



INTERNATIONAL JOURNAL OF SCIENCE FOR GLOBAL SUSTAINABILITY DESIGN, CONSTRUCTION AND TESTING OF CELLPHONE DETECTOR

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ABSTRACT

A cell phone detector is a device specifically designed to detect and locate the presence of a cell phone in a specific area. Cell phone detection has been studied for a long time. Techniques have been developed or proposed on how to detect cell phones. Most of them are trying to exploit features such as audio systems, RF systems, and common materials in phones and study how these can be used as the basis for cell phone detection. This study uses the cell phone's RF system as a function to detect the presence of a cell phone. Using relatively inexpensive and available electronic components, a circuit that detects signals in the 0.9 GHz to 3 GHz range is used to detect a mobile phone in use. The constructed cell phone detector can detect the presence of various activated cell phones within 1.5 meters around it and indicate this by flashing a light emitting diode (LED) connected to its output. Even if the cell phone is in silent mode. The circuit test results show that the cell phone detector works well.

Keywords: Cell phone, radio frequency (RF), Light Emitting Diode (LED), electronic components

1.0 INTRODUCTION

The role of communication varies depending on the context of the modern world. Whether for business, educational purposes, or to supplement personal needs, communication has a role to play in filling any loopholes that arise from the hinges of connecting media. Communication is one of the most important qualities in life. Without communication, many things will not run optimally. Recently, the wireless communication industry has experienced a dramatic boom at home and abroad, and the number of cell phone users has increased (Priti et al., 2019).

A cell phone is a device that can make and receive phone calls over a radio link while traveling over an extended geographic area. It is now possible to instantly communicate with people who are far away from anywhere in the world. It does this by connecting to a cellular network provided by a cellular service provider that allows access to public cellular networks. (Edwin et al., 2016).

In the GSM (Global System for Mobile communication) and LTE (Long Term Evolution) bands, cell phones use radio frequency (RF), which ranges from 700 to 2600 MHz. This means that the signal is high-frequency and extremely strong. When a cell phone is in use, it transmits a signal in the form of a sinusoidal wave that travels through the area. The base station's receiver picks up the

electromagnetic radiation that is carried by the encoded audio/video signal (Albert, 2018).

Cell phones have become an integral part of our daily lives, offering convenience and connectivity. However, there are certain situations where the use of cell phones is prohibited or unwanted, such as in classrooms, libraries, exam halls, theaters, and hospitals. In order to address this issue, the design and construction of mobile phone detectors have become increasingly important. Cell phone detectors are devices specifically designed to detect and locate the presence of mobile phones within a certain area. These detectors are not only useful in enforcing rules and regulations but also in maintaining security and privacy (Malekjahani et al., 2019).

However, manual inspection is no longer sufficient to keep away people from an unauthorized use of cell phones in all confined places, most of the time they carry these devices concealed into the prohibited areas. Therefore, to combat them, we need automatic detection of cell phones (Ajasa et al., 2014).

Nonetheless, cell phone detectors currently on the market are relatively expensive and difficult to obtain in developing countries like Nigeria. Overall, the design and construction of cell phone detectors is a crucial area of research. It requires interdisciplinary collaboration between

engineers, scientists, and designers to develop innovative and efficient solutions. It involves considering factors such as sensitivity, compatibility, ease of use, and cost to create efficient and accurate detectors. Cell phone detectors are essential tools in addressing the issue of unauthorized use of cell phones in restricted areas. As a result, the goal of this research paper is to design and build a reasonably cheap electronic device that is efficient, accurate, and easy to use.

2.0 METHODOLOGY

2.1 Materials

Materials used in this study are Antenna, LM324AD IC, Transistors, Resistors, Capacitor (103), matrix board, bread board, jumper wire, 9v battery, battery connector, LED (red & green) and Toggle switch.

2.2 Circuit Design

Figure 2.1 shows the block diagram of the design set up. The circuit basically consists of three units; sensing unit, amplifier unit and the indicator unit. Once the RF antenna receives wireless signal after the circuit has been powered by a 9 Volts dc battery, the operational Amplifier LM324AD amplifies the received signal which makes the LED to flicker when signal is detected.



Figure 2.1: Cell phone detector Block diagram

2.2.1 The Sensing Unit

A disc capacitor (103) and a loop antenna make up the bulk of the sensing device, which detects radio frequency disturbance from an activated mobile phone and reacts by providing a very modest signal (voltage). It is necessary to detect frequencies between 0.9 and 3 gigahertz. High frequency parasitic effects affect passive components. A 0.22 μ F ceramic capacitor with fixed leads that are 18 mm long and 8 mm wide makes up the loop antenna. These measurements provide a large enough area to capture the desired frequencies. Since it is a loop antenna, the capacitor charges and stores energy when no signal is detected. When the field generated by the presence of a mobile phone is detected, it upsets the energy balance in the capacitor. A 0.01 μ F capacitor is connected to the antenna side. The antenna is intended to allow the detector to receive the optimal signal level from the cell phone (Arya & Vinod, 2020).

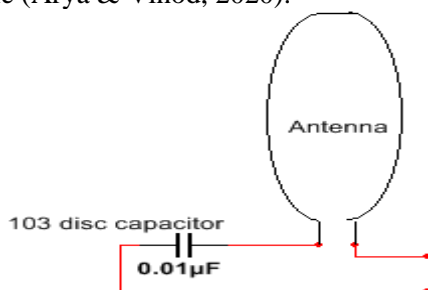


Figure 2.2 RF sensing circuit

2.2.2 The Amplifier Unit

The amplifier unit consists of three stages of identical high-gain non-inverting operational

amplifiers: an input differential stage, an intermediate single-ended high-gain stage, and an output buffer stage. The output voltage is low and must be boosted to drive a notification device (LED or audible buzzer). When the cell phone is in standby mode, the output voltage of the current-voltage converter is only 10mV. Therefore, to achieve the desired signal, linearity, or distortion-free conditions, we recommend using a Class a power amplifier. Figure 2.3 shows an operational amplifier circuit.

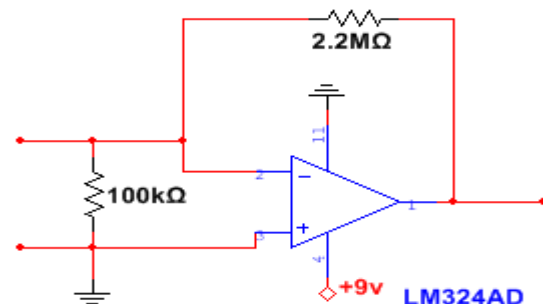


Figure 2.3 Op-amp amplifier circuit

2.3.3 The Indicator Unit

The final stage is the output stage which is made up of a monostable multi-vibrator, was integrated with the amplifier. The chosen notification in the design were a LED. The LED was connected to the emitter of the last transistor of the final amplification stage. The operating point of the voltage at the emitter was held at about 3.0v to ensure that a small variation of the voltage due to voltage swing from the current to voltage converter would make the LED to blink. (Edwin et al., 2016)

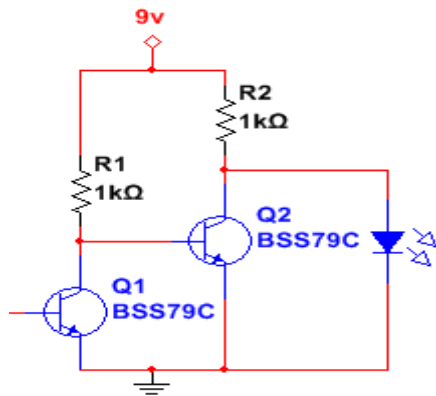


Figure 2.4 indicator circuit

The portable cell phone finder circuit was accomplished by interfacing the over three units together. The signal picked up from an activated cell phone could be amplified because the antenna unit was linked to the amplifier stage's input. The output of the amplifier unit was connected to the indicator unit, which glows when a detected activated cell phone. Figure 2.5 depicts the full circuit for the mobile phone detector.

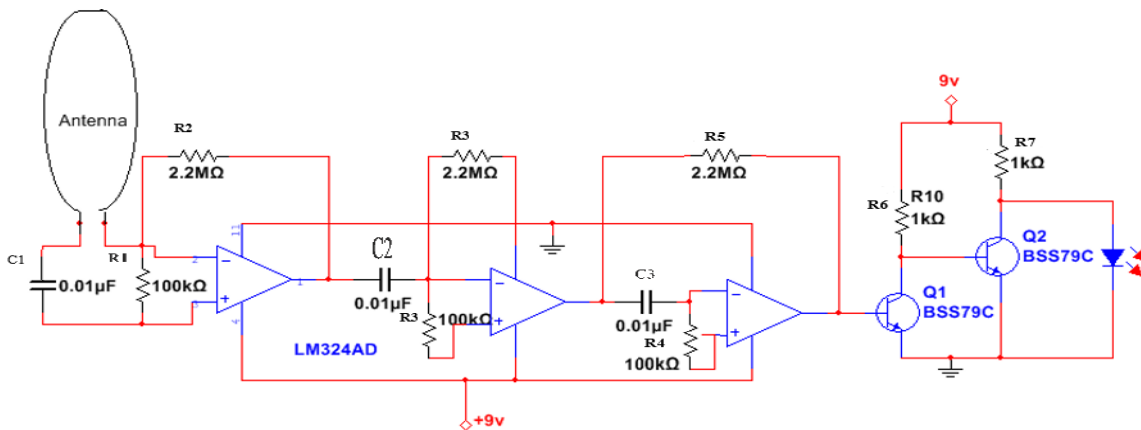


Figure 2.5: Cell phone detector Circuit

2.3.4 Operations of the Designed Circuit

The transmission frequency of a mobile phone is in the range of 0.9 to 3 GHz with a wavelength of 3.3 to 10 cm. Mobile eavesdropping requires circuitry to detect gigahertz signals. Here, the circuit uses a $0.01\mu\text{F}$ disk capacitor (C1) to detect the RF signal from a cell phone. The capacitor lead length is fixed at 18mm, and the distance between the leads is 8mm to obtain the required frequency. The disk capacitor, along with the wire leads, acts as a small gigahertz loop antenna that collects the cell phone's RF signal. LM358AD op-amp IC was used in the circuit as a current-voltage converter with capacitor C3 connected between its inverting and non-inverting inputs. Capacitor C2 works with the line inductor as a transmission line to block the signal from the cell phone. This capacitor generates a

field, stores energy, and transfers the stored energy in the form of a small current to the input of the LM358AD. This interrupts the LM358AD's balanced input and converts the current to the corresponding output voltage. Capacitor C1 and high resistance resistor R1 keep the non-inverting input stable and allow the output to transition high easily. Resistor R2 provides a discharge path for capacitor C1. Feedback resistor R3 forces the inverting input high when the output goes high. Capacitor C3 is connected to R5 for phase compensation and gain control to optimize frequency response. When C2 detects a cell phone detection signal, the LM358AD's output will alternate between high and low depending on the signal frequency. This causes the LEDs across resistor R4 to flicker.

2.3 Construction

A cell phone's transmission frequency ranges from 0.9 to 3 GHz and its wavelength from 3.3 to 10 cm (Bukar et al, 2019). For a cell phone detector, a circuit that can recognize gigahertz signals is necessary. Before permanently assembling the circuit by soldering the electronic components on a Vero board (matrix board), it was first designed and tested on a breadboard. The circuit created by depositing a thin layer of conducting materials on an insulating board's surface. The matrix board's surface is covered

with the various individual electronic components, which are then soldered to the connecting circuit and all of the connections are made correctly. Figure 2.6 is the figure of assembling of electronic components on a bread board.

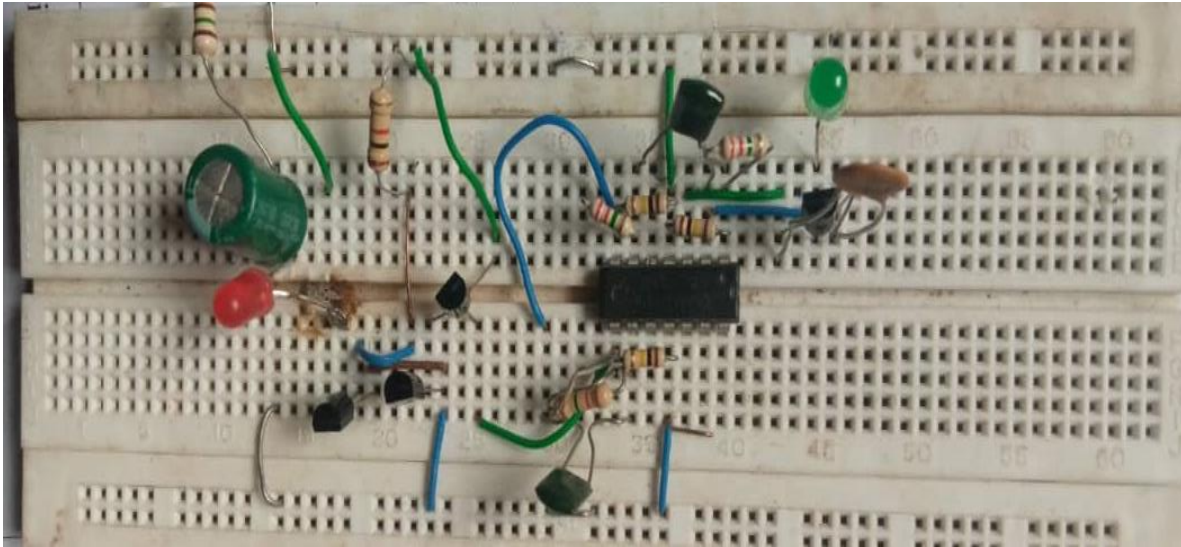


Figure 2.6: Assembling of electronic components on a bread board

2.4 Casting

The cell phone detector was encased in a plastic container together with the 9V battery. Two LED were used, the red which blink whenever an active phone was detected and a green LED which turn on when the power switch is turn on. Figure 2.7 is the Constructed cell phone detector



Figure 2.7: Constructed cell phone detector

3.0 TESTING AND RESULT DISCUSSION

3.1 Testing

The various components were first tested, to ensure that they were in good working condition before mounted on a bread board. The voltage values of the components were measured with a

multimeter and the result shows that each component has a certain value when there is no signal or when the cell phone is activated near the detection area. The reason for this is not far-fetched, as the battery supplies the voltage and passes it through a circuit that spans all the components.

When an activated phone is brought into the detection range, the voltage over each component either increases or decreases. When a signal is received by the antenna, there is a varying voltage increment across the capacitors (C1, C2, and C3) from 3.0, 0.19 and 2.72V to 3.12, 0.91 and 2.96V, respectively. The voltage on the LED also increases from 0.5 to 1.29V. There is a voltage drop across the Op-Amp LM324AD from 6.32 to 5.72V as the signal is received by the antenna. The fluctuation is due to the irregularity of the signal because it is a sine wave.

The constructed detector was tested using four different mobile phones types/models (HOM 3320, Nokia 200, Techno F1 and Infinix 556). The mobile phones were placed at some distance from the detector, turned on and a phone call was made and SMS as well as WhatsApp messages were sent to the mobile phones, when mobile-phone receives the signal at the particular-place, the green LED blink was observed for indication of the cell phone presence. The maximum distance in which when exceeded the green LED did not blink was measured and recorded. Figure 3.1 shows a cell phone detector when (a) no cell phone signal is detected and (b) radio frequency (RF) is detected.

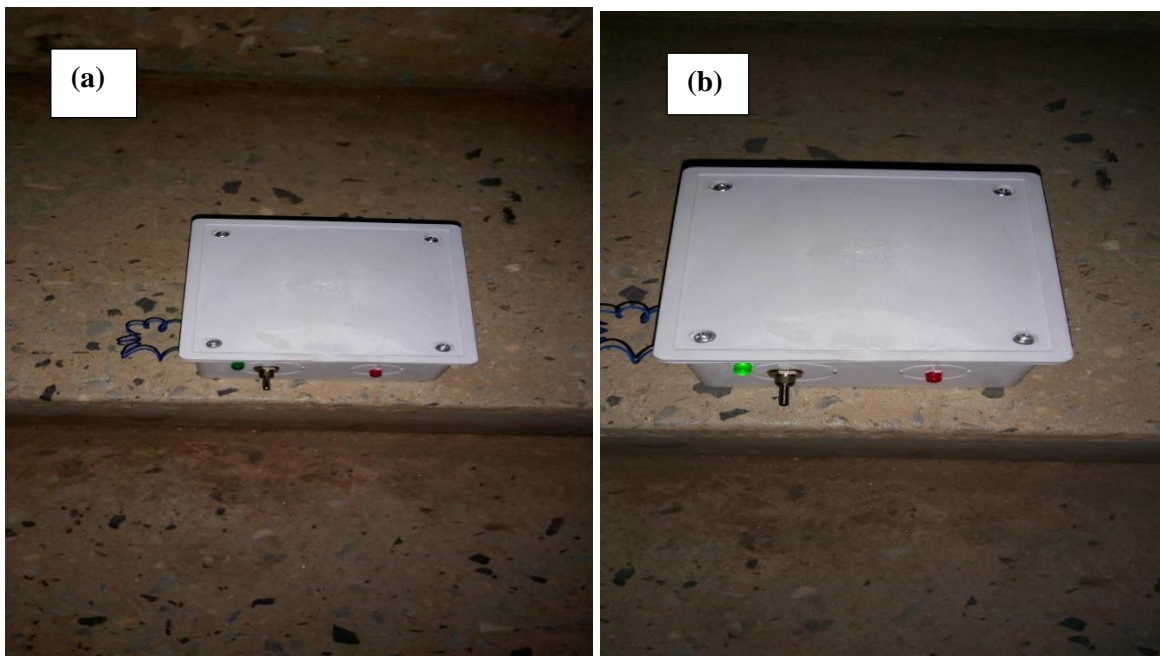


Figure 3.1 shows a cell phone detector when (a) no cell phone signal is detected and (b) radio frequency (RF) is detected.

3.2 Result and Discussion

The electrical components are used to design an optimized detector circuit and tested accordingly. The circuit in detection mode can detect the radio frequency from 0.9 to 3GHz, which is the radio frequency signal range required for cell phone operation, and the LED will start blinking. The test results are analyzed and verified using cell phones. From the result obtained, it shows that, each component has a certain value when there is no signal near the detection area or when there is no activated cell phone. The reason is that the battery supplies the voltage, and that voltage flows through the circuits of all the components. In the presence of a signal, the voltage of each

component varies due to variations in the supply voltage due to differences in the power consumption of each component. Some of the components used in the device are active, while others are passive.

The testing result of the cell phone detector shows that if no calls were received and no messages (SMS/WhatsApp) were sent to the cell phone near the detector, the green LED did not light up and no emission was observed. However, when a call is received or an SMS or WhatsApp message is sent, the green LED lights up and continues to flash until the communication between the two phones ends. We also observed that the intensity

of the green LED illumination decreased as the phone moved away from the detector and eventually disappear.

Also, the detector response depends not only on the distance but also on the phone type/model. Based on cell phone detector test results, three types of cell phones (HOM 3320, Nokia 200, and Techno F1) were found to cause LED flashing at a distance of 1.5m. However, the Infinix 556 phone caused the LED to blink at a range of 1m. This is because some phones have high shielding that cannot be easily detected, and some phones cause the red LED to flash momentarily higher intensity than others at the same distance.

4.0 CONCLUSION

In conclusion, the cell phone detector developed in this study provides a simple, cost-effective, and reliable solution for detecting the presence of cell phones. It serves as a valuable tool for maintaining privacy, security, and compliance with certain regulations in a variety of environments. The built-in cell phone detector could detect the presence of an activated phone at a distance of 1.5 meters and signal that by turning on an LED connected to its output. Further research and improvements can be carried out to improve its functionality and adapt to evolving technological advances.

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