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Design and Implementation of Mobile Phone Signal Detector

[1]Gopiya Naik. S, [2]Mohamed Adnan Khan, [2]Manojgowda S.P
[1]Associate Professor, [2] Students, Department of Electrical and Electronics Engineering, PES College of Engineering, Mandya, Karnataka (India)
Corresponding author email: gopiya_s@yahoo.co.in

Abstract

This paper presents, design and development of a digital signal detector, which is capable of detecting incoming and outgoing signals from mobile phones. The presence of an activated mobile phone can be detected by this handy, pocket-size mobile signal detector from a distance of one and a half meters, which can be employed in preventing the use of mobile phones in examination rooms, confidential halls, etc. It is also useful for detecting the mobile phone used for spying and unauthorized video transmission. The deviceiscapable to detect the incoming and outing calls, text messages, and video transmission, even if the mobile is kept in the silent mode. The instant the device detects radio frequency transmission signal from an activated mobile phone, the light emitting diode starts blinking. The alarm will continue until the signal transmission decays. The complete circuit is assembled on a general purpose printed circuit board, is as compact as possible and is enclosed in a small box.

Keywords*: Signal Detection, Mobile Phone, Light Emitting Diode, LC Circuit, Printed Circuit Board.*

INTRODUCTION

Now-a-days, there is an increased interest on problems concerned to the use of mobile phones prohibited zones. The reason behind this is mainly due to disturbance, as well as misuse of mobile phones by the owners and users. Other places like churches, mosques, offices, and prisons, just to mention a few, are not left out. There is a urgent need for the detection of mobile phone signals in areas like these. Efforts have been made in tackling these issues but they all have their own shortcomings, one of such is the jammer of mobile phone. It is an instrument used to prevent cellular phones from receiving signals from base stations. When used, the mobile phone jammer effectively disables mobile phones. These devices can be used in any site, but are suitable only in locations where a phone call will be disruptive particularly, as silence is expected [1, 2]. The shortcoming of such a technique is the inability to do the calls during emergencies.

However, this detector has the feature of receiving and making calls during emergencies, except that the alarm and the light emitting diode (LED) will start beeping and blinking, respectively. The Mobile phone makes use of radio frequency signal having wavelength of 30cm at 872 to 2170 MHz, i.e., the signal contains high frequency associated with large energy. When mobile phone is set on, it transmits the signal in the form of sinusoidal wave passing through the space. The encoded audio or video signal which is picked up by the receiver in the base station is in the form of electro-magnetic radiation.

LITERATURE REVIEW

The technology currently available in the open market employs mostly discrete components and a design procedure using a down converter in conjunction with a band pass filter. These technologies are not sufficient as they are inaccurate and expensive too. The very first detection technique, a radio frequency signal detector using tuned inductor-capacitor (LC) utilizes discrete components is difficult to implement [3]. They are although, very simple to construct, but requires precision tuning. This design when analyzed was seems to be inaccurate. The design incorporates tuned LC circuit which is used to detect low frequency radiation signal in the amplitude modulation and frequency modulation bands. It detects signals in the GHz frequency range used in mobile phones with the transmission frequency of mobile phone ranges from 0.9 to 3 GHz. A capacitor, C is used as a part of the LC circuit, while the lead (coiled wire) of the same forms the L to receive radio frequency signals from the mobile phone. When mobile phone is activated the radio frequency transmission signal is detected by the detector and starts doing a beep alarm and the LED blinks [3, 4].

The second technology seems to be accurate but has its own drawbacks, in addition to be very expensive. The two well-known mobile phone detecting devices available according this technique are developed by Berkeley Varitronics Systems and mobile security products. These organizations manufacture the wolfhound mobile phone detector and mobile buster, respectively. The Berkeley Varitronics systems Wolfhound cell phone identifies personal computers, code division multiple access, global system for mobiles and cellular bands atradio frequency signals. It is also able to directionally find and locate cellular phones which are very close to it [5]. The Wolfhound is found to be a great method to detect mobile phones, but they randomly detect communication of mobile phone in the zone and not necessarily the phone or device that set it off.

The mobile buster by the mobile security product offers continuous monitoring of mobile phone and has got voice alert that informs the user to shut off their phone if they are detected. The mobile buster can only receive the signal and does not transmit, making it useful for the areas that are sensitive to use of mobile phone. It also detects mobile phones which are in the standby mode. The mobile buster can also effectively detect from people for bringing their mobile phones into the prohibited areas. However, like the Berkeley Vantronics systems it has got drawbacks as it takes about 20 minutes todetect if it is in standby and that the phone needs to be on and its detection could be random transmission in that region.

DESIGN PROCEDURE

The traditional radio frequency detecting device employing tuned LC circuits is not good for detecting signals in the Gigahertz frequency range which is required in mobile phones because of the high frequency of transmission and large amount of energy output.

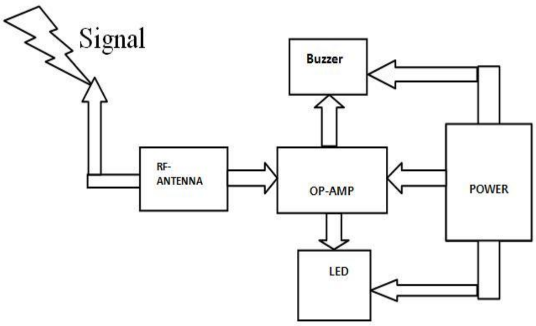

Fig. 1:*Block Diagram.*

The construction of this compact and handy mobile phone signal detector [6, 7] is simple and less expensive. For the construction to be understandable and appreciable, a more detailed description of the design is required as shown in the block diagram.

The design consists of four stages as in fig. 1.

1. Sensor stage
2. Power stage
3. Operational Amplifier stage, and
4. Response stage

As shown in fig. 1, when the radio frequency antenna receives the wireless signal once the circuit has been energised by a 9Volt dc supply, the operational amplifier (LM358AN) amplifies the signal received which later triggers the buzzer and makes the LED to flicker when signal has been detected.

Operating Principle

The signal frequency of transmission of mobile phone varies from 0.9 to 3 GHz having a wave length of 3.3 to 10cm. The circuit which is able to detect Gigahertz frequency signal is essential for a mobile bug. So the circuit requires a 0.1µF disk capacitor (C2) to capture the radio frequency signals from mobile phone. The lead of the capacitor is fixed at a length of 18mm having the spacing of 8mm between the leads to get the desired frequency. The disk capacitor along with the leads is acting as a small Gigahertz loop antenna to collect radio frequency signals from mobile phone. Op-amp (U1) in the circuit is performing the job of current-to-voltage converting device associated with capacitor C3 connected between its inverting and non-inverting terminals.

Capacitor C2 which is used along with the lead inductance acts as a transmission line that intercepts the signals from the mobile phone. This capacitor develops a field, stores energy and transfers the stored energy in the form of small current to the inputs of U1. This will upset the balanced input of U1 and convert the current into the corresponding voltage output. Capacitor C1 along with large value of resistor R1 keeps the non-inverting input stable for easy swing of the output to higher state. The discharge path for capacitor C1 is provided by the Resistor R2. The inverting input is made high by the feedback resistor R3 when the output becomes high. For phase compensation and gain control to optimize the frequency response, Capacitor C3 is connected to R5 and null inputs of U1.

When the mobile phone signal is detected by C2, the output of U1 becomes high and low alternately according to the signal frequency. This makes the LED to flicker via resistor R4, connected at the output, pin 7 of the U1, which in turn triggers the buzzer.

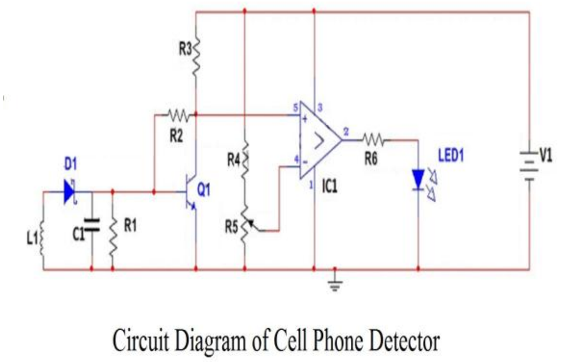

Fig. 2: *Circuit diagram of cell phone detector*

IMPLEMENTATION

Construction on Bread Board

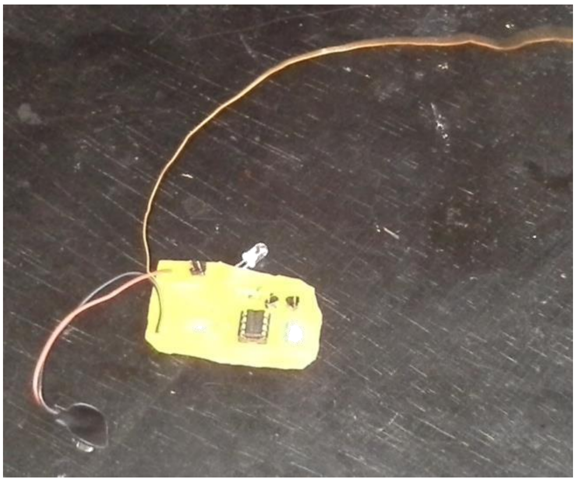

Fig. 3: *The Assembled Circuit.*

The rigging up of components is first made on a bread board before being translated it on to a PCB (Fig. 3). Straddling the channel U1 was placed on the board. The variable resistor was placed with the pins on separate rows once the orientation of the chip was noted.

The middle pin of the variable resistor, R5 is connected to pin 6 of the op-amp IC, and top and bottom pins to the bottom rows of the board. To the bottom two rows the battery supply will be connected. Capacitor, C3 is inserted between the middle and top pins of the variable resistor, R5. Pin 4 of the U1 is connected to the bottom left row of the board. Several other locations will use this connection for ground.

A 6.8MΩ resistor (R2) and a capacitor (C1)are connected between pin 3 and pin 4 of the IC. It should be noted that pin 4 is connected to the ground. A capacitor (C2) is then connected between pin 3 and pin 2 of the op-amp IC.

A 6.8MΩ resistor (R1) is connected between pin 3 of the op-amp IC and bottom pin of the variable resistor. A wire is required to perform this connection. It is noted that the bottom pin of the variable resistor need be connected to the positive terminal of the battery. A 6.8 Ω (R3) is also connected between pin 1 and pin 2 of the op-amp IC.
A wire is used to connect pin 1 and pin 5 of the IC. One terminal of the 1KΩ (R4) is connected to pin 7 of the op-amp IC. The other terminal of the LED is connected to pin 8 and the short leg to the row above pin 8 (the row where one of the 1KΩ resistor terminal is connected).

The bottom right row to the long terminal of the LED, i.e. pin 8 is connected using a wire. One end of a long wire constituting the antenna is connected to pin 2 of the U1. To the bottom left of the board the black wire of the battery is connected, while the red wire is connected to the bottom right row of the board.

RESULTS AND DISCUSSION

The designed circuit was tested in the lab and ensured by taking the readings of each component before the detector detects an active mobile phone and when it does not. Three lab tests were conducted using a spectrum analyzer and function generator. The assembled circuit was also tested using a mobile phone.

The tests were performed using a function generator and spectrum analyzer, respectively, to the input and output using BNC coax cables. The first test was carried out to check whether the op-amp IC could amplify the received signal, the second test was on how the LED works together with the buzzer and the last test was to ensure how bright and loud the LED and buzzer could be, when the circuit receives signal from the function generator. At the end of these tests, the detector is said to be working at expected level with high efficiency.

The voltage values of each component were taken using a multimeter and are given in Table 1. It is concluded from the table that when there is no signal or activated mobile phone near the detection area, there is a constant value for each component. The reason for this is that as the battery supplies the voltage; it goes through the circuit across each component. The voltage across the LED and buzzer is not sufficient to produce an alert, as the rating to produce a sound from the buzzer is 3 to 24 Volts, while that of the LED is 1 to 3 Volts.

Table 1: *Voltage Values across each Component*

S/N	COMPONENT	VOLTAGE(V) (when no signal)	VOLTAGE(V) (when there is signal)		
1	Buzzer	1.28	3.5	2.75	1.78
2	LED	0.54	1.9	1.05	0.92
3	C3	2.89	2.61	2.51	1.53
4	C1	3.00	2.75	2.61	2.01
5	C2	0.19	0.15	-	-
6	LM358AN	6.32	5.80	5.72	5.62

Once the activated mobile phone is brought in the vicinity of detection range, the voltages across each component will vary i.e. either increases or decreases. When the signal is received by the antenna there is a fluctuation in voltage drop across the capacitors, C1, C2, and C3 and the U1. This fluctuation is due to the irregularity in the received sine wave signal. During this instant the voltage across the buzzer fluctuates between the values of 3.5 to 1.78 Volts and gives only a sharp sound at 3.5Volts, whereas a faint sound at 2.75Volts and no sound at 1.78Volts. The voltage across the LED also varies and fluctuates as the signal comes and goes, but it comes only at a voltage of 1Volt and above. The instant the mobile bug detects radio frequency transmitted signal from an activated mobile phone, it starts giving a beep alarm and the LED blinks as shown in Fig. 4. The alarm continues until the signal transmission decays. Fig. 5 shows the device when not receiving any signal.

For the mobile phone test, a Nokia mobile phone was turned on and a phone call was placed with the detector nearby. It was observed that once the call was made and the detector detects the signal, the LED comes up along with the sound but later stops even when the call was not aborted. After much trouble shooting, it was found that the wire used for antenna was weak, and when a better wire was used the circuit was working effectively and efficiently.

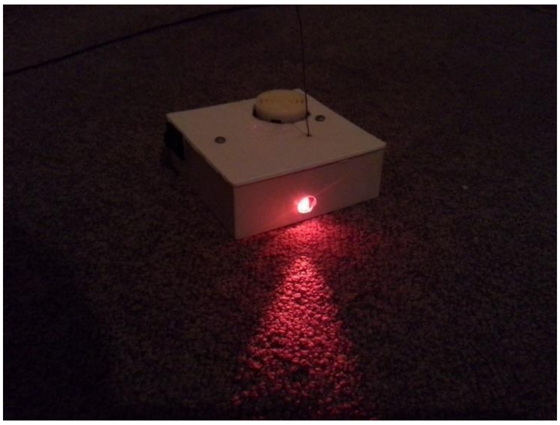

Fig. 4: *Device when detecting the signal*

Fig. 5: *Device when not detecting the signal*

CONCLUSIONS

Mobile phone technology is gaining a wide spread popularity with high rapidly because of its new data capabilities and added features like: Bluetooth, high resolution cameras, memory cards, and internet accessibility make them ideal for getting data in and out of secure facilities. A mobile phone utilizes different transmission protocols: FDMA/CDMA. These protocols can dictate how the cellular phones communicate with the tower. Many business organizations and educational institutions depend on keeping their information protected and build imploring methods like: searching everyone entering and exiting, which requires a lot of man power and money. This portable mobile phone detector which detects the presence of an activated mobile phone from a distance of 1m to 1.5m can be used to prevent instances quoted above and also to detect the use of mobile phones in the restricted areas.

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Gopiya Naik. S obtained the BE degree in Electrical and Electronics from MCE, Hassan, M.Tech in Power System from NIE, Mysore and Ph.D from IIT, Roorkee. He has got total 24 years of teaching experience and published many papers in national and international journals of repute. At present he is working as an associate professor in the department of Electrical and Electronics Engineering at PESCE, Mandya, Karnataka. His research interest includes power distribution system planning, renewable energy systems and integration, micro grid.