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Cellular Signal Identifier Using Operational Amplifier

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Abstract – *Development of a Cellular Signal Identifier enhances security and privacy. The ubiquity of cellular device has raised Cellular Device Monitoring concerns regarding their misuses in many sensitive areas, such as secure facilities, examination centers and theaters, where their usage poses security threats and invades personal privacy. To address this issue, we have developed a Cellular Signal Identifier, a compact and efficient device capable of detecting and alerting to the presence of active cellular devices within its vicinity. This paper outlines the design, construction, and testing of the Cellular Signal Identifier, emphasizing its functionality, sensitivity, and real-world applications. We also explained the implementation of a user-friendly interface that allows us for an easy configuration and monitoring. The results indicate high sensitivity and minimal false alarms, furthermore we also discuss the ethical and legal considerations associated with its use, as well as its potential impact on societal norms.*

Key Words: Signal, sensitive, identifier, cellular, user-friendly, privacy, design, construction.

1.INTRODUCTION

A cellular device, often referred to as a mobile device or cell phone, is a portable electronic gadget that utilizes cellular networks for communication. These devices enable users to receive phone calls, send messages, and access the internet wirelessly [1]. Concerns about using mobile phones in unapproved, restricted regions have received more attention in recent years. The inappropriate use of mobile phones by both owners and users is a major contributing factor to the rising interest [2] Not excluded are other spaces like offices, churches, and mosques, to name a few. In places such as these, mobile phone signal detection is necessary.

Many ideas and innovations are done to solve this problem but all of these solutions have its own limitations and shortcoming.

One of those innovations is signal jammer, it is used to prevent cellular devices from receiving RF signals [3]. When this jammer used it disables the phones for the timing it's active because of jamming the signals. Jammer is mainly is used in such places where silence is primary thing or in such places where use of cell phones is prohibited [4]. The limitation of this jammer is that a person cannot use his/her cellular device in the case of emergencies.

The cellular signal identifier allows the use of cell phones in emergencies because it just detects the RF signals, it does not block them, except the alarm will keep beeping and the light will be continuously blinking.

The cellular device produces RF signals which has wavelength 30Cm at 872 up to 2170 MHz, this signal has huge energy frequency and high frequency.[5]

1.1. Literature Review

In 2019, Y. Gao, et al. in their paper "Mobile Phone Passive Positioning Through the Detection of Uplink Signal," states that the process of high-precision locating and, a passive way for locating the cellular device by capturing the preamble sequence which can be applied to 5G even 4G communication system [6]. In 2010, Berkeley et al. Varitronics Systems, "Cell phone Detector" these Companies produce the wolfhound cellular device detector and cellular buster. The Berkeley Varitronics systems Wolfhound cell phone detects Computers (PCs), Global System for Mobiles (GSM) and Code Division Multiple Access (CDMA), cell phone bands using RF International Journal of Engineering Research & Technology (IJERT) [7]. In 2014, Ajasa, A.A. et al. "Design and Development of a Mobile Phone Signal Detector", has proposed in their paper that the presence of an activated cellular device can be detected by this device, which is pocket-sized cellular signal detector which can detect from a distance of one or a half meter, which can be used in preventing the usages of cellular device in confidential rooms, examination halls, [8]. In 2011, Scott, Nicholas, et al. "Study of Cellular Phone Detection Techniques". This paper studies the techniques of detecting cellular devices. It examines about the technologies which is currently available, an already existing design which utilizes maximum discrete components, and a design by using a down converter; in conjunction with a bandpass filter [9]. In 2015, Deshpande Tamvi et al. "Active Cell phone detection and Display using Atmega-8 Microcontroller", the paper deals with the detection of GSM signals and displaying the signals on a LCD screen with the use of an ATmega-8 microcontroller. According to it the cellular device will ameliorate to maintain the formation of security in the restricted areas to protect the breach potent data [10].

2. DESIGN AND SIMULATION

Due to the transmission and high frequency and enormous energy outcome, signals from the GHz frequency band are used in cellular device which cannot be detected by a regular RF detector that uses tuned LC circuits.

This tiny mobile phone signal detector has an extremely easy-to-assemble, low-cost construction. The more thorough description of the design of use the given block diagram is necessary in order to make the construction more comprehended and appreciated.

The design of cellular signal identifier has four stages.

1. Input stage
2. Amplification stage
3. Common Emitter Amplifier stage
4. NE555 timer stage

2.1. Materials Used

Table -1: Components used in the circuit

Components	Quantity	Range	Value
Resistors	6	1k-2.2M	1k
Capacitors	8	0.01u-2.2M	0.01u
CA3130	1	5V-16V	5v
BC548	1	110Hfe-220Hfe	110Hfe
NE555	1	4.5V-16v	5v
Buzzer	1	1kHz-kHz	7kHz
Battery	1	--------	12v
Led	1	3w-33w	3w
Antenna	1	-------	-------
Switch	1	-------	-------

2.1.1. IC CA3130

The CA3130 is a versatile operational amplifier known for its high input impedance, low input current, and excellent frequency response. With its wide supply voltage range, it's adept at various signal processing tasks, including audio amplification, filtering, and instrumentation applications.

2.1.1. IC NE555

The NE555 IC is a versatile and widely used integrated circuit known for its timer and oscillator functionalities. This chip is favored for its ability to generate accurate time delays and oscillating signals.

2.1.3. Buzzer

The buzzer is an electro-acoustic system which produces sound by generating vibrations through an oscillating electronic circuit. It typically consists of an electromechanical component that produces an audible tone or noise.

2.1.4. Resistor

The resistor is an electrical component which is designed to limit the flow of electric current in a given circuit. They are used to reduce the voltage levels, it also controls the amount of current flow through a circuit, divide the voltages, adjust the signal levels, and also limit the current to LED lights, among many other applications.

2.1.5. Capacitor

A capacitor is an electrical component used to store and release electrical energy in a circuit. When voltage is applied across the plates, it stores electric charge. Capacitors are characterized by their capacitance, measured in farads (F), which determines their ability to store charge

2.1.6. LED

The LED is a short form of Light Emitting Diode, which is a semiconductor device which emits light whenever an electric current is passing through it.

2.1.7. Transistor BC548

BC548 is a commonly used NPN (BJT) bipolar junction transistor which is employed in a wide array of electronic circuits. Known for its versatility, this transistor is suitable for low-power applications, serving as an amplifier for small signals or as a switch to control higher currents based on input signals. With its three terminals - Base, Collector, and Emitter.

2.1.8. Battery

The battery is an energy storage device that converts the chemical energy into electrical energy. Battery consists of one or electrochemical cells, which contains of positive and negative terminals (anode and cathode) and it is immersed into an electrolyte solution. When it is connected to a circuit, the chemical reactions within the it produces electrical current.

2.2. Block Diagram

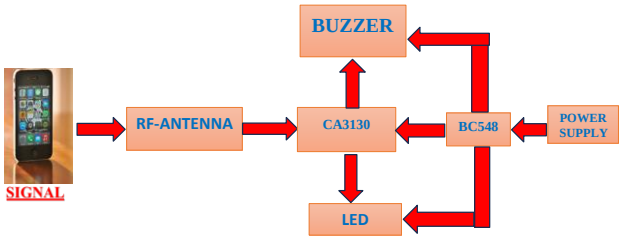

Fig -1: Block diagram of cellular Signal Identifier

2.3. SIMULATION

A wire is attached to a LED's long terminal (pin 8) which is at the bottom of the right row. (Pin 2) IC is connected to one of the ends of a long wire, or an antenna. Then the battery's black wire is attached to the board's bottom left corner, and the red wire is attached to the bottom right corner.

Designing an affective Cellular Signal Identifier circuit requires a good understanding of electronics and wireless communication. Here, is the fundamental design of the circuit:

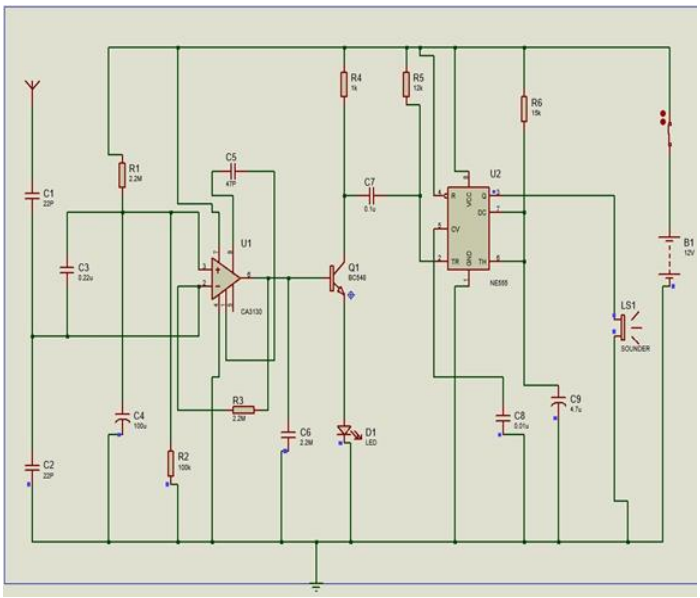

Fig -2: Schematic Diagram of Cellular Signal identifier

2.3.1. Input stage

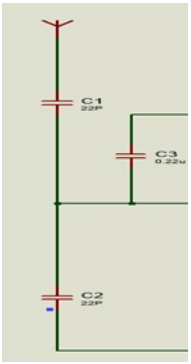

Fig -3: Input Stage

This above circuit receives radio frequency 600MHz – 39GHz signals using a gigahertz loop antenna and to acquire high radio frequency. Because of its wide surface area and inexpensive value, the 22 pf (C2) is the material of choice. Signals from the electronics device are intercepted by C2, which then transmits energy in the form of current to the integrated circuit input amplification stage CA3130.

2.3.2.CA3130 Amplification Stage

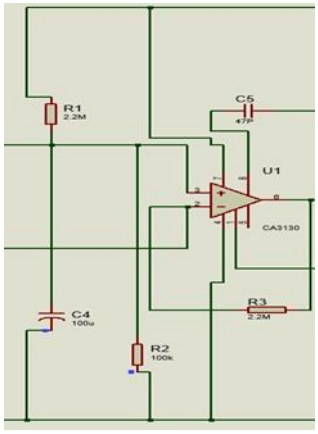

Fig -4: CA3130 Amplification Stage

Large resistor R1 and capacitor C4 maintain noninverting input steady, allowing for a simple output swing to high. Capacitor C4 has a discharge route provided by resistor R4. When the output rises, the feedback resistor, R3, turns the inverting input high. Phase adjustment and gain control are employed via capacitor C5, which is linked across the strobe pin, to maximize the frequency responsiveness.

2.3.3. Common Emitter Amplifier Stage

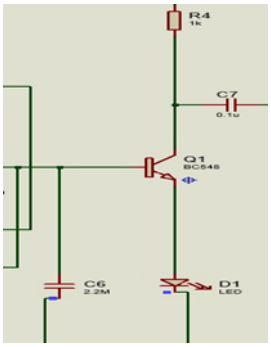

Fig -5: Common Emitter Amplifier Stage

Transistor Q1 acts as a switch to deliver a DC voltage for the second stage. R4 connected with the collector side of the transistor helps to maintain the desired voltage of 5.8 V. Transistor Q1's bias is maintained by C4 to enable quick switching.

2.3.1.NE555 Clock Circuit

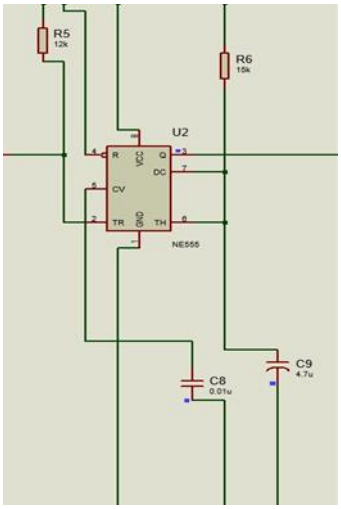

Fig -6: NE555 Clock Circuit

The circuit is a basic NE555 timer blink circuit when the timer acts as a stable oscillator, up-to-dated for our desired frequency in order to drive our circuit.

3. RESULT ANALYSIS

In this paper we have used two circuits to detect the presence of cellular device. After analyzing the outcomes of these circuits, we concluded that whenever a cellular device is brought near the circuit which has antenna in it, detects the radioactive frequency (RF) that are emitted by the cellular device when it's in use or it is in standby mode. This antenna Cellular Signal Identifier consists of a high-frequency transistor and a tuned LC circuit. That could serve as a tiny antenna for gigahertz loops. Disk capacitor and the lead of the LC circuit collects the RF signals from the cellular device and amplify them using the transistor. The amplified signals are then fed to a buzzer or a LED that indicates the detection of the mobile phone.

Table 2: Voltages of different components during presence/absence of signal

S/No.	Components	Voltages (when there is no signal)	Voltages (when signal is there)		
1	Buzzer	1.35	4.2	2.92	2
2	LED	0.6	2.2	1.2	1.1
3	C1	3.3	2.95	2.71	2.21
4	C2	2.2	0.17	-----	-----
5	C3	3.2	2.71	2.61	2.63
6	CA3130	6.42	5.5	5.62	5.72

The frequency that is switched by a sequence of two capacitors is detected by the antenna. The 900–1800 GHz frequency range is detectable by the antenna.

The amplifier can amplify even the weakest RF signals can be amplified by the amplifier. Pin 6 of the op amp produces a voltage of roughly 1 volt when an active GSM is brought close to the circuit. The voltage increases or decreases between 1.2 and 0.8 volts when the variable ceramic capacitor is connected between pins 1 and 8.

After the amplification of the signal, it goes to the alarm system and the buzzer in the alarm system get activated and start producing sound. The sound stays on for the certain time constant and that time constant is controlled by the 555 timer. The timing components R1 and C2 influence the design of the monostable timer.

4. CONCLUSIONS

We have concluded after simulations and designing circuit that whenever the RF signal is passed through the antenna the device is activated and the alarm start producing sound with a constant time period using NE 555 timer. Our device plays a very crucial role in detecting cellular device where its use is prohibited. After our analysis we came to a result that the cellular device has to be active in order to detect RF signals produced by the cellular device. The signal is captured, then it goes through an amplification process where the signal is amplified up to 1,00,000 times to get the better output in the buzzer.

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