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Design and Development of a GSM Phone Jammer

Otasowie P. O. and Chukwunomnazu E. H.

Department of Electrical and Electronic Engineering,
University of Benin, Benin City, Nigeria.

Abstract

This paper presents a design and development of a Global System for Mobile Communication (GSM) Phone Jammer. It is developed for the purpose of neutralizing network signal from GSM network.

The developed circuit of the GSM Phone Jammer consist of power supply stage, the signal generation stage, the radiofrequency tuned inductance capacitance oscillator stage and the radiofrequency amplifier stage. The developed circuit was realized by the use of a high frequency transistor in designing the radiofrequency (RF) tuned inductance capacitance (LC) oscillator that generates GSM band carrier frequency modulated with noise. The modulated carrier wave/frequency (jammer signal) is amplified by an external antenna that transmits the modulated wave into space.

The circuit was designed, constructed, tested and found to perform satisfactorily as it was able to jam four GSM networks of MTN, Airtel, Etisalat and Globacom. The circuit cost was N5,500 which is reasonably not very expensive to afford.

***Keywords*:** GSM phone, jammer, network operator, frequency band.

1.0 Justification for the Work

The GSM phone is one of the most successful transceiver unit with its many capacity including internet web browsers, digital filming and recording, camera, radio, television etc. The advantage of GSM phones cannot be overemphasized but its indiscriminate use has made it to constitute a nuisance.
In hospital theatres where GSM phone should not be used because the signal may interfere with the medical equipment in the hospital which can lead to serious complication. In churches, schools, meetings, banks, law court, libraries etc where outmost silence is needed, GSM phone can cause distraction. These conditions led to the design and development of a GSM phone jammer.

1.1 Introduction

Since the early 1980's when the first cell phone was developed and marketed by Motorola Corporation, USA. The advancement of it has moved from 1G to 3G. The phones available nowadays have higher efficiency than their previous counterpart[1,2].

In the same bandwidth, the frequency are allocated to each other (channel multiplexing) with channel having its own frequency but within the allocated frequency range. Radios, television sets, microwave communication, satellite communication have their own frequency range. The ultra high frequency (UHF) used by television is 200MHz-900MHz while GSM phones operate within a frequency band of 900MHz-1.8GHz[3,4].

The GSM phone jammer is a circuit that jams or blocks the incoming frequency from the network operators so that the users phone cannot have network signal in the vicinity or range of the jammer signal.

To jam GSM phone signal, the frequency of operation of all the mobile network must be noted. In Nigeria, the frequency range is from 900MHz-1.8GHz. Within this range of frequency, channel allocation (specific frequency) is assigned to the network operators by the Nigerian Communication Commission (NCC)[5]. Each Network operator such as Glo, Etisalat, MTN, Airtel etc are allocated different frequency between 900MHz-1.8Gz.

Corresponding author: ***Otasowie P. O.,*** E-mail: -, Tel.: +2348037921371

To jam the signal from a network, the jamming frequency oscillator must be able to produce a tunable frequency between 900MHz-1.8GHz and can deliver a power of 800mw to 1 watt. The jammer carrier frequency is modulated by noise of a sweeping frequency from 1-500KHz. Since sensitivity is to pick the strongest signal irrespective of Network, it will tend to pick the generated false signal instead of the Network signal.

There are two method of designing a jammer circuit. The fist is the use of a Radio Frequency Voltage Control Oscillator (RFVCO) where the noise voltage is carried to set the carrier frequency. The other method is the use of a high frequency transistor about 2GHz rating in designing capacitor (LC) tuned circuit. This second method was used in this work[6-8].

1.2 Previous Work

Dual Band mobile jammer for GSM 900 and 1800 was realized at the Department of Electrical Engineering, Jordan University, Jordan. This work was realized using different blocks of (i) noise generator (ii) noise amplifier (iii) negative voltage generator (iv) balance modulator (v) mixer circuit (vi) voltage control oscillator (vii) RF amplifier module[9].

This work is not very efficient because

(i) The power of the RF module and the voltage control oscillator is fixed

(ii) The inductance capacitance (LC) oscillator used in the voltage control oscillator cannot generate much higher frequency. These inefficiency was addressed in our work

2.0 Design Consideration and Analysis

The design of the circuit is in four stages which are

(i) the power supply stage. This include voltage regulator, low pass filter and bias resistor to the light emitting diode
(ii) The signal generator: This include the square wave generator and noise generator
(iii) The radiofrequency (RF) Oscillator: This include the feedback capacitor and decoupling capacitor
(iv) The radiofrequency (RF) amplifier

2.1 Power Supply Stage

The power supply unit consist of a 12 volts regulator to maintain a voltage supply to the circuit. The 12 volts consist of 8 x 1.5 volts dry cell battery connected in series to get 12 volts.

2.11 Voltage Regulator

LM317T adjustable voltage regulator was used to obtain a constant voltage supply to the circuit.

The output voltage is given by

$$V_{out} = V_{ref}\left(1 + \frac{R_2}{R_1}\right) \quad - \quad - \quad - \quad - \quad - \quad - \qquad (1.0)$$

Where R_2 is the unknown resistor

R_1= 220Ω standard

V_{ref} = 1.25volt reference voltage

V_{out} = required output voltage

$$V_{out} = 1.25\left(1 + \frac{R_2}{R_1}\right)$$

$$R_2 = \left(\frac{V_{out}}{1.25} - 1\right)R_1 \quad - \quad - \quad - \quad - \quad - \quad - \quad - \qquad (1.1)$$

With Vout = 9 volts, R_1 = 220Ω

$$R_2 = \left(\frac{9}{1.25} - 1\right) x220 \qquad = 1.364\text{k}\Omega$$

R2 ≈ 1.5kΩ was used as it is the nearest preferred value

2.12 Low Pass Filter

In transmitter design it is necessary to introduce a filter in the power line to prevent the power from radio frequency interference (RFI).

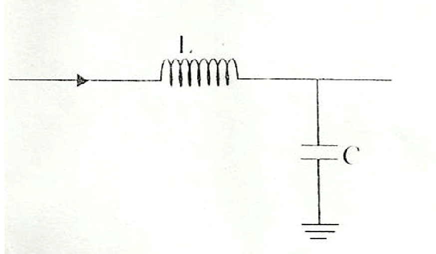

Figure 1: An LC Pass Filter

L is known as RFI coil. It can be coil wound or wounded on a ferrite coil.

From the low pass filter analysis

$f_c = \left\{\frac{1}{2\pi\sqrt{LC}}\right\}$ - - - - - - - - (2.1)

Where f_c is the cut off frequency of the filter.

In design $f_c <<< f_{signal}$

f_{signal} is the highest signal produced by the signal generator.

$F_{signal} \geq$ 50KHz (modulating)

For low pass design, $f_c = 30\%f_{signal}$ $= \left\{\frac{30}{100}\ x\ 50\right\}KHz$ = 15KHz

The equation for radio frequency interference

$L = \left\{\frac{1}{4\pi^2 f_c^2 C}\right\}$ - - - - - - - - (2.2)

C is assumed to be 0.001μf

$L = \frac{1}{4\ x\ (3.142)^2\ x\ (15\ x\ 10^3)\ x\ 0.001\ x\ 10^6}$ = 112.5mH

The current rating of L should be able to withstand the short circuit of LM317T which is 1.5Amp.

L = 112.5mH

2.13 Light Emitting Diode BIAS

Light emitting diode is a visual indicator to indicate that power is flowing to the circuit. For practical purpose the reference diode voltage drop is 0.6 volts.

$R_{11} = \left\{\frac{vcc - v_f}{I_f}\right\}$ - - - - - - - (2.3)

From ohms law $\left(1 = \frac{V}{R}\right)$

Where I_f is the maximum current the diode can handle.

I_{fmax} = 25mA {manufacturer specification}

$I_{fmin} = 20\%I_{fmax}$ ----- depending on the intensity of the bulb

$I_{fmin} = \frac{20}{100}\ x\ 25 = 5mA$

Since I_f flows through R_{LED} (series connection)

$$R_{11} = \left\{\frac{9 - 0.6}{5mA}\right\} = 1.68\text{k}\Omega$$

R_{11} = 1.5kΩ was used as the nearest preferred value

3.0 Signal Generation

The section consist of two signal generators, one producing a square wave and the other produce wave that does not have a constant amplitude.

3.1 Square Wave Generator

The 555 timer was used in the generation of the square wave. For perfect square wave generation we have;

$T = 14.553R_3C_4$ - - - - - - - (2.4)

$T = \frac{1}{P}$ - - - - - - - - (2.5)

$F = \frac{1}{T}$ - - - - - - - - (2.6)

F = 50KHz (chosen)

$$T = \left\{\frac{1}{50\ x\ 10^3}\right\} = 0.00002\ sec$$

$0.00002 = 14.553R_3C$

$$R_3 = \left\{\frac{0.00002}{14.553C}\right\}$$

$C_4 = 100 \times 10^{-12}$

$$R_3 = \left\{\frac{2 \, x \, 10^{-5}}{14.553 \, x \, 100 \, x \, 10^{-12}}\right\} \text{ R3} \approx 13.742\text{k}\Omega$$

$R_3 = 12\text{k}\Omega$ was used as it is the nearest preferred value

$R_4 = 10R_3 = 120\text{k}\Omega$

$R_4 = 200\text{k}\Omega$ was used because it is readily available

3.2 Noise Generator

The noise generator is designed using zener diode in reverse bias mode.

$V_z = 6.8$volt (specified by manufacturer)

$P_z = 500$mw (specified by manufacturer)

$I_z = ?$

$$F = \left\{\frac{P_Z}{V_Z}\right\}_{Max} \qquad - \quad - \quad - \quad - \quad - \quad - \quad - \qquad (2.7)$$

$I_z = 73.53$mA

From max rating $I_z = 73.53$mA

To bias a zener, 10% of its current rated capacity is used.

$$I_{z(min)} = 10\% I_{z(Max)} \qquad - \quad - \quad - \quad - \quad - \quad - \qquad (2.8)$$

$$I_{z(min)} = 7.353mA$$

$$R_5 = \left\{\frac{vcc - v_Z}{I_Z}\right\}$$

(R_5 is in series with V_z)

$$R_5 = \left\{\frac{9 - 6.8}{7.353mA}\right\} = 299.19\Omega$$

$R_5 = 330\Omega$ nearest preferred value

The decoupling capacitor C5 is removed and is used to couple the noise generated (avalanche noise) due to the reverse pn junction into pin 5 of IC2.

4.0 RF Oscillator

RF oscillator was use to generate the GSM band carrier frequency. The RF oscillator use the more stable LC parallel tuned circuit. The circuit is

$$f_{osc} = \left\{\frac{1}{2\pi\sqrt{LC}}\right\} \qquad - \quad - \quad - \quad - \quad - \quad - \quad - \qquad (2.9)$$

From GSM frequency $f_{osc} = 900\text{MHz} – 1.8\text{GHz}$

For a frequency of 1.8GHz, the winding of L_2 would prove difficult. So L_2 is fixed while C_7 is computed for.

Choosing $L_2 = 3.3$nH

$C_7 = ?$

F = 1.8GHz

Equation (2.9) reduces to

$$C_7 = \left\{\frac{1}{4\pi^2 f_{osc}^2 L}\right\}$$

$$C_7 = \frac{\left(1 \, x \, 10^9\right)^2}{4\pi^2 (1.8)^2 \, x \, 3.3 \, x \, 10^{-9}} = 2.34pf.$$ This is the minum turning of the value of the capacitor.

For maximum turning of the capacitor, f = 900MHz

$$C_7 = \frac{(1 \, x \, 10^{-6})^2}{4 \, x \, (3.142)^2 \, x \, (900)^2 \, x \, 3.3 \, x \, 10^{-9}} = 9.47pf$$

C_7 is choosing to have a variable to capacitance of 1-10pf.

4.1 Choice of Transistor

Since the range of operation is in Gigahertz, a transistor transmitting above 1.8GHz should be used. We choose C2570 as the transistor of the RF oscillator and BFQ34 as the power amplifier (RF).

The following data were chosen

$F_I = 5$GHz

$I_{c(max)} = 70$mA

$V_{BE} = 0.3$volt

$P_{w(max)}$ = 0.600watt
Hfe = 40mins
Collector emitter voltage = 12v
Collector base voltage = 25v
From the parameter above the device has a power of 0.6watt and maximum current of 70mA.
$P_{c(used)} = 40\%\ P_{max}$ - - - - - - - (2.10)
$P_c = \left\{\frac{40}{100}\ x\ 0.6\right\}$
= 0.24watts
Since power = I_V - - - - - - - (2.11)
$I_C V_{CE} = P_C$ - - - - - - - - (2.12)
Also $I_C V_{CC} = P_C$ (an estimate to obtain I_C)
$I_c = \left\{\frac{P_c}{V_{CC}}\right\} = \left\{\frac{0.24}{9}\right\} = 26.67$mA. This is the value for the collector current
For maximum bias, $I_B = 0.11_C$
Or $I_B = \left\{\frac{I_c}{hfe}\right\}_{min}$
Solving for both,
I_B = 2.267mA (maximum bias condition)
I_B = 0.667mA (using hfe minimum)
The second I_B ensures low power wastage at the base. Hence,
I_B(used) = 0.667mA
From h parameters of transistor
$I_B = I_B\beta$ - - - - - - - - (2.13)
$I_E = I_C + I_B$ - - - - - - - - (2.14)
$I_E = I_C$; $I_C >>> I_B$ - - - - - - (2.15)
$V_{BB} = V_{BE} + V_E$ - - - - - - - (2.16)
To bias a transistor: $V_E = \frac{1}{4} V_{CC}$
V_{CC} = 9volt
$V_E = \frac{1}{4} V_{CC} = \frac{9}{4} = 2.25v$
V_{CE} = 9 – 2.25 = 6.75v
Power dissipated on the collector is given as
$P_c = \{I_c V_{cE}\}$ - - - - - - - - (2.17)
= 26.67mA x 6.75
= 180mw
$V_{BB} = V_{BE} + V_E$
= 0.3 + 2.25
V_{BE} = 0.3 (data sheet)[10]
V_{BB} = 2.55volt
$V_{CB} = V_{CC} – V_{BB}$ - - - - - - - (2.18)
= 9 – 2.55
V_{CB} = 6.45volt
$I_1 = 0.1 I_B$
I_1 = 0.1 x 26.67mA = 2.667mA
$I_2 = I_1 - I_B$ - - - - - - - - (2.19)
I_2 = (2.667 – 0.667)mA = 2mA
From ohms law, V = IR - - - - - - (2.20)
$R_6 = \left\{\frac{V_{CB}}{I_1}\right\} = \left\{\frac{6.45}{2.66}\right\} = 2.418k\Omega$
$R_6 = 2.71\Omega$ nearest preferred value
$R_7 = \left\{\frac{V_{BB}}{I_2}\right\} = \frac{255}{2mA} = 1.27\Omega$
$R_7 = 1.2K\Omega$ nearest preferred value
$R_E = \left\{\frac{V_E}{I_E}\right\}$

$= \left\{\frac{2.25}{26.67mA}\right\}$

$R_E = 84\Omega$

$R_E = 87\Omega$ nearest preferred value

4.2 Feedback Capacitor

The feedback capacitor provide positive (+ve) feedback to cause the entire circuit to become unstable. For high frequency oscillator operating in GHz, the impedance (reactive capacitance) between collector and emitter is in the range of 40mΩ - 50mΩ.

$$X_C = \left\{\frac{1}{2\pi fc}\right\} \quad - \quad - \quad - \quad - \quad - \quad - \quad - \quad - \qquad (2.21)$$

$$X_C = \frac{1}{2\ x\ 3.142\ x\ 2\ x\ 10^9\ x\ C}$$

$$C_9 = \left\{\frac{1}{2\ x\ 3.142\ x\ 2\ x\ 10^9\ x\ X_C}\right\}$$

$$X_C = 50$$

$$C_9 = \frac{1}{2\ x\ 3.142\ x\ 2\ x\ 10^9\ x\ 50} = \left\{\frac{10^{-9}}{200\ x\ 3.142}\right\} = 1.591\ x\ 10^{-12}$$

$C_9 = 1.8pf$ as nearest preferred value

4.3 Decoupling Capacitor

The decoupling capacitor C_8 forms a filter with R_7 to pass the required chosen frequency.

$$\left\{\frac{1}{2\pi R_7 C_8} = \frac{1}{2\pi\sqrt{LC}}\right\}$$

This simplifies to

$$2\pi R_7 C_8 = 2\pi\sqrt{LC}$$

$$RC_8 = \sqrt{LC}$$

$$C_8 = \left\{\frac{\sqrt{LC}}{R_7}\right\}$$

$$C_8 = \frac{\sqrt{3.3\ x\ 10^{-9}\ x\ 10\ x\ 10^{-12}}}{1200\Omega} = 0.1518pf$$

$C_8 = 0.5\mu f$ nearest preferred value

5.0 RF Amplifier

RF amplifies the signal from the LC oscillator and is used to drive the antenna. In this work class A collector fixed bias is used as an RF amplifier circuit.

$I_{10} = I_B + I_C$ – (KCL) - - - - - - (2.22)

$I_E = 0$ (emitter leg ground)

$V_{CE} = V_{CC}$ $V_E = 0$

For max bias $I_B = 0.11_C$

Output power, $P_C = \{I_C V_{CE}\}$

$P_C = I_C V_{CE}$

$P_C = 500mw$ (chosen design value)

$V_{CE} \approx 9volt$

$$I_C = \left\{\frac{P_C}{V_{CE}}\right\} = \left\{\frac{0.5}{9}\right\} = 55.6mA$$

$$I_B = 0.11_C = 5.56mA$$

$$I_B = I_C + I_B$$

$$= (55.6 + 5.56)mA = 61.16mA$$

Since I_{10} flows through R_{10}

$$R_{10} = \left\{\frac{V_{CE}}{I_{10}}\right\} = \left\{\frac{9}{61.16mA}\right\} = 147\Omega$$

$R_{10} = 150\Omega$ nearest preferred value

$$P_{10} = I_{10}^2 R_{10} = 0.56watts$$

$R_{10} = \left\{\frac{V_{CE} - V_{BE}}{I_B}\right\} = \left\{\frac{9 - 0.6}{5.56mA}\right\} = 1510.79\Omega$

Transformer T1 is non-entreat, a ratio of 3 to 6 is used for the relay.

The gain of a single transistor is given by:

$G = \left\{\frac{R_{Load}}{R_E}\right\}$ - - - - - - - - (2.23)

Where R_{Load} = Load Resistor

$R_E = R_e + re$ - - - - - - - - (2.24)

R_e = External Resistor

re = intrinsic resistor and has a value of 25Ω

Since $R_e = 0$

$G = \left\{\frac{R_{Load}}{re}\right\} = \left\{\frac{150}{25}\right\} = 6$ (neglecting coil reactance)

For X gain

$G = \left\{\frac{R_{Load} + Z}{re}\right\}$ - - - - - - - (2.25)

$Where\ Z = \sqrt{R^2 + X_L^2}$ - - - - - - (2.26)

Real value ≡ 0

$X_L^2 = (2\pi fl)^2$

$Z = 2\pi fl$ - - - - - - - - (2.27)

L = inductance, f_0 = oscillator frequency

$G = \left\{\frac{R_{Load} + 2\pi L\Delta f}{re}\right\} = \left\{\frac{150+6.284L\Delta f}{re}\right\},\ \Delta f = f = 2GHz$

$L = 0.01\mu H$

$G = \frac{150 + 6.284\ x\ 0.01\ x\ 10^{-6}\ x\ 2\ x\ 10^{9}1}{25} \approx 2GHz$

Since the frequency is tunable, the ac gain varies.

6.0 Principle of Operation

When the SW1 is closed, current flows into the circuit to IC_1 and through R_{11}. R_{11} bias LED (Red) to come on. IC_1 generate a stabilize 9volt with the help of R_1 and R_2. Capacitor C_2 decouples the power supply source and makes it stable. The output voltage is feed via an LC low pas filter L_1 and C_3 is to remove (block) radio frequency interference (RFI) from reaching the battery which would seriously damper the circuit. The stabilize 9volt is used to feed IC_2 (NE555), the RF oscillator and RF Amplifier stage. At turn on, the 555 timer produces a square wave pulse (frequency) with the aid of its external component R_3, R_4 and C_4. The timer operating in the stable mode generates a frequency given by $f = \frac{1}{0.693\,(R_3 + 2R_4)C}$. The frequency can be varied by the 200KΩ trim pot. Pin 5 which is the control, voltage is feed from a 1μf coupling capacitor at the output of 6.8volt zener bias from the positive supply. The reverse bias of the zener in the knee region by R_5 causes the zener to generate an inter noise called avalanche noise. This noise does not have a fixed amplitude or frequency. The output of the zener diode is used to modulate the square wave generated by the IC_2.

The output of IC_2 which is a varying pulse width, is blocked by capacitor C_6 to prevent the DC component from reaching the oscillator circuit. The output pulse from C_6 is used to modulate the carrier wave generated by the Q_1 action. Q_1 is a high frequency transistor operating in the cut off mode. The LC parallel tuned circuit at the collector determines the frequency of operation. The inductor L_2 and trim pot capacitor C_7 help to set the frequency. The frequency is given as $f = \frac{1}{2\pi\sqrt{L_2C_7}}$. The frequency of the tuned LC parallel circuit can be varied by turning C_7. Capacitor C9 provide positive feedback to ensure continue oscillation. While R_6, R_7 and R_8 set the operating point of Q_1 in the cut-off region. The output of the modulated carrier wave is coupled to the RF amplifier stage via C_{10}. This ensures that the oscillator is not damped. The RF amplifier operating a class "A" collector fixed base bias amplifier consist of R_9, R_{10} and T1. T1 is an intermediate frequency coil (IF) use to couple the output signal to the external antenna. The IF coil can be turned by a ferrite beed to match the antenna impedance to that of the RF amplifier circuit. The antenna transmit the modulated carrier wave into space.

7.0 Construction

After design analysis, the value obtained (nearest preferred value) were sourced from the electronic stores locally. The components were physically tested to ensue that they are in good condition using digital multimeter. The power section was built directly on a vero board while the signal generator was tested on breadboard (testing board) before transferring to vero board using 60 watts soldering iron. The transmitter and amplifier (RF) was soldered last. The soldering was neat as the strip copper introduces capacitance into the RF circuit. The strip that are not used was carefully removed to reduce board capacitance. The RF section was covered with forming faraday shield to prevent external frequency interfering with the circuit.

7.1 Installation

After the construction of the casing the dimensions were brought together using exposy resin and super glue. Drilling machine was used to drill hole for the housing of the power indicator, antenna, and the ON/OFF switch. The circuit board was lifted off the ground to reduce capacitance between the RF section and the floor of the casing. The circuit was suspended using nuts and bolt to fasten it into position.

7.2 Testing

Testing was carried out after installation to ensure that the finished design work was in accordance with the design parameter used. The test result is shown in Table 1

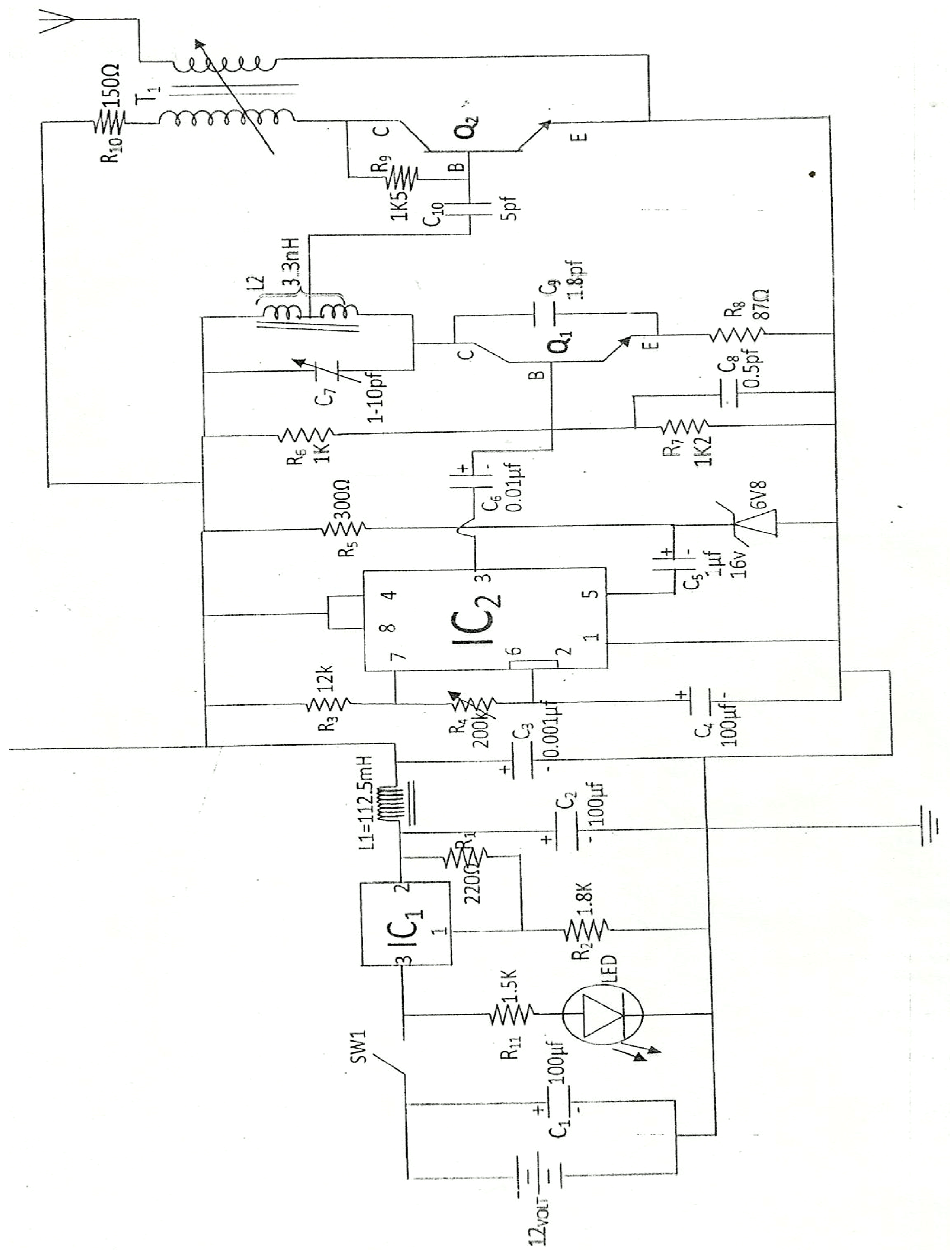

Fig. 2: Complete Circuit Diagram of a GSM Jammer

Table 1: Test result of device working voltage

S/NO	ITEM MEASURED	MEASURED VALUES	EXPECTED VALUES
1	Power Supply (Input Voltage and Input current)	12.6V 2Amp	12V 2Amp
2	LM 317T (Input voltage, Output voltage, Max output current)	12.6V 9V 1.5Amp	12V 9V 1.5Amp

7.3 Bill of Engineering Quantity

Table 2: Bill of Engineering Quantity

S/ NO	COMPONENTS	UNTI PRICE (N)	QUANTITY	AMOUNT (N)
1	Resistor	5	11	55
2	Electroytic capacitor	40	3	120
3	Power dode	5	2	10
4	Voltage regulator (LM317T)	50	1	50
5	Ceramic capacitor	5	12	60
6	Transistor (C2750)	100	1	100
7	Transistor (BFQ34)	800	4	3,200
8	Power switches	40	1	40
9	Light emitting diodes (LED)	5	1	5
10	Inductor	100	8	800
11	Soldering iron	100	1	100
12	Jumper wires	50	1	50
13	Vero board	50	1	50
14	Zener diode	10	1	10
15	Casing (plastic)	500	1	500
16	Antenna	200	1	200
17	Battery case	50	2	50
18	Ceramic capacitor (pico farad)	10	10	10
19	Battery	10	8	80
20	Ic socket 4 pin dual	10	1	10
	TOTAL			**5,500**

8.0 Conclusion

In conclusion, the design of a GSM jammer was very successful, as the design device was able to neutralize mobile phone from receiving network operators. This device works in dual band. It jams both the GSM 900 and 1800 bands. The device was able to jam the four well known GSM network signals of MTN, Airtel, Etisalat and Globacom. The circuit cost was N5,500 which is reasonably not very expensive to afford.

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