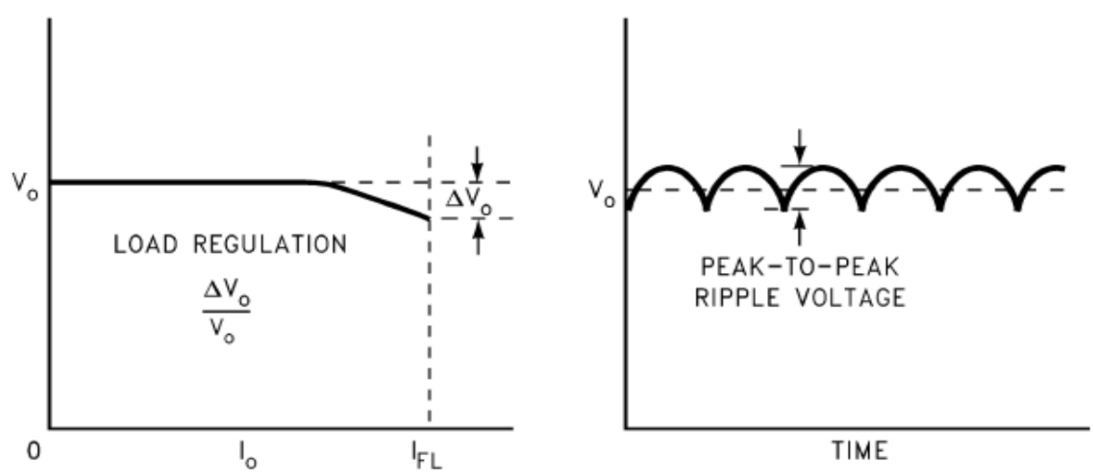


Figure 3-2 Power Supply Load Regulation

3.2.1 Overload Protection

Power supplies are provided protection from short circuit and overload which could cause fire. for that purpose fuses and circuit breakers are used. A fuse has a short piece of thin wire which break if too much current flows. this will disconnects the load and power supply and the circuit stops working until the problem is identified and the fuse is replaced.

A circuit breaker contains an thin wire that heats, break and triggers a spring which shuts the circuit down. Once the element cools, and the problem is identified the breaker can be change and the power restored.

3.3 Transformer

A transformer consist of magnetic coil that works on the principal of electromagnetism. A transformer has two sides one with more number of turns than others. the electric supply can be connected on either side depending on the output required. An ideal transformer imposes no load on the supply (feeding the primary) unless there is a load across the secondary. A transformer core may be made of different materials such as Air core is used to provides the least coupling but is ideal for RF circuits and high frequencies. Iron core transformer are used to improve the magnetic properties of circuit. Powdered Iron core is a Steel magnetic formed into a core especially suited to where there is a very high power or significant DC component in the winding. Ferrite core using magnetic materials to obtain high frequency performance. Generally Air core and Iron core transformers are used. The transformers converts the primary input voltage or current to secondary or desired voltage or current by coil or winding turn ratio. Normally the primary coil has larger turns than secondary one for converting high voltage or current to low voltage and current.

3.3.1 Working Of Transformers

A simple transformer is shown in Figure 3-3. This is a simple transformer, with two windings. The primary winding will induce a magnetic field into the core. The magnetic field is concentrated by the core, and nearly all of it will pass through the windings of the secondary as well, where a voltage is induced.

Figure 3-3 Simple Transformer

The magnitude of the voltage induced in the secondary coil is determined by a formula, which determines the number of turns of primary and secondary coil that is turn ratio (N).This can be calculated by dividing the secondary turns by the primary turns [4].

N = Tsecondary / Tprimary..........Eqn 3-1

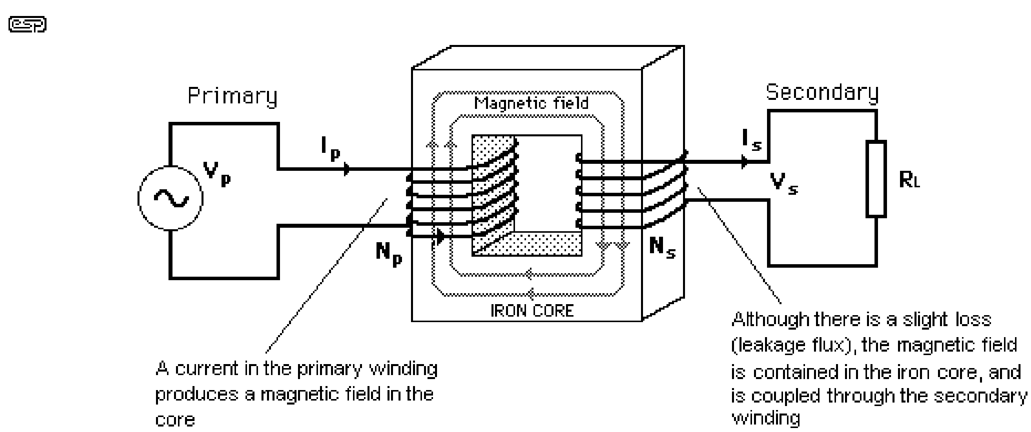


Figure 3-4 - Essential Workings of a Transformer

Tprimary is the number of turns of the primary winding and Ts is the number of turns of the secondary winding. A transformer with 1000 turns on the primary winding and 100 turns on the secondary winding has a turns ratio of 1:10

Vsecondary = Vprimary * N..........Eqn 3-2

The turns ratio can be calculated from the primary and secondary voltages .

N = Vsecondary / Vprimary..........Eqn 3-3

If a voltage of 220VAC is applied to the primary, we would get 22V on the secondary, and this is indeed what will be measured. The transformer is also used to transform current.ie

Isecondary= Iprimary / N..........Eqn 3-4

If a current of 2A were drawn by the primary than a current of 20A would be available at the secondary. The current is increased and voltage reduced. This would be possible only if the transformer is 100% efficient, but normally it is working with 70 to 80% of efficiency and if a 220 VAC is applied at primary its output ranges from 15 to 18V at secondary. Smaller transformers have a lower efficiency.

Normally a load is connected to the secondary winding and current flow in the secondary winding transferring electrical energy from the primary circuit through the transformer to the load. In an ideal transformer, the induced voltage in the secondary winding (Vsecondary) is in proportion to the primary voltage (Vprimary) and is given by the ratio of the number of turns in the secondary (Nsecondary) to the number of turns in the primary (Nprimary) as follows

Vsecondary/Vprimary = Nsecondary/Nprimary..........Eqn 3-5

3.4 Diode Bridge Converter

A rectifier converts an AC voltage to a pulsating DC voltage. A smoothing filter (capacitor and resistor in parallel) will then be used for smoothing purpose and removing of AC ripples to produce pure DC voltage. Rectifier circuits are used in our circuit to convert 220 VAC and 50 Hz frequency to pure DC form for input to our circuit. A simple diode rectifier shown in Figure 3-5 below

Figure 3-5 Simple Diode bridge configuration

3.4.1 Basic Operation

In the Figure 3-6 below, when the input connected to the left corner AC input is positive, and the input connected to the right corner DC input is negative, current flows from the upper supply (red diode) terminal to the right path to the output, and returns to the lower portion supply terminal via the black path.

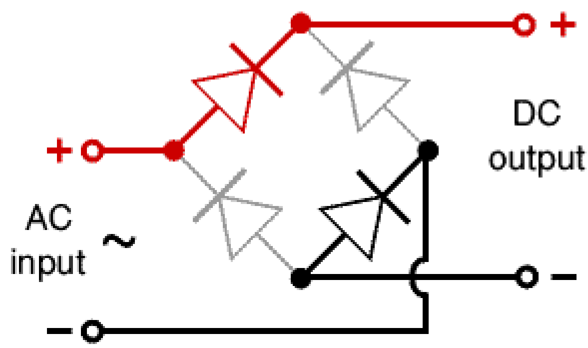


Figure 3-6 Diode bridge connection

When the input connected to the left corner is negative, and the input connected to the right corner is positive, current flows from the lower supply terminal to the right along the black diode(positive) path to the output, and returns to the upper supply terminal via the red diode (negative) path. In both case, the upper right output remains positive and lower right output negative. The general working of bridge rectifier shown in Figure 3-7 below.

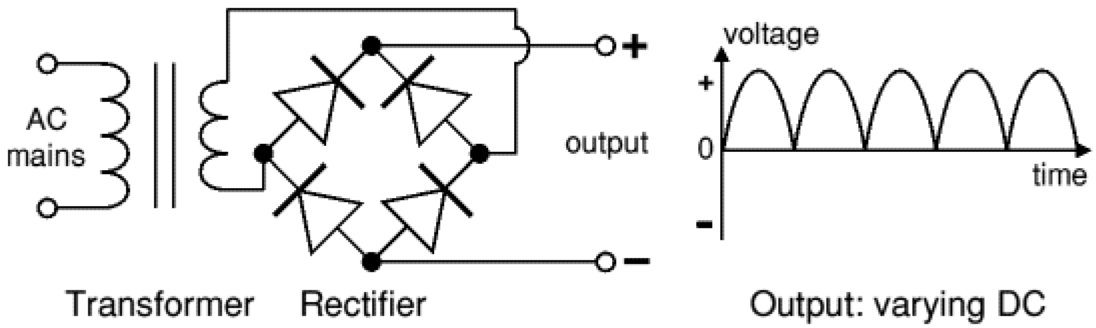


Figure 3-7 Diode bridge working

when 220VAC is supplied to transformer it steps down the voltage to 18 VAC at 80% efficiency ratio of transformer. The bridge rectifier converts that AC to pulsating DC. Figure 3-8 shows complete working of power supply phase [5].

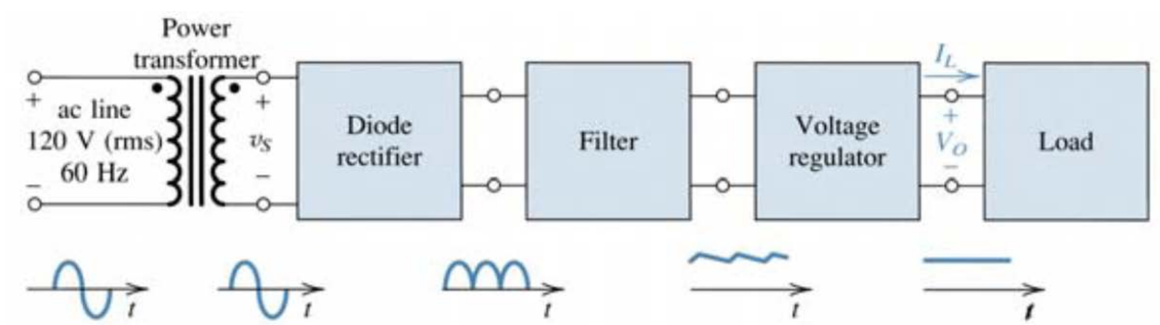


Figure 3-8 Power supply working

If 120 VAC supply is used with 60 Hz of frequency it is first stepped down using transformer and diode rectifier is used to obtain pulsating DC voltage. Filter smoothes the pulsating DC to obtain pure DC voltage at input of circuit.

3.5 Smoothing

The DC voltage supplied by a rectifier would consist of a half sine waves with the voltage varying between √2 and zero times the RMS voltage. This nature of supply is of no use for powering circuits because any RF circuits would have the huge level of ripple superimposed on the output. To smooth the output of the rectifier a capacitor and resistor is used in parallel with each other and with the load. The capacitor charges up when the voltage from the rectifier rises above that of the capacitor and then as the rectifier voltage falls, the capacitor provides the required current from its stored charge.

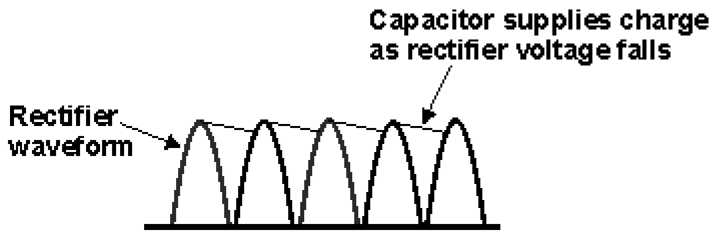


Figure 3-9 Smoothing action of a reservoir capacitor

Discharge path for the capacitor, apart from internal leakage is through resistor connected in parallel with capacitor.

3.5.1 Smoothing capacitor value

The smoothing capacitor value depends on the resistor load and frequency. the below formulas shows how these values to be selected [6].

$$C >> 1 / (f^*R_{load}) \quad \text{..........Eqn 3-6}$$

There will always be some ripple on the output of a rectifier using a smoothing capacitor circuit, it is necessary to be able to estimate the approximate value. The Figure 3-10 shows the ripple for a full wave rectifier with capacitor smoothing.

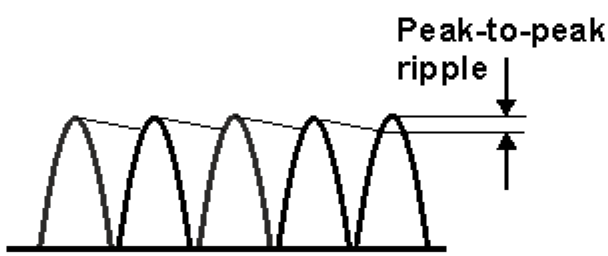


Figure 3-10 Peak to Peak ripples

Generally a 1000 Micro Farad (1000uF) capacity smoothing capacitor is used but If the amount of ripple in the voltage is more than 10% of total output voltage then a capacitor with a higher value e.g. 2,200 micro Farads - should be used.

3.6 Schematic diagram of power supply module

The schematic diagram of power supply phase is shown in Figure 3-11below. The 220CAC is first step down to 18 VAC with 80% efficiency of transformer with 10:1.the bridge rectifier converts that AC to DC.The voltage contain pulsating DC voltage which is removed by smoothing capacitor connected with parallel with 1K resistor which acts as load. The pure Dc is than fed in to the input of circuit for use. Figure 3-11 shows a Power supply design.

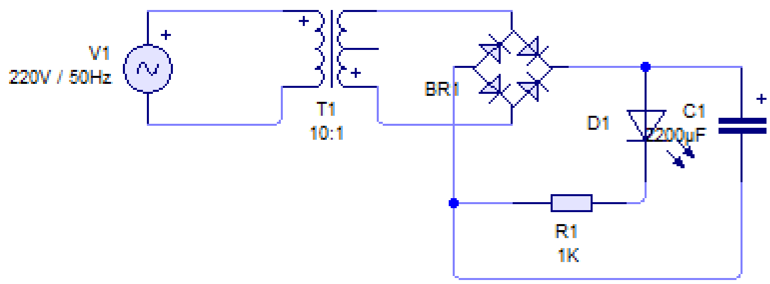


Figure 3-11 Schematic Diagram of Power Supply

3.7 Summary

Power supply phase form an important portion of any circuit. Correct voltage supply with required input voltage and power is essential for working of any electronic circuit. The power supply design for jammer circuit are required to provide input voltage from 15-18V and input power of 1 Watt for correct working of subsequent stages. The alternate arrangement of power supply by using two 12 volts batteries in parallel can be made along with designing inbuilt power supply but getting accurate input voltage and power can be problem with batteries being used.

SIGNAL GENERATION AND SIGNAL POWER AMPLIFICATION

4.1 Introduction

The NE-555 IC is used for signal generation and LM386 IC is use for signal and power amplification. NE-555 is a 8-pin timer IC that is one of the most useful ICs and it is used in many projects. It used in most cases where a timer is required. It has two versions 555 and 556.The 556 is a dual version of the 555 with a 14-pin configuration. The 555 and 556 can be used with a supply voltage in the range 4.5 to 15V.The Figure 4-1 below shows a pin configuration of 555 IC.

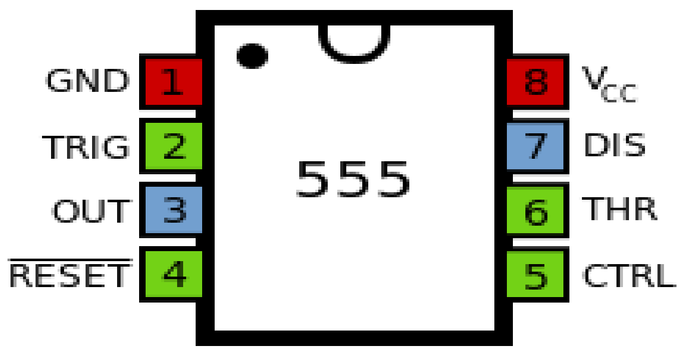


Figure 4-1 Pins of NE-555 IC

The following are complete specification of NE-555 IC that is used to generate frequency or signal. It has 8 pins configuration. Pin 1 is ground, Pin 2 is used for triggering, pin 3 is used to get output, pin 4 for Reset, Pin 5 for control of signal/noise, Pin 6 through pin, Pin 7 for discharge of capacitor and pin 8 for Vcc.

The NE-555 IC can be configured in Astable, Bistable and Monostable mode but it is used in astable configuration in jammers to get sinusoidal signal. It can be configured in Monostable and Bistable mode also if nature of noise signal is such that if only one peak of signal is desired in jamming signal.

4.2 Specification of NE-555 IC

It has a supply voltage of 4.5-15 V,current rating at Vcc=+5V is 3-6 mA,current rating at Vcc=+15V is 10-15 mA,maximum output current is 200 mA,maximum power decipation is 600 mW and Power consumption is 30mW@5V,225mW@15V.A 15 volt signal is desired in jammer to get input power of 1 watt and to transmit 3 watt signal at output of jammer.

4.3 Inputs of 555IC

555 IC has 8 pins. These configuration are shown in Figure 4-2 below.

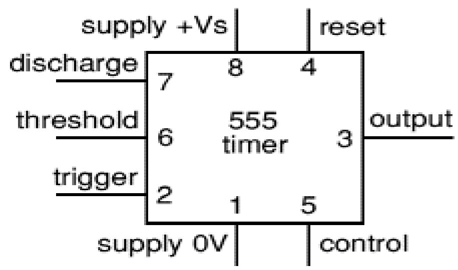


Figure 4-2 Pins configuration of NE-555 IC

The complete functions of each pin is shown in Table 4-1.Complete configuration are also discussed at start of this chapter but exact function are shown in table 4-1 below.

Table 4-1 Pins Working of NE-555 IC

Pin No	Function of pin	Name
1	Always Ground or 0V	Ground
2	If Voltage falls below 1/3 Vcc it will trigger the pulse	Trigger
3	Used for Pulsating output	Output
4	It will interrupts the output timing interval	Reset
5	It is set to default 2/3 Vcc	Control
6	It will ends pulse when the voltage is greater than Control	Threshold
7	It is used to discharge the capacitor	Discharge
8	Used to Supply voltage (4.5V - 15 V)	Vcc

Trigger input is used to monitors the discharging of the capacitor in an astable circuit. when trigger input is less than $^{1}/_{3}$ Voltage supplied it makes the output voltage high (+Vs). It has a high input impedance > 2MΩ. Threshold input is used to monitors the charging of the timing capacitor in astable mode. when threshold input is greater than $^{2}/_{3}$ Voltage supplied this makes the output low (0V). Reset input When reset input is less than about 0.7V this makes the output low (0V), overriding other inputs. it should be connected to +Vs when it is not required. Control input is normally not required and it is normally connected to 0v with 0.0101µF capacitor to eliminate noise. It can be left unconnected if noise is not a problem and in our circuit it is left unconnected because we require noise at output. Discharge pin is not an input. It is connected to 0V when The timer output is low and is used to discharge the timing capacitor in astable circuits. Output pin is The output of a 555 IC is used to get output and it can be in form of sink and source up to 200mA.

4.4 Modes of operation of NE-555 IC

The 555 timer IC can be used in Astable Mode, Monostable Mode, Bistable Mode. The prime focus will be on Astable mode, which is used in jammers to produce timing signal. Bistable and Monostable mode can also be used to generate jamming signal but it is not commonly used in jammers as both positive and negative peak of sinusoid signal is required for effectively jamming of signals.

4.4.1 NE-555 IC Astable Mode

An astable circuit is use to produces a square wave, this is a digital waveform with sharp transitions between low (0V) and high (+Vs).The circuit is called an Astable because it output is continually changing between low and high i.e. 0V to Vcc. The Figure 4-3 shows the 555 IC in Astable mode configuration. The NE-555 IC can also be used in Bistable, Monostable configuration mode, however only astable mode in jammer is used to produced square wave which is desired to get a noisy signal.

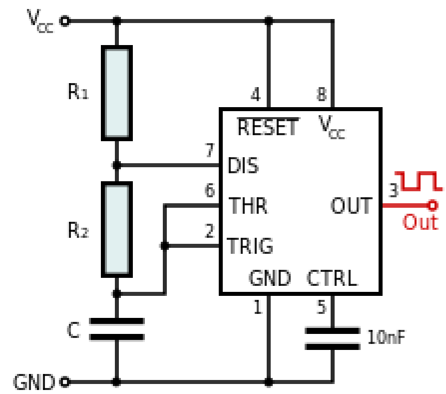


Figure 4-3 NE-555 IC in Astable Mode Configuration

The time period (T) of the square wave is the time for one complete cycle [7].

T=0.7*(R1+2R2)*C1..........Eqn 4-1

F=1/T..................................Eqn 4-2

F=1.4/ (R1+2R2)*C1...........Eqn 4-3

Where T = time period in seconds (s) ,F= frequency in hertz (Hz) ,R1 = resistance in ohms (Ω),R2 = resistance in ohms (Ω) ,C1 = capacitance in farads (F) .Eqn 4-1 is used to calculate time period of signal and Eqn 4-3 gives the generated Astable signal frequency in Hertz.

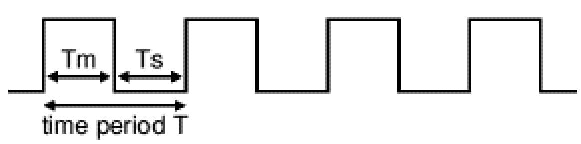


Figure 4-4 NE-555 IC Complete cycle Astable Mode

The time period can be split into two parts: T = Tm + Ts

Tm = 0.7 × (R1 + R2) × C1.......... Eqn 4-4

Ts = 0.7 × R2 × C1....................... Eqn 4-5 where Tm is mark time or peak or crest of wave and Ts is space or null period of wave.If R2 is much larger than R1 than Tm and Ts will be equal. An LED can be made to flash briefly with long gaps by connecting it (with its resistor) between +Vs and the output. This way the LED is on during Ts ,flashes will be brief if R1 is larger than R2,It will make Ts short and Tm long. If Tm must is less than Ts than a diode can be added to the circuit. The value of R1, R2 and C1 can be choose from table 4-2 to get desired frequency. The frequencies is combination of capacitor values resistors R1 and R2.Capacitors are available in small ranges therefore it should be selected first and then the value of resistors which is available at a variety of ranges could be selected. The Table 4-2 shows that if select a capacitor of value 0.1 µF and we want to generate a frequency signal of 6.8 Hz than Resistor R1 could be 1 kΩ,10 kΩ,100 kΩ with R2 10 kΩ,100 kΩ,1 MΩ Respectively.

Table 4-2 Astable Frequencies

555 Astable Frequencies			
C1	**R2 = 10kΩ R1 = 1kΩ**	**R2 = 100kΩ R1 = 10kΩ**	**R2 = 1MΩ R1 = 100kΩ**
0.001µF	68kHz	6.8kHz	680Hz
0.01µF	6.8kHz	680Hz	68Hz
0.1µF	680Hz	68Hz	6.8Hz
1µF	68Hz	6.8Hz	0.68Hz
10µF	6.8Hz	0.68Hz (41 per min.)	0.068Hz (4 per min.)

It is best to choose C1 first because capacitors are available in just a few values. R1 and R2 are available in variety of ranges. Designing astable circuit the following points must be kept in mind. First Select C1 from table above to suit the frequency range we require. Select R2 to give the frequency (f) we requires. R1 to be much smaller than R2 (so that Tm and Ts are almost equal).R2=0.7/(f*C1),R1 to be about a tenth of R2 (1kΩ min.) unless we want the make time Tm to be longer than the space time Ts. It is best that R2 to be make variable, If R1 is variable it must have a fixed resistor of at least 1kΩ in series

4.4.1.1 Astable operation

In astable mode, the 555 IC timer generate a continuous stream of rectangular pulses having some specified frequency. Resistor R_1 is connected between V_{CC} and the discharge pin 7 and another resistor (R_2) is connected between the discharge pin 7, and the trigger pin 2 and threshold pin 6. the capacitor is always charged through the combination of R_1 and R_2, and discharged only through R_2.In the astable mode, the frequency of the pulse stream depends on following formula [8]

F = 1 / (ln(2) * C*(R1+2R2))..........Eqn 4-6

R2 is kept larger than R1 to increase mark time of wave form and if it is kept equal to R1 than space time of wave will be Nine times higher than mark time of wave. The charging time period of capacitor for each pulse is given by

Tc=ln(2)*(R1+R2)*C.......................Eqn 4-7

Where ln(2) shows the actual value at which a capacitor is charged than than full peak value of 1.It is only charged to 0.69 value of the actual capacitor value and than start discharging.

and the discharging time from each pulse is given by

Td=ln(2)*R2*C..............................Eqn 4-8

The power capability of R_1 must be greater than =vcc/(R^2).

4.4.1.2 Duty cycle in Astable Mode

The duty cycle of an astable circuit is shown in Figure 4-5.For a standard 555astable circuit the mark time (Tm) must be greater than the space time (Ts), so the duty cycle must be at least 50%: Figure 4-5 shows the Different Duty Cycles.

Duty Cycle= Tm+Ts=R1+2R2

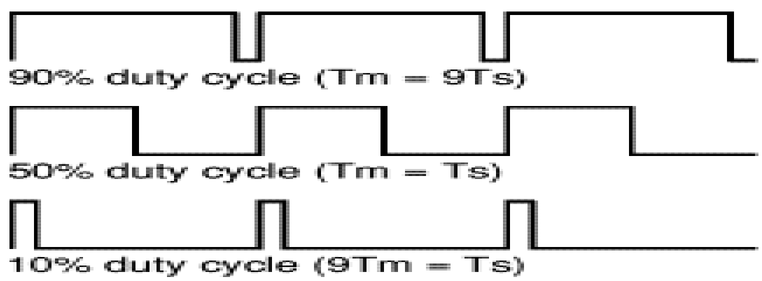


Figure 4-5Astable Mode Duty cycle

In Astable mode the capacitor C1 is charged by flowing current through R1 and R2. The threshold and trigger inputs pins is used to monitor the capacitor voltage and when it reaches to $^{2}/_{3}$Vs (threshold voltage) the output voltage becomes low and the discharge pin is automatically connected to 0V. The capacitor is discharges by current flowing through R2 into the discharge pin and resistor R1 is not used. When the voltage falls to $^{1}/_{3}$Vs (trigger voltage) the output voltage becomes high again it disconnect the discharge pin and allow the capacitor to start charging again. This cycle repeats continuously unless the reset input is connected to 0V

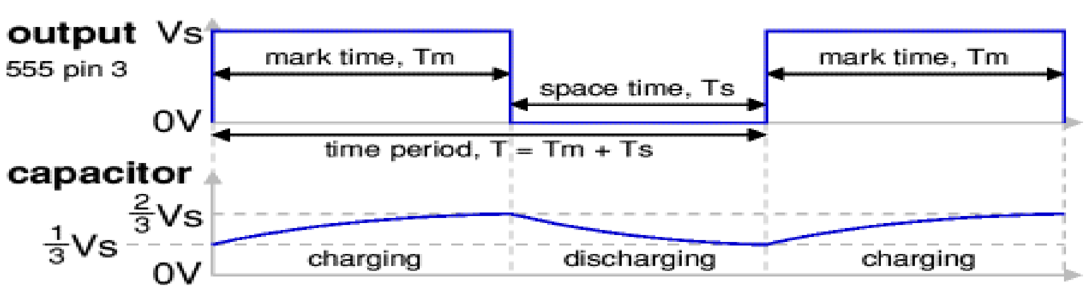


Figure 4-

4.6Astable Mode Clock Signal Generation

An astable mode is used to provide the clock signal for circuits. A low frequency stable (< 10Hz) can be used to flash an LED on and off, higher frequency flashes can also be set but it is too fast to be seen clearly. An audio frequency stable (20Hz to 20kHz) can be used to produce a sound from a loudspeaker.

4.5 Schematic Design of signals generation

The Schematic Design of 555 IC is after power supply phase is Shown in Figure 4-7. Its preliminary work is carried out using Live Wire software.

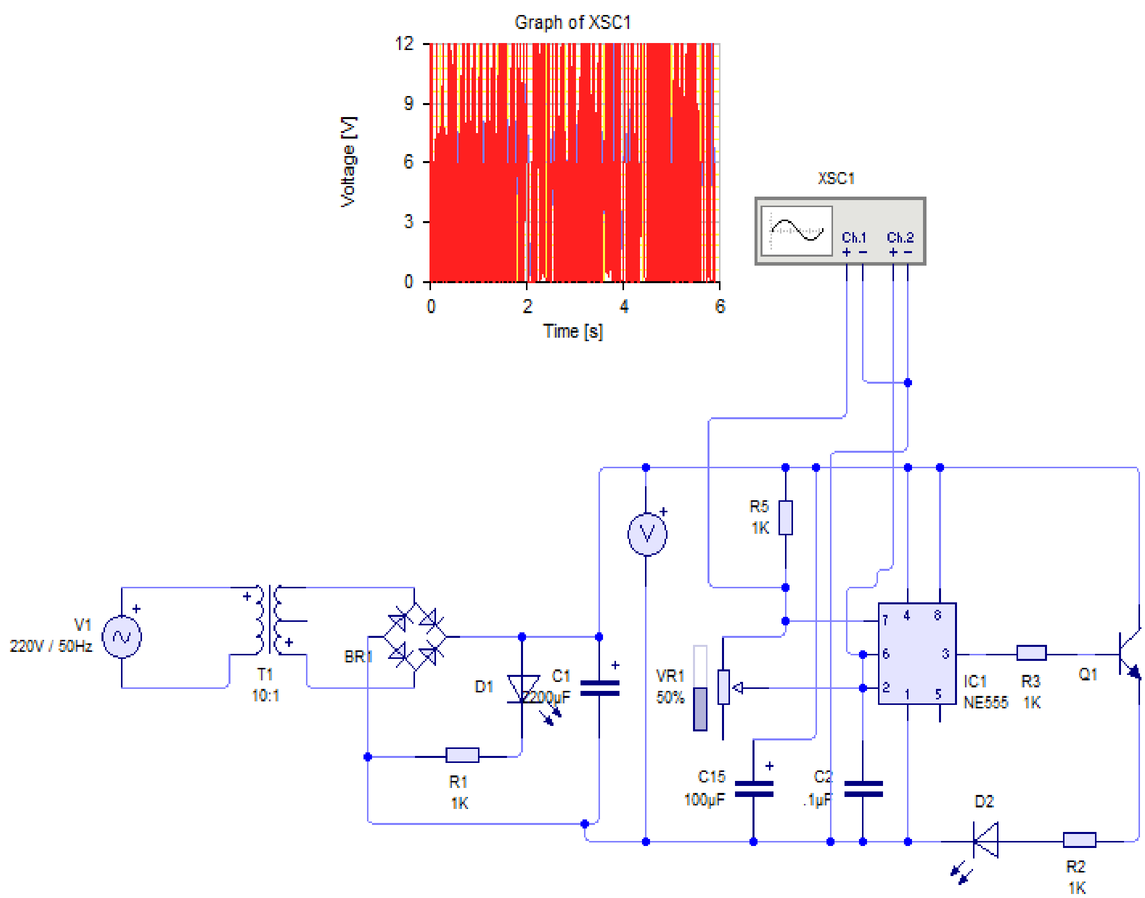
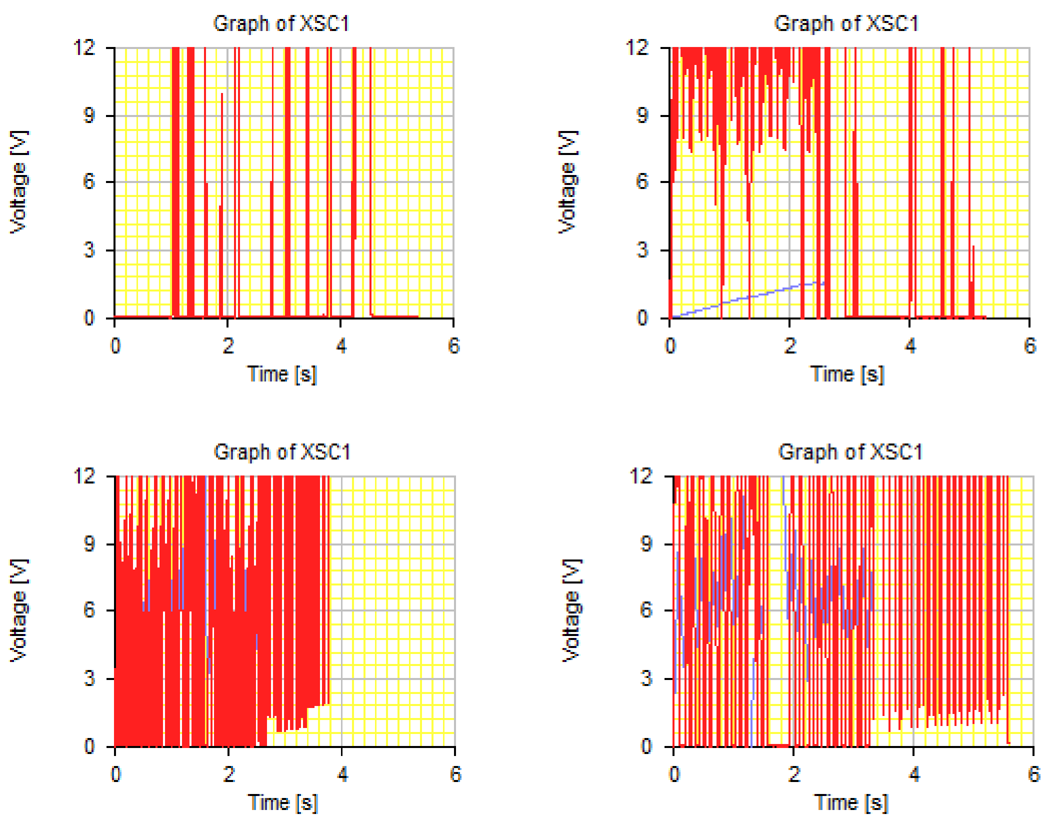


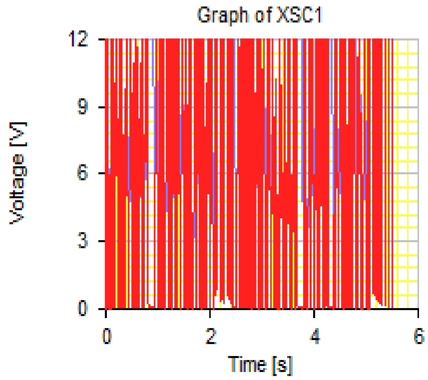
Figure 4-7Schematic Diagram of 555 with astable mode

The 220 VAC is converted to 15-18 VDC by using transformer and bridge rectifier with 220 µf capacitor and 1KΩ resistor in parallel for smoothing of pulsating DC.The1 watt input signal is than send to the input of 555 IC.The555 IC is configured in astable mode to get timing output and to produce desired frequency. Resistor R2 is kept variable to change the output signal frequency and to tune it to desired frequency. the output current of 220mA which is high current and is passed through resistor of 1 KΩ at output to make it low. Voltage at output is amplified to be used for next stage by using transistor at series with output pin. when circuit is connected to the 220 V AC supply it is converted to 15 V DC and LED at output is blinked and oscilloscope shows the generation of signal. Magnitude of signal or frequency can be change by varying the values of variable resistor and capacitor C2.

4.6 Analysis

The different signals generated at output of 555IC are shown in Figure 4-8





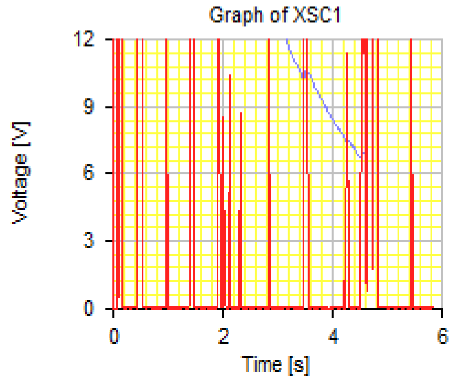


Figure 4-8 Output Frequencies Graph Of 555 IC

4.7 Noise Amplifier

Amplifier or simply amp, is a device for increasing the power of a signal. It is also called an electronics amplifier a current/voltage is the input to the amplifier. Amplifiers can be distinguished from one another on basis of number of factors which include,Gain,Bandwidth,Linearity.These factors affect the performance of Noise amplifier

4.7.1 Gain

The gain of an amplifier is the ratio of output to input power or amplitude, and is usually. (When measured in decibels it is logarithmically related to the power ratio

$$G(dB)=10\log(P_{out}/(P_{in})). \text{ .... Eqn 4-9}$$

RF amplifiers are often specified in terms of the maximum power gain obtainable.

4.7.2 Bandwidth

The bandwidth of an amplifier is the range of frequencies for which the amplifier gives "satisfactory performance". The definition of "satisfactory performance" may be different for different applications. However, a common and well-accepted metric is the half power points (i.e. frequency where the power goes down by half its peak value) on the output vs. frequency curve.

4.7.3 Linearity

When the signal drive to the amplifier is increased, the output also increases until a point is reached where some part of the amplifier becomes saturated and cannot produce any more output; this is called clipping, and results in distortion, but the ideal amplifier behaves linearly whereas the practical amplifier has the nonlinear behavior and they are linear only under certain limits.

4.8 Noise

Noise is an undesirable but inevitable product of the electronic devices and components, also much noise results from intentional economies of manufacture and design time. This is a measure of how much noise is introduced in the amplification process. The metric for noise performance of a circuit is noise figure or noise factor. Noise figure is a comparison between the output signal to noise ratio and the thermal noise of the input signal.

4.8.1 Output range

Output range is the range, usually given in dB, between the smallest and largest useful output levels. The lowest useful level is limited by output noise, while the largest is limited most often by distortion. The ratio of these two is quoted as the amplifier range. More precisely, if S = maximal allowed signal power and N = noise power, the range R is

$R = (S + N) / N$.................... Eqn 4-10

Besides the above mentioned criteria for the selection of the amplifiers there are many other points to be kept in mind during the selection of the amplifiers.

4.9 OP AMP 741

The Operational Amplifier is probably the most versatile Integrated Circuit available. It is very cheap especially keeping in mind the fact that it contains several hundred components. The most common Op-Amp is the 741 and it is used in many circuits. The OP AMP is a 'Linear Amplifier' with an amazing variety of uses. The OP-AMP has two

Inputs, INVERTING (-) and NON-INVERTING (+), and one output at pin 6.Figure 4-9 shows pin configurations of OP AMP 741.

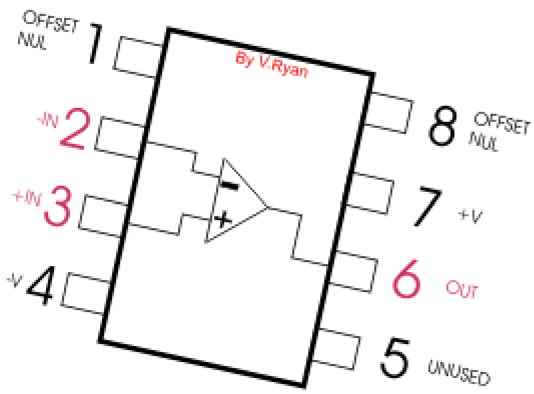


Figure 4-9 LM386 Pin Configuration

The important pins are 2, 3 and 6 because these represent inverting, non-inverting and voltage out .IC 741 can b used in two configurations [9]

4.9.1 Inverting

When pin 2 is the input and when output is checked at pin 6, the output is out of phase from the input by 180 degrees which means the output is inverted. The inverted output is required when the signal waveform is required to be inverted or to make it out of phase from original signal. Normally in jammer this pin is not used because the signal generated at input is simply to be amplified with same phase.

4.9.2 Non-Inverting

In this configuration pin 3 is the input and the output at pin 6 is not reversed means the input and the output are in phase. In jammer for amplification of noise this configuration is used as signal which is generated is simply to be amplified with higher power and same frequency as the target set and no inverting of signal is required. so pin 3 is normally used than pin 2 to get non inverting configuration.

4.10 IC LM 386

The next stage is the further mixing and addition of the noise added in the first stage. This is done by the IC NE 386. However due to the non-availability of IC in the software used its schematic equivalent circuit consisting of two op amp 741 is used. The top view the LM 386 is shown in Figure 4-10.

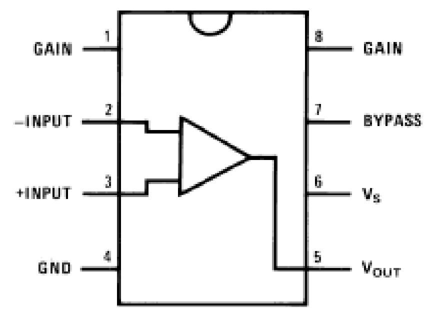


Figure 4-10 LM386 Top View

4.10.1 Gain Control

To make the LM386 more versatile pin 1 ,8 are used if pin 1,8 are open then it provides the gain of 20 i.e. 1 watt signal is amplified to 1.20watts . the configuration is shown in Figure 4-11 diagrammatically.

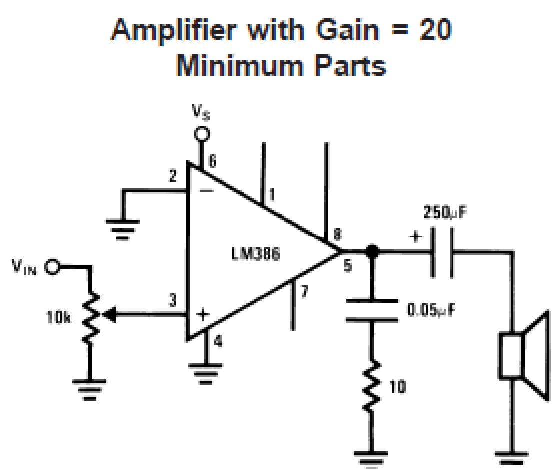


Figure 4-11 LM386 IC Gain Control

The OP AMP 741 Pin1,8 are left open. However the configuration which have used in LM386 is that a capacitor is used in between pin1,8 which results into the gain of 200. That's the maximum gain which can be obtain from it. For the DC source resistance excess offset can be eliminated by putting a resistor from the unused pin to the ground pin. When using for the high gins like 200 it is better to bypass the unused pin. It prevents the degradation of the gain and also reduces the chances of the instabilities. This can be obtained by a short to ground as shown in Figure 4-12.

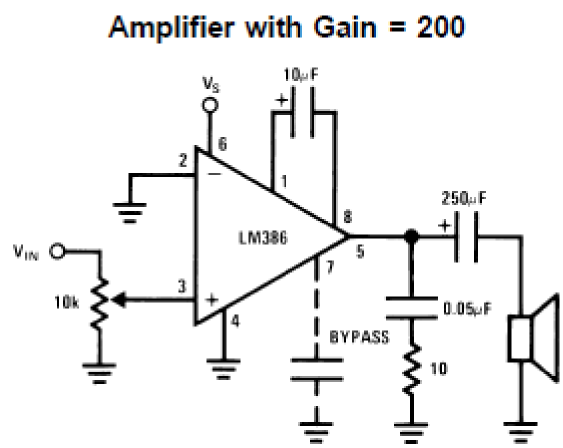


Figure 4-12 LM386 IC Gain Maximum Gain Configuration

The schematic diagram in Figure 4-9 has only been shown for the understanding of the IC however in practical circuit LM386 is used so just by the pins mentioned above desired results can be obtained. All the voltages are measured with respect to the ground pin i.e. pin 4.

There is another potentiometer vr2 in this stage with the same purpose of the change in the intensity of the amplification. The module is also completely shown in Figure 4-12 in form of its actual implementation in the circuit.LM 386 IC is replaced by two operational amplifier in circuit diagram because live wire software used for designing of software portion and design do not support LM 386 IC and its internal configuration which uses two operational amplifier is used for same purpose to get the desired amplification which could be achieved in case of using single LM 386 IC.

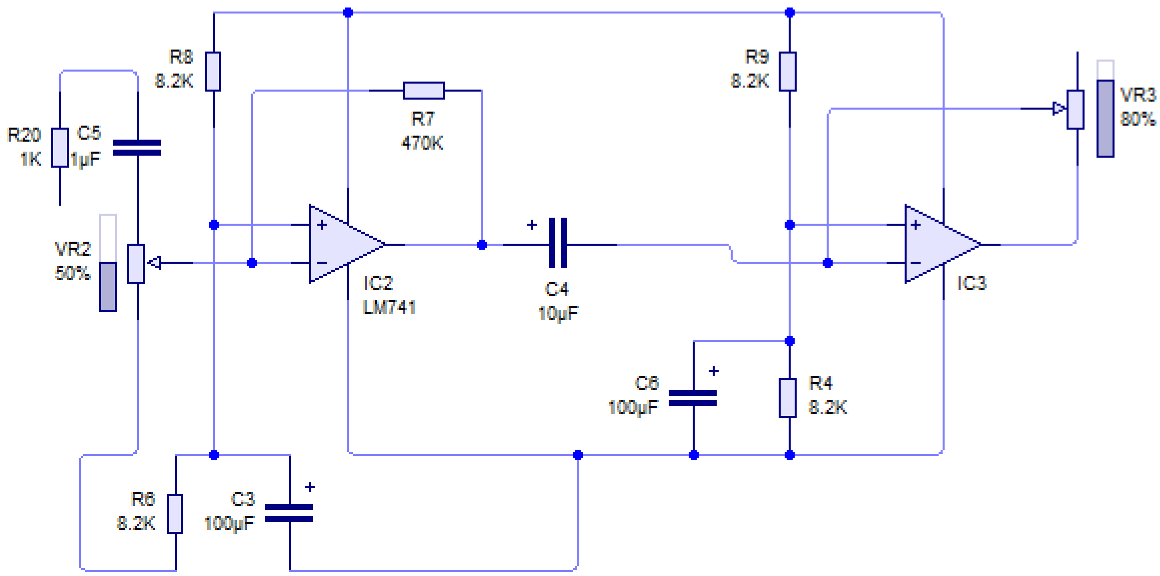


Figure 4-13 Schematic Diagram Of LM386 IC

4.11 Working Of Noise Amplifier Stage

Another potentiometer vr2 is used in this stage with the same purpose of the change in the intensity of the amplification. The working of the stage shows that the initial resistance and the capacitor are used to remove the ripples. Then a variable resister is applied which is used to control the amount of the amplification. And the feedback resistance is used to obtain a gain of 200.the capacitor C4 is used. For the smoothing of the output. The amplifiers are in comparator configuration as it compares the voltage across R6, C3and R8 in first stage and C6, R4 and R9 in the second stage and feeds the higher voltage to the power amplifier

Two amplifiers are used in this module. The first amplifier is in configuration to produce the gain 200 i.e. if input signal is 1 watt it will amplify it to 3watts.The 3 watt signal will easily jam the 1 and 2 watt signal that is any walkie talkie VHF set with power less than 3 watt.

4.12 Summary

The signal generation and power and noise amplification module focus on the designing and development of a low cost and efficient desired signal and noise generation and then amplification of that signal with maximum gain required in jamming circuit. The 555 IC is used for signal generation purpose and by using the best combination of resistor R1 variable resistance R2 and capacitor in astable mode, The combination of different frequencies are achieved. The required frequency is set by varying the variable resistor The LM 381 IC is used for noise amplification The signal generated by 555 IC is then fed to power amplification stage to get maximum gain and noise amplification.

Chapter: 5

RF AMPLIFICATION SECTION

5.1 Introduction

The RF section plays a vital and key role in the designing of a jammer. It is a very important part of a jammer because the signal that is going to produce the jamming and disruption of the communication is being generated and amplified over here and is of key important and after the generation and amplification of the RF jamming signal the transmission is carried out. The RF section also defines the quality of the jammer and the parameters that mostly effects the range of the amplifiers are very much linked with this stage of the jammer. The power of the radio signal that is amplified to such a high level so that it produce the jamming signal and disrupt communication process.

5.2 Radio Frequency(RF)

RF stands for radio frequency. Radio frequency is the frequency that can be used for the sake of the wireless communication that can be varied from the range of 3 KHz to the 300 GHz and are the radio waves correspondence. These are the rate of the oscillation and the rate of the oscillation are usually electrical not commonly the mechanical. For the radio communication to take place the transmitting and the receiving sides must be equipped with the antennas. Antenna can transmits millions of the signals at a time so for a radio communication to take place the antennas must be tuned to the specific range of frequency where signal is to be transmitted.

The table of the different bands of the radio frequency signals and there corresponding wavelength are as shown in the Table 5-1.

Table 5- 1 Radio Frequency Bands

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

5.3 Tuned Circuit/Resonant Circuit

When the inductor and the capacitor are connected together they are also called the tuned circuit or the resonant circuit or the LC circuit. This circuit is used to produce the oscillations and the frequency that is required for the transmission. The value of the frequency produced can be increased or decreased depending upon the values of the LC circuit. The inductor and the capacitor together forming the resonant circuit are started acting as the electrical resonator because the electrical energy is being stored at the circuits resonating frequency[10].

This circuit is being used for multiple purposes Generation of a signal at a specific frequency and Choosing a signal from the more complex band of frequency or complex frequency for a specific frequency. The tuned circuit can be consider as an ideal or the perfect in the sense because it do not need the use of the resistors which produces the losses and the dissipations of the power and the energy so in this sense loss of these are exempted in the resonant circuit. This circuit working is to produce oscillation and at the same time with the minimum effect of the damping so there is a need to keep its resistance as low as possible. This circuit is not lossless but is with minimum loss. We change the frequency of our jamming signals with the help of the variable capacitor placed along the resonant circuit to our required band of the VHF frequency between 136 MHz to 174 MHz and then utilize this band of frequencies for transmission of the jamming signal which will produce the jamming for IEDS operating at these frequencies.

5.4 Working Of Tuned Circuit

When a charged capacitor is connected across inductor ,flow of charge will pass through inductor and starts creating the magnetic field around itself and results in the reduction of the voltage on capacitor. Slowly and the gradually the whole of the charge around capacitor will be vanished and at last the voltage will be equal to zero. Hence the voltage would be zero around capacitor but the current will not be zero around because of the inductor as it is resisting to the changing in the current hence the current would not be zero to keep this current in the flow the energy is being consumed from the magnetic field which will be slowly and gradually become less and less. The current starts the charging of the capacitors with voltage that of the different polarity as to that which was original.

When magnetic field is absolutely finished the charge will be saved in the capacitor of opposite polarity as was earlier and the current will be stopped. And the cycle will be repeated with the alternatives directions of the current in the inductor. The charge will moves forwards and the backwards across the plate of the capacitor by passing through the inductor. The energy will remains in oscillation until the losses of the internal dissipation of resistances makes it zero and can be compared as the harmonics and the pendulum. Frequency of oscillation is dependent upon the used values of the inductors and the capacitors. The oscillations can be up to millions per second. By Kirchhoff's voltage law the sum of all the voltages across the capacitors and the sum of all the voltages across the inductors are zeros.

Inductor voltage + Capacitor voltage = zero..........Eqn 5-1

By the Kirchhoff's the current through capacitor and the current through inductors are always equal.

Inductor current = Capacitor current.......................Eqn 5-1

There are three tuned circuits that are being used in our project along with three variable capacitors that are to be used to tuned the frequency in our desired VHF band of (136 MHz to 174MHz). The general form of the LC circuit is as given below in the figure 5-1.

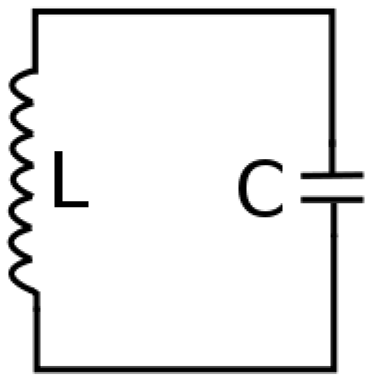


Figure 5-1 General LC circuit

The LC circuit that is being used in our project consist of the inductor of the value 6,5 and 1 Microhenry depending on the stage of the RF because for our band this value of the inductor can perform the required function. The capacitors that are used is of capacitance 5 and 6 Picofarad depending upon the stage of the RF amplifiers. For range (88 to 108 MHz) the inductor of the 10 Microhenry is being used. The LC circuit that is used in the first stage of the RF amplification section is given in the figure 5-2.

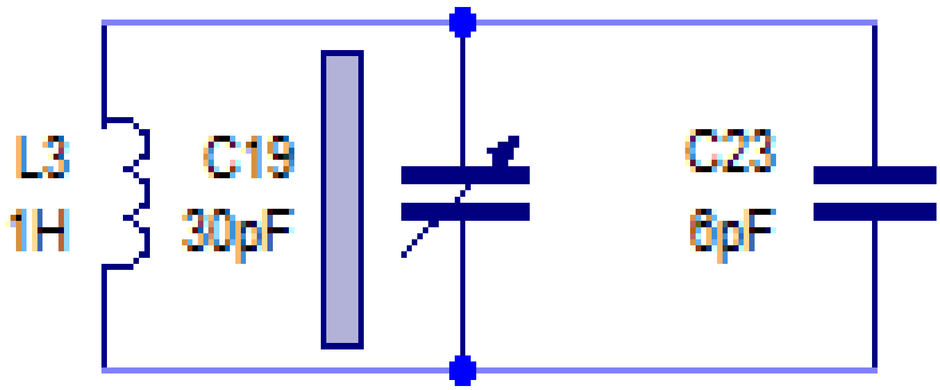


Figure 5-2 LC circuit for stage 1

Here the capacitor that is used is of 6 Picofarad and the inductor that is used is of 1 Henry because it is the lower amplification stage. Here the additional variable capacitor is not part of LC circuit , that is used is for generating the carrier in the VHF band. The LC circuit that is used for the second stage and the third stage of the RF amplification stages are shown in Figure 5-3.

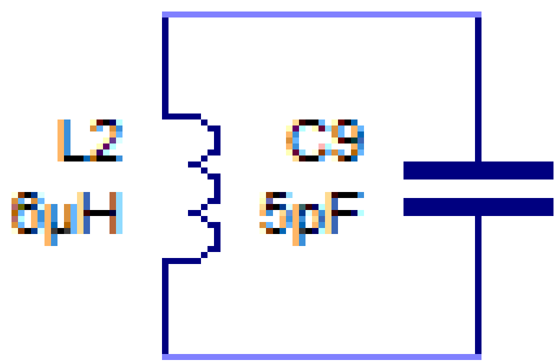


Figure 5-3 LC circuit for stage 2

The LC circuit that is used for the third stage of the RF amplification is shown as in Figure 5-4.It consist of 5µH Inductor and 5 pF capacitor.

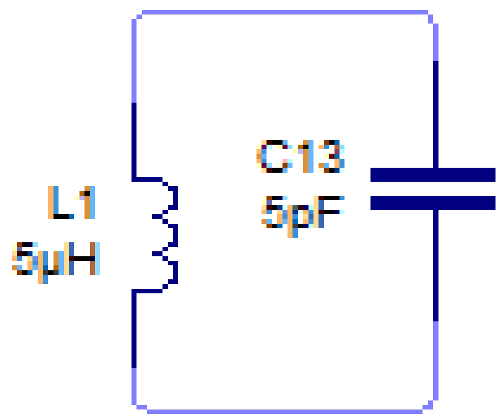


Figure 5-4 LC circuit for stage 3

5.5 Stages Of The RF Section

Depending upon the different output power levels there are three stages for the amplification of the RF signals. In these stages the power of the signal is amplified to such a high level so that it produces the disruption and high distortion results in the jamming of the IEDS that are going to be operated remotely for destructions and supersede the signals of the IEDS.

5.5.1 First Stage Of RF Section

After the signal that has been passed through the stage where there its maximum amplifications of its noise has been occurred and the low noise amplification has been done the signals than enters the first stage of the RF section for the power amplification purposes. When the signals enter in this stage first of all it passes through the RC circuit where the ripples of the signals are removed and the smoothening of the signal is done. The signal received is of low power around 500Milliwatts and after passing through this stage the power of the signal becomes up to the 1 watt. The diode is used after the each stages of the jammer to avoid the going back the harmonics of the each stage in the backward direction so that it may not damage the other circuitry. In this the tuning capacitor is used which is of variable capacitance of the range from zero to thirty Picofarad so when its value is changed depending upon the required frequency that is required for the carrier frequency changing that interrupt for the jamming and we can tune it according to our requirement. As we changes the capacitance the carrier will be changed accordingly. The capacitance of the RC circuit which is 6 Picofarad also helps in avoiding its frequency that is being created for the carrier from being overshooting and remains the frequency in the desired band of frequency. There are no antennas attached to this portion of the RF section because the power output is low of this section but the rest two portion are equipped with the antennas because the power parameters of these portions are good rather than the first. The figure of first stage of RF section is given in Figure 5-5.

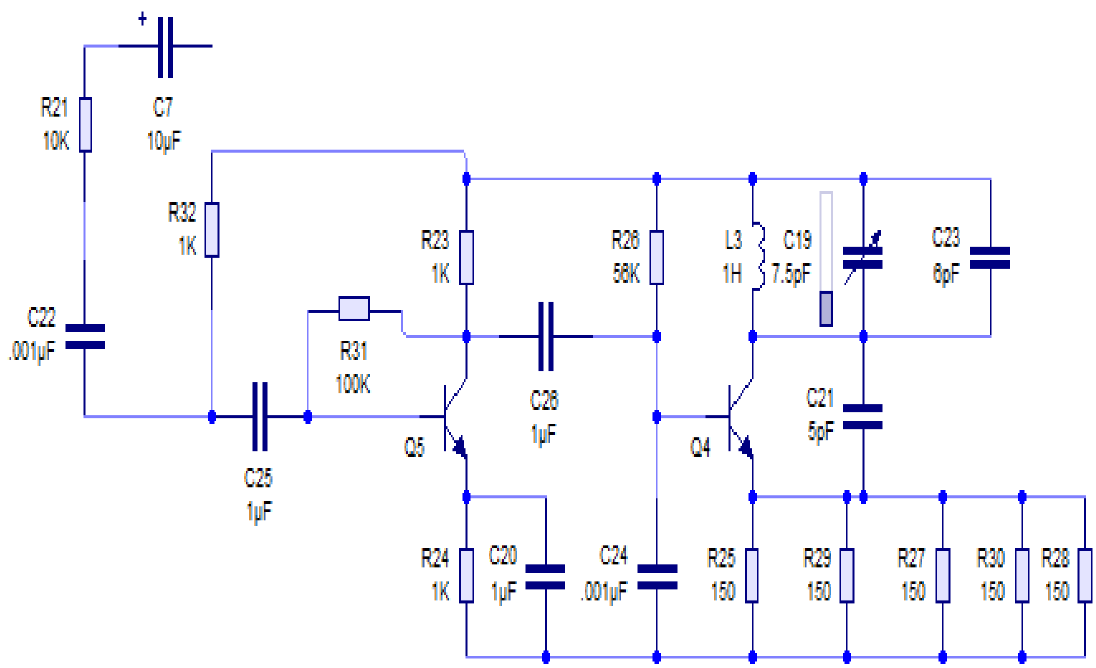


Figure 5-5 RF circuit for stage 1

A series of 5 resistances is used in Figure 5-5 having the resistance of 150 ohms each and the power rating of 0.5 watt each without using the 1 single resistance instead having the equivalent power rating and the equivalent resistance because of the reason that a series of the resistance provides the stability and the reliability to the system and provides the redundancy to the system. The resistances on the base of the transistor are used for the biasing of the transistor. The biasing of the RF transistors is done at the 10 percent. The 10 percent means that voltage at the base of transistor should be 10 percent of the voltage that is available at the collector. e.g. if the collectors voltage is 22V than the base voltage should be 2.2V so the values of the resistors are taken and selected accordingly. The other resistance that is producing the negative voltage ensures that the voltage at the base of the transistor should not exceeds more than 10 to 15 percent of the collectors voltage so keeping in that range. A capacitor of small value (it can be of 0.01Microfarad) is used because when the biasing of the of the RF transistor is done it produces high voltages back, and to avoid this the lowest value capacitor is used which stops the high back voltages and saves the circuitry from damage.5 picofarad capacitor is used between the collector and the emitter , it is very much important because it causes the oscillation of the signals .The oscillations are produced and the signal is oscillated and also loops back from the emitter to the base than again to collector and again from collector to the 5 picofarad capacitor and then back to the base of the transistor by the emitter. If these oscillations do not occurs the transistor will heat up within few seconds of its operation and results in failure of the jammer.

5.5.2 Second Stage Of RF Section

The RF signal after the amplification through the first stage of the RF section enters the second stage of the RF section. Here more powerful transistor is used for amplification of the signal. The RF signal passes through the RC circuit having 0.01Microfarad capacitor and 10kΩ resistor. This RC circuit will block the ripples and do the smoothening of the RF signal. After passing through the RC circuit the signal is ready for the amplification through the transistor. The biasing of the RF transistors is done at the 10 percent. The two resistances that are used are of 10kΩ and the 100kΩ. There values is selected in such a way that it produces 10 percent voltage at the base of the transistor for biasing. There equivalent values are 9kΩapproximately. Here we used two resistors for reliability and stability and to stop a back voltage.

The other resistance that is producing the negative voltage ensures that the voltage at the base of the transistor should not exceeds the 10 to 15 percent of the collectors voltage so keeping in that range. Its value is taken here 3.9kΩ and also doing the smoothening of the signal. A capacitor of small value (it is of 0.01Microfarad used here) is used because when the biasing of the of the RF transistor is done it produces high voltages back, To avoid this the lowest value capacitor is being used which stops the high back voltages and saves the circuitry from damage. For range (88 to 108 MHz) carrier generation the inductor of the 10 Microhenry being used, as our range is of the (136 to 174MHz) so we used the inductor of 6 Microhenry, which will produce the suitable results according to our requirements. A 5Picofarad capacitor is used which will stops the carrier frequency from overshooting and remains the frequency within the specified limits. A variable capacitor of range from zero to thirty Microfarad capacitance is being used for changing the frequency of the carrier that is being generated by the inductor. As we changes the capacitance the frequency of the carrier will be changed and can be adjusted according to our requirements. The charging and the discharging of the capacitor will produce the oscillation. Two antennas are used for the transmission of the RF signal ,which are Omni-directional and transmit signal in all direction. The transistor used for the power amplification of the signal is C1971.The transistor of second stage C1970 produces the amplification of the RF signal up to approximately 3 watts. The figure of second stage of RF section is as given Figure 5-6.

A series of 10 resistances is used having the resistance of 150 ohms each and the power rating of 0.5 watt each without using the 1 single resistance instead having the equivalent power rating and the equivalent resistance because of the reason that a series resistance provides the stability and the reliability to the system and provides the redundancy to the system. They produces an equivalent of 5 watts rating power negative peak. There are two antennas are placed at the transmission points which are Omni-directional in nature. The first antenna is placed at the collector point and the other antenna is place at the emitter point which is after passing through the 5 Picofarad capacitor between collector and the emitter. The two antennas are used because they will produce the jamming of the signal at both of the positive and the negative peaks and fails the triggering /detonation of the IEDS and hence produce the complete and perfect jamming.

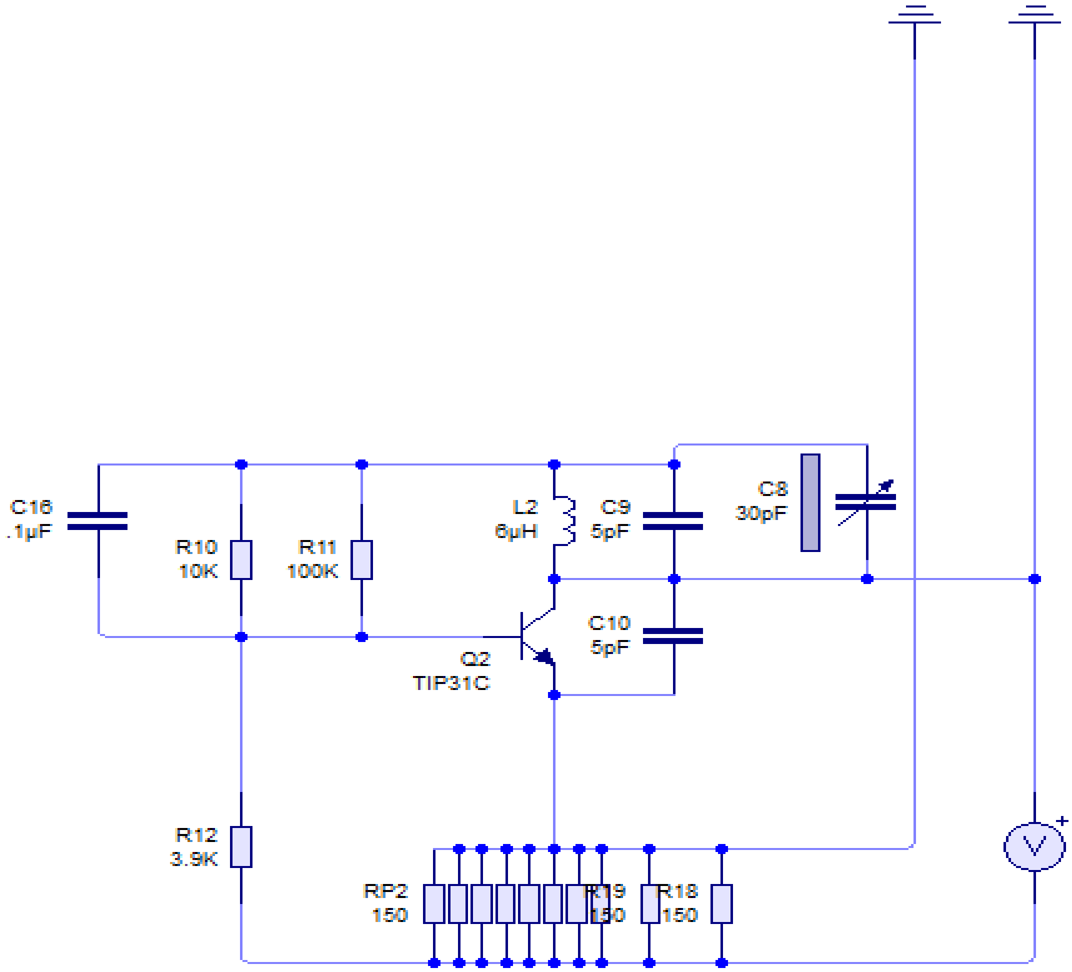


Figure 5-6 RF circuit for stage 2

5.5.3 Third Stage Of RF Section

The third stage of the RF section produces even the more power signal than the second stage .The RF signal that is transmitted from this is of more power than the signal that was transmitted from the second stage because of the change of the resistor from C1970 to C1971 that is even more powerful than the earlier. This RC circuit will block the ripples and do the smoothening of the RF signal. After passing through the RC circuit the signal is ready for the amplification through the transistor, when the RF signal passes through the RC circuit having 0.01Microfarad capacitor and 10k resistor. The transistor C1971 will produces the power output of approximately equal to the 4 watts and produces the better jamming and in terms also supports the jamming of the second stage of the RF section.

The third stage will cover the area which is at far end and the second stage will cover the less radii and both will blocking the near and the far end areas of the IEDS.

5.6 Benefits Of Multiple Stages

The multiples stages provides with efficiency, reliability, stability and redundancy to the jammer and it's working. It helps to protect the jammer from getting held. If one stage of jammer is not workings the other stage will provides the backup for jamming. These stages also provides the efficiency in working to the other stages. The figure of third stage of RF section is as shown in Figure 5-7

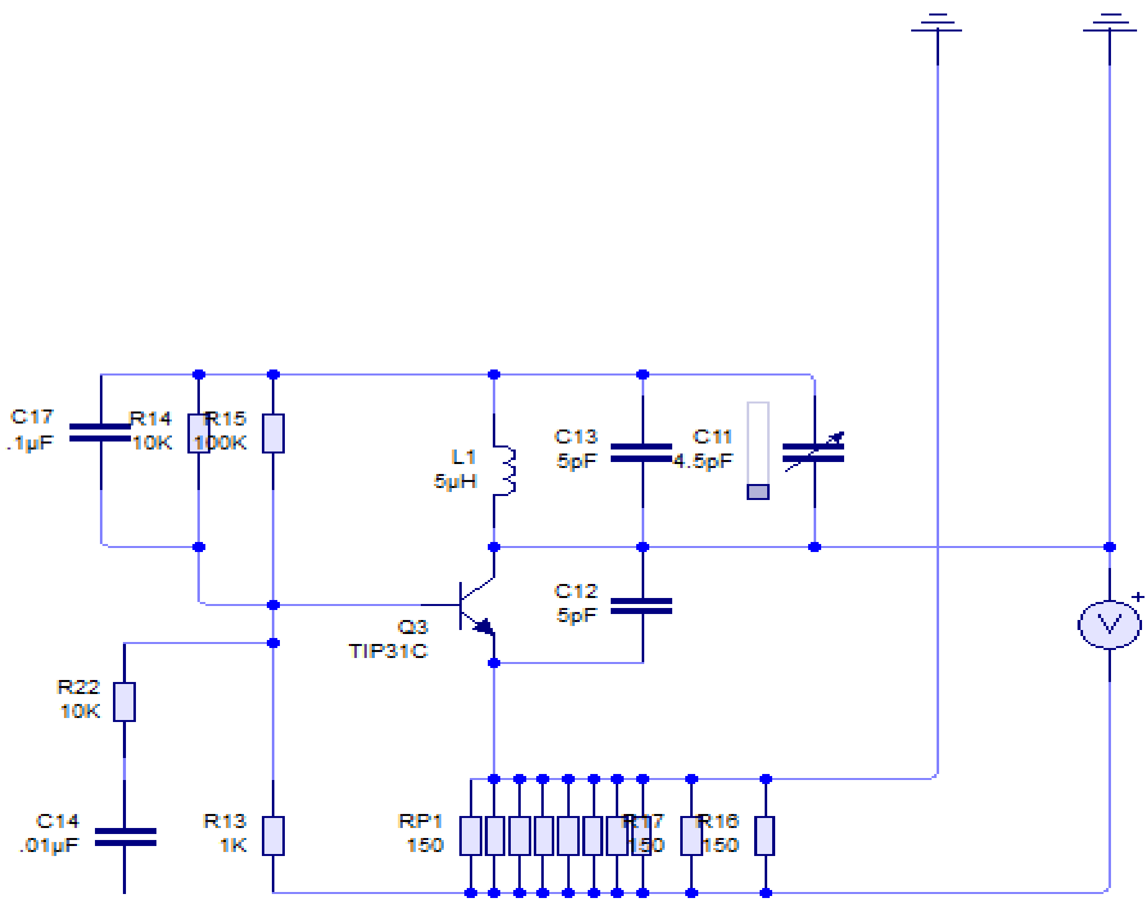


Figure 5-7 RF circuit for stage 3

Chapter: 6

ANTENNA SYSTEM

6.1 Antenna Basics

Antenna is device which is capable of converting the electrical waves into electromagnetic waves and vice versa and is capable of receiving and transmitting of the signal. Antenna is capable of the transmission of the electromagnetic waves into the air at the transmitting terminal and at the receiver terminal it capable of receiving the signal as electromagnetic wave and convert it into the electric wave. Antenna can be used for both of the purposes receiving and transmitting. For the wireless communication the antenna plays a very important role. They can be used for a lot of the purposes, for broadcasting of TV channel, radio, for dual way wireless combination, for communication through satellite, for mobile communication etc and is typically made from the conducting metallic material which are connected through a transmission line for its dual operation of transmitting and receiving.

The oscillating electrons current stimulating through the antenna creates an oscillating magnetic field around the antenna and the electronic charge also forms the oscillating electric field around the element and hence the time dependant electromagnetic radio waves starts radiating far from the surface of the radiating antenna as the moving electromagnetic field into the space around the antenna and at the receiver these electromagnetic waves applies forces on the electron of the receiving antenna part results in oscillation at the receiving part and hence produces the current due to the forward and backward movement of the electrons. The gain of the antenna shows that the extant of the power that is delivered/radiated in the direction of the maximum radiation. The 3db gain shows that the power will be twice. The efficiency and the gain of the antenna are related by the formula given at Eqn 5-3 [11].

$$G=r*D$$ ....Eqn 6-1

6.2 Placement Of Antenna

There are four VHF antennas placed in our VHF jammer project. A pair of the antenna are placed in the second stage of the RF section and a pair of antenna are placed in the third stage of the RF section. The 2 antennas of the second stage of the RF section provides the jamming of the IEDS for the near area and the other two antennas of the third stage of the RF section provides the jamming for the farther area so in terms provides the complete jamming of the signals which is going to trigger the IED .The four antennas provide the support to each other in terms of the stability and in terms of the working of the jammer. These antennas are Omni-directional in nature and provide the radiation of the signal in all the direction and are called the telescopic antennas. These antenna can be extended to its maximum available limit. The placement of the two antenna in the second stage of the jammer is shown by the arrows in the Figure 6-1.

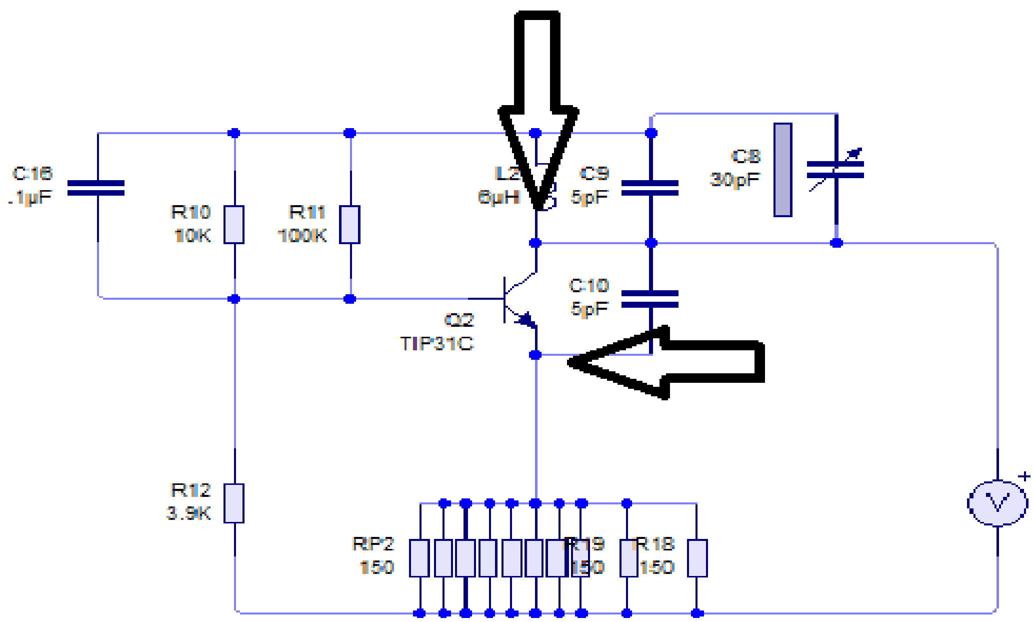


Figure 6-1 Antenna placement for stage 2

The two antennas are placed to cover the both the positive and the negative peaks of signal and covering the whole signal for jamming of the IED. The placement of the two antennas in the third stage of the jammer is shown by the arrows in the Figure 6-2.

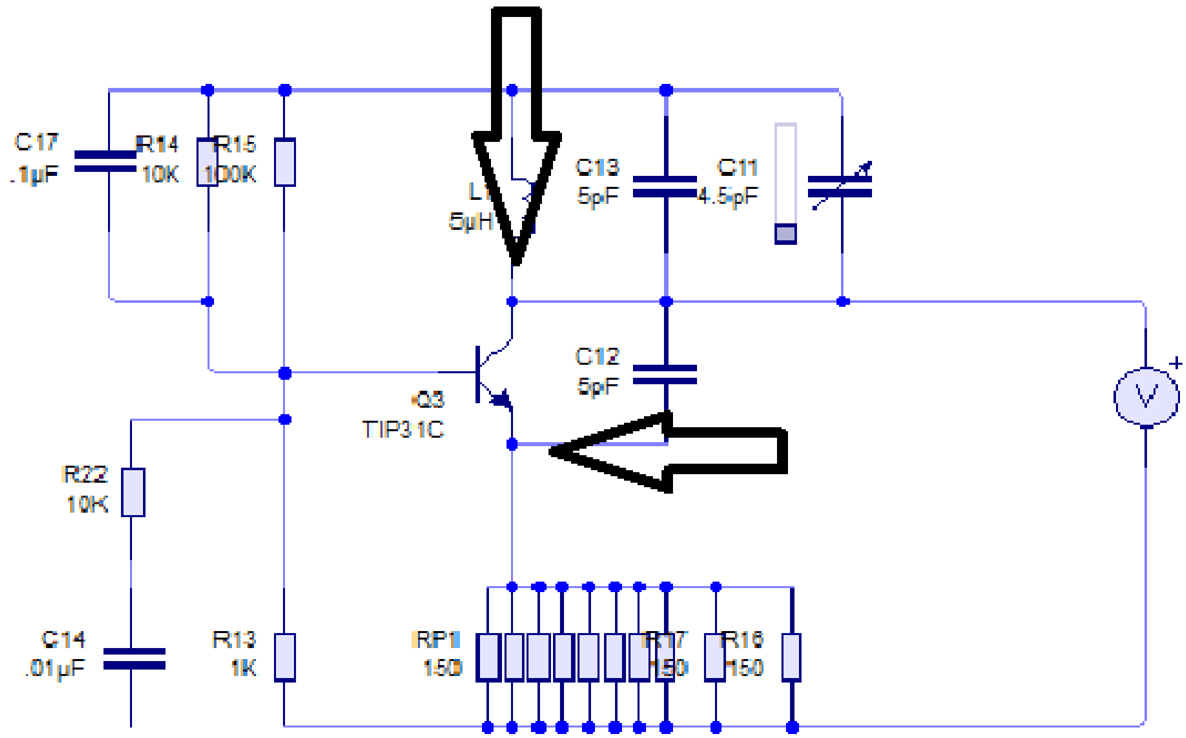


Figure6-2 antenna placement for stage 3

These Omni-directional VHF telescopic antennas provides the gain of the 3 dB. The shape of the telescopic antenna is shown in the Figure 6-3

Figure 6-3 Telescopic antenna

6.3 Different Radiation Pattern

The VHF antennas shows Omni-directional radiation pattern. Different types of radiations of the antennas are shown in Figure 6-4

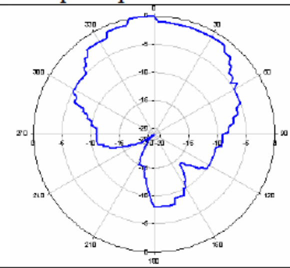
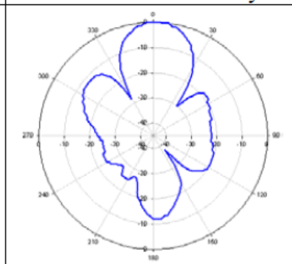
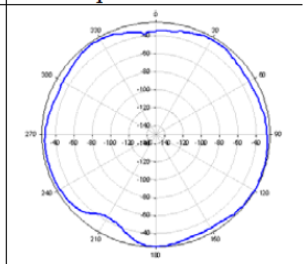
Antenna Type	Square patch antenna	4 x 2 Antenna Array	Dipole Antenna
Measured Radiation Pattern			
Radiation Pattern Type	Broader beamwidth pattern	Directional pattern	Omnidirectional pattern
HPBW	89°	27°	All directions

Figure 6-4 Different radiation patterns

Chapter: 7

INTEGRATED SET UP

7.1 Introduction

The integrated setup is shown in Figure 7.1. Power supply generates the input of 15 volts and 1 watt. The transformer and bridge rectifier are used for the conversion of AC-DC .The input signal is then fed to the input of NE-555 timer IC which generates a signal and noise is added to the signal. The signal which is basically a noise now is then put into the amplification stage where the signal is amplified as per the requirement of the noise to be added using the variable resistors. When the signal is amplified to 3 Watts it is passed to the transmission stage where using the trimmer capacitor the frequency to be jammed is tuned meaning thereby the carrier frequency is adjusted and then the last stage of transmitting through the antennas. The complete circuit diagram is shown in figure 8.1.

7.2 Future work

It is said that there is always a room for improvement so as it’s the nature of human being to keep improving the existing and exploring the unexplored. so there was a need felt to carry out a detailed analysis as to how improvements’ can be made in the existing jammer. There are number of the fields on which the jammer can be improved as it is just a prototype project and for commercial use it can be improved.

Factors which can be improved are Power output,Range,Power supply, Antenna modification and Sweeping frequency. These factors can be improved to get greater efficiency and effective jamming.

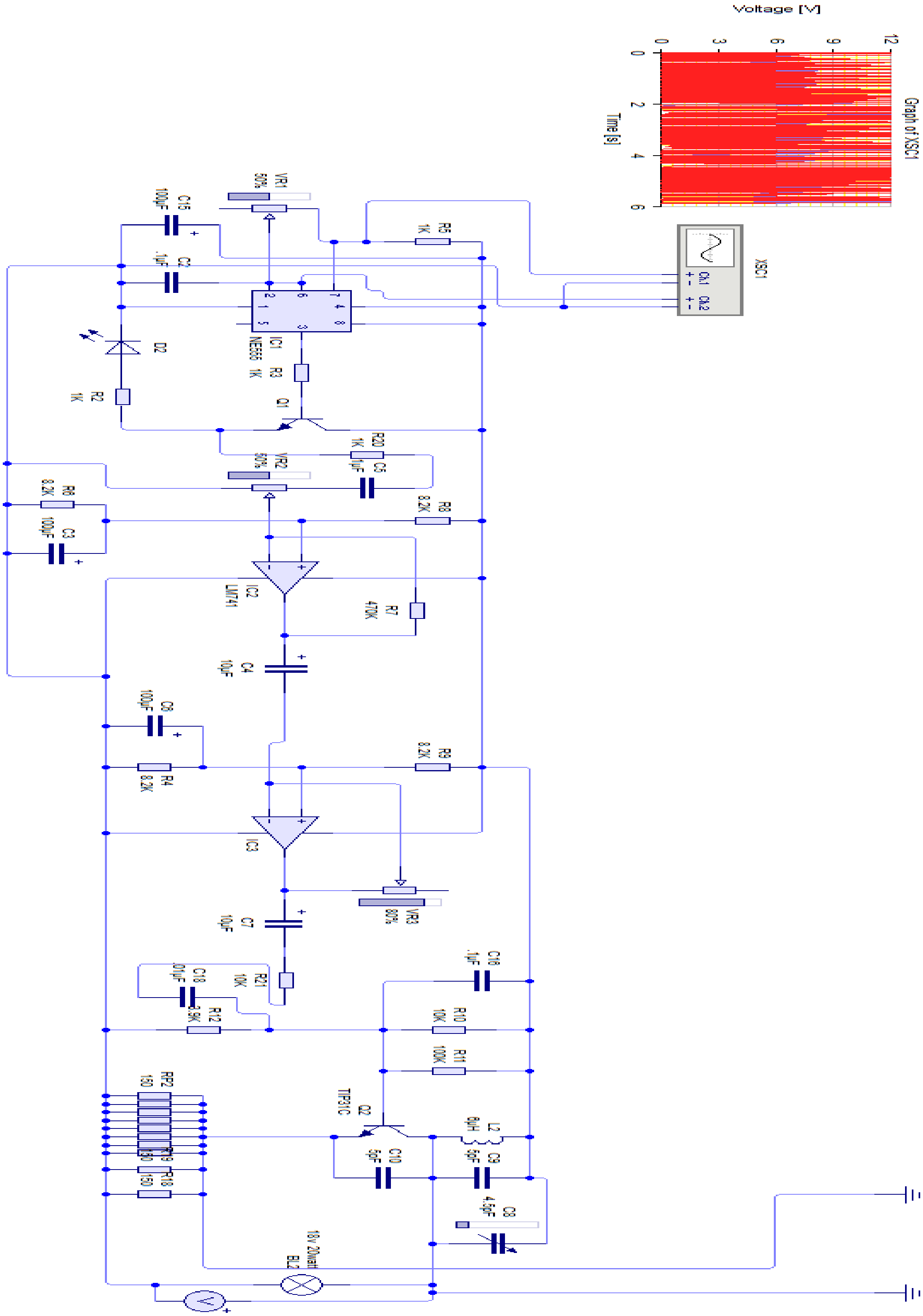


Figure 7.1- Complete circuit diagram of Jammer

7.2.1 Power Output

The jammer presently gives an output of 3 watt. Which can be improved by using the transistors of higher output power rating. Then there will also be a need to improve the cooling system of the circuit as presently only the heat sinks is used in design and demonstrated jammer. The cooling system can be improved either by using the fan ,using the air cooled system.

7.2.2 Range

The range of jammer is function of the power output more the power output more the range is. The range of jammer presently 10-15 feet. This range is good for prototype projects but if we have to launch this project in market then we need to improve the range in all direction. Jammer presently transmits in diameter.

7.2.3 Power supply

Power supply is the important module as it provides the input power for the working of the circuit. At present a 15 volt /1 watt signal is generated which is further amplified to 3watts. If a transistors of higher power rating is used then a high power signal is to provide to the circuit. Electronically regulated power amplifier supplies will yield better results than classic, capacitor smoothed ones We can also use the battery as source but then we have to add voltage regulator as we see that battery may fluctuate .fully regulated power supplies are "stiff" - this means that they will work up to a level and no more, period. They could make it easier to double the power into half the load, but they will not allow for dynamic power bursts much above the nominal rating. They could be made to allow for it, but that would make them still more expensive and massive.

7.2.4 Antenna modification

Improving the antenna is one way to get better performance. As there is a perception that people insist that using a higher gain/more directional antenna will always be better, as it improves data flow in both directions. Presently a rod antenna is used which is expendable and has a gain of 3db. Antenna which has a better gain can be used again to improve the range of the jammer. The VHF unidirectional antennas are the better option for this.

7.2.5 Sweeping frequency

The sweeping-frequency technique can be implemented with commercial equipment but it is a difficult and time-consuming measurement. Another option which can be worked upon by using the trimmer capacitor and by using the tuner we can increase the frequency coverage of the jammer up to UHF range (300-3000 MHZ) that way the jammer can keep on sweeping the frequency and jam the current frequency. And also besides that we can also use a frequency sweep generator. A sweep frequency generator is described whose center frequency can be varied from 10 kHz to 50 MHz the scale can further be varied. It has a tunable pulse generator with output voltage attenuator, diode mixer for calibration, and a saw tooth voltage generator as a source of frequency deviation.

7.3 Conclusion

A proto type VHF jammer against IED has been designed and is capable of jamming the vhf communication particularly in the range 134-176 MHz the jammer consist of power supply, noise generation and amplification and transmission using vhf antenna .This prototype project finds its applications in many crucial areas specially the military and law enforcing agencies.

USER MANUAL

Objective

To Effectively use the jammer and to Jam the IED signal

Installation

Place the four telescopic antennas in the four given ports of VHF jammer. Extend the length of the telescopic antenna according to the requirement and for the appropriate results and range. Diagram of the antenna ports are given in the Figure A.1 below

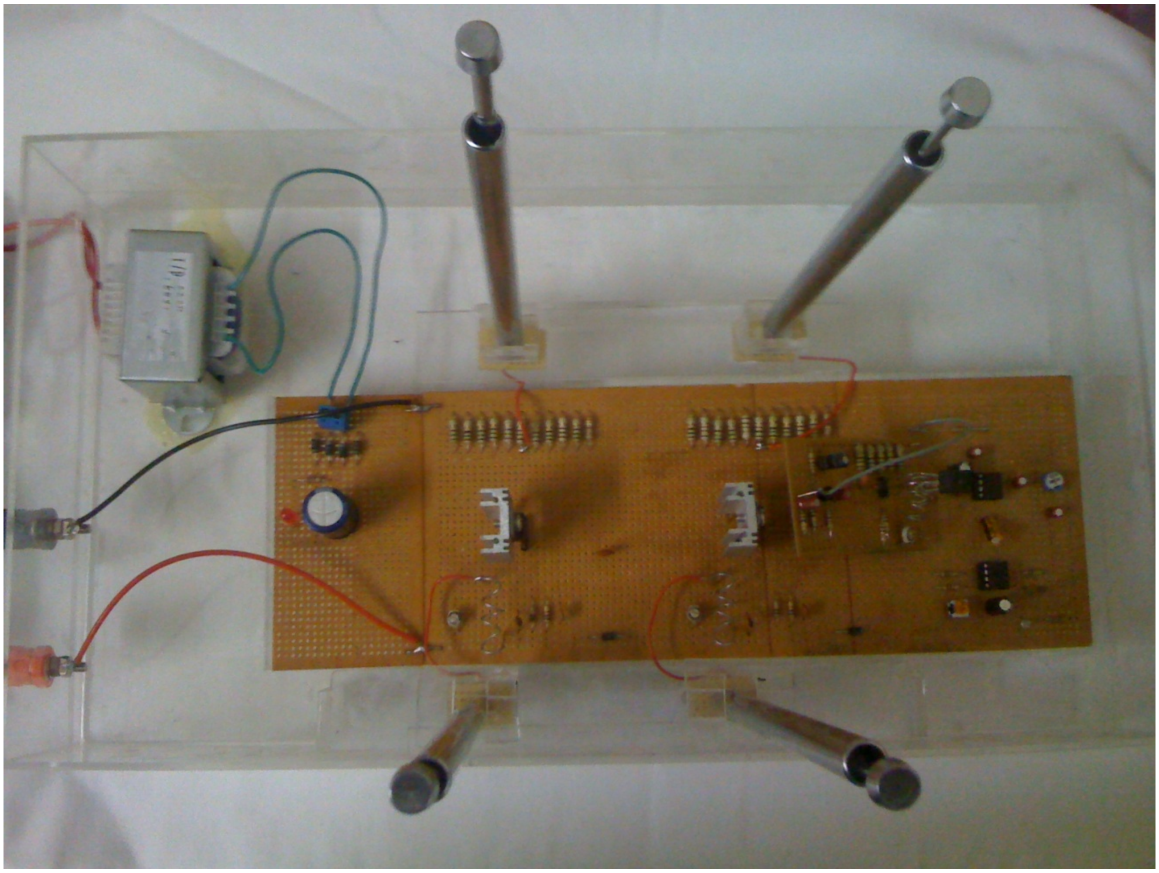


Figure A.1 VHF Jammer Antenna Ports

Power supply will be required for the operation of the VHF jammer that can be portable or the AC power supply according to the requirements of the operation. The portable power supply will provide 18 volts by connecting the two batteries of 9 volts each in series and in case of AC power supply 220 volts are converted into 18 volts by using the step down transformer.

Operation

Connect in case of portable ,the two batteries in series of 9 volts each to the ports of the VHF jammer shown in the circle, they will provide 18 volts and ground.

In case of AC power supply just plug in for the operation ,the red LED will start blinking and will indicate that the jammer has started working in both cases. The location of the ports for battery power supply is shown in Figure A.2 below

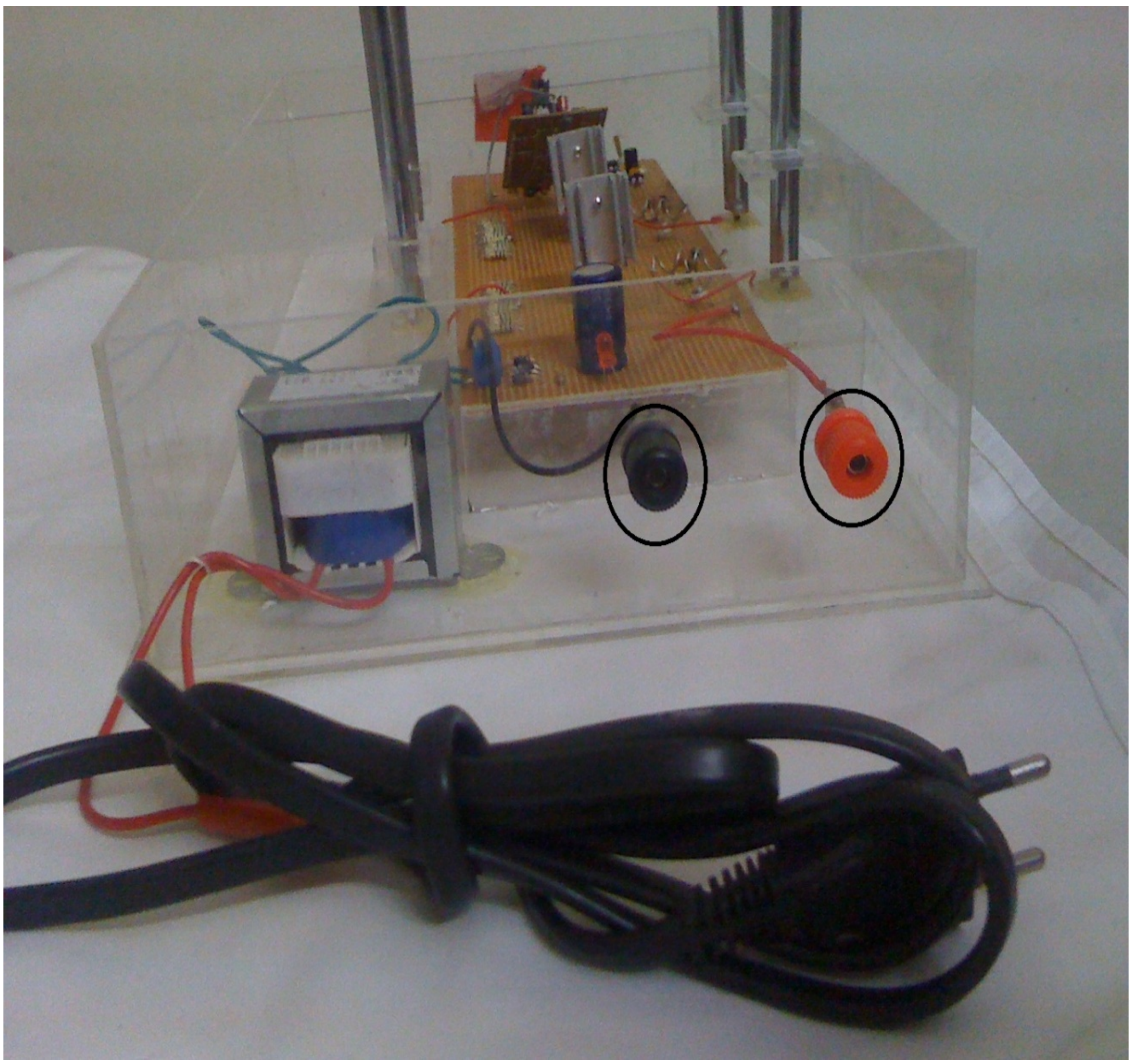


Figure A.2.VHF Jammer Power Supply Ports

Precautions

Do not keep the Voltage level too high, Do not touch the metallic layer of Antenna, Connect and Extract Antenna properly, Do not keep the jammer ON for more than 20 minute. As transistor will heat up and Turn OFF Jammer after completing demonstration

Trouble Shooting

If the beam has not shifted in the required direction then perform these steps. Check that the supply attached to the Jammer is turned ON and working correctly, the Red LED will show the continuity of the power source. Check out the supply voltage do not exceeds the maximum appropriate limits and remain within the Specified Range. Do not cover the surface of the jammer with the plastic sheet during its operation because it will affect the working of the RF transistors and Switch off the jammer after its work is done, so to avoid the transistor from being heat up.

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