DESIGN AND CONSTRUCTION OF A CAR IMMOBILISER WITH SMS ALERT

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Abstract

As technological knowhow is on the increase, so also are those of criminals and die hard professional thieves who beat existing car security gadgets to carry out their notorious activity. One advantage such criminals enjoy is the inability of existing car security gadgets to establish communication between the car and its owner from the exact instant of intrusion. This gives criminals ample time to deactivate the car security. This work bridges this gap using a common and handy everyday communication tool, the mobile phone. With the very wide GSM coverage, one of its products, the Short Message Service (SMS) can be employed to send an alert to a vehicle owner who in turn sends an instruction to the car, to initiate safe and remote vehicle immobilization.

Keywords: Immobilizer, S.M.S, micro-controller, sensor, and activation/de-activation

Introduction

Most car security devices parade features like doors, bonnet and boot protection, sensor, ignition controller, central window and door locking system, trafficator’s flasher, a mono or multi-tone siren to mention just a few (www.oztion.com.au), (www.larmtjanst.se). These however are noted for their characteristic failures and false alarm. Later car securities were furnished with additional features based on Radio-Frequency (RF) wireless technology which is limited to 800 metres radius from the transmitter. The only limitation of this design is that if the car is out of the coverage area, it cannot be immobilized (Aliyu, 2005). With the coming in of GSM/CDMA technology, its application to car security was experimented with success especially in vehicle tracking. Its limitation is that it gives the location of the nearest BTS (Base Transmission Station) the device is communicating with but not the exact location of the car. The next generations in car security system were incorporated with built-in tracking system using GPS technologies. This makes it possible to track the exact car location by communication with the tracking company. Its limitation is that when the car is parked in an underground parking lot it will not work, because there is no clear sky visibility (www.livingdigitalindia.aol.com).

The aim of this work is to take advantage of the wide coverage of GSM technology to design a car security device with ability to report any intrusion to the users’ mobile phone by sending an SMS, ability to alert the immediate neighborhood via siren or buzzer and light indicators and most importantly, ability to immobilize the car engine via SMS from the user. This promotes direct communication between car and owner in times of trouble and so helps to reduce the high rate of car thefts.

Design and implementation

Block Diagram: A block diagram is one which shows all the individual functions of a system and how the signal flows through the system (Schler, 1984). The block diagram highlighting the functional sections for the device is shown in figure 1.
The role of each unit will now be explained sequentially.

**Power Supply Section:** This is the unit capable of supplying a direct voltage and current to the electronic circuit under test (Grobs and Mitchel, 2003). It takes its unregulated +12V input directly from the car battery to supply stable +5V needed by the device. Figure 2 shows the power supply circuit and components’ details.

The power supply circuit is furnished with a Single Pole Single Toggle (SPST) switch S\textsubscript{7} used to control the flow of electric current into the circuit, a Light Emitting Diode (indicator) LED\textsubscript{5} with a current rating of 12mA. To sustain this, current limiting resistor R\textsubscript{10} was introduced to reduce the amount of current entering it. To get the value of R\textsubscript{10}, from Ohms law:
\[ R = \frac{V}{I} \quad (1) \]

Where \( V \) is battery voltage which is 12V. Substituting into (1) gives;

\[ R_{10} = \frac{12}{0.012} = 1000Ω \]

A voltage regulator Integrated Circuit IC2 (7805) was introduced to peg the output at +5V. Smoothing capacitors \( C_6 \) and \( C_7 \) of values 4,700\( \mu \)F and 220\( \mu \)F smoothing the voltage at the input and output terminal of 7805 respectively. Also, \( D_7 \) and \( D_8 \) (1N4148) are signal diode used to assist keep the output voltage of 7805 constant. To bust the current, a power transistor TR1 (D 2394) was used as a current amplifier. Capacitor \( C_8 \) of value 470\( \mu \)F, smoothing the voltage at the emitter of transistor TR1.

**Control Section:** The control section is responsible for the activation and de-activation of the Micro-controller via two press switches \( S_1 \) and \( S_2 \). As shown below.

![Control Section Diagram](image)

**Sensor Section:** Sensors are transducers designed to convert any physical quantities (heat, sound, light, pressure, etc.) into electrical signals, (Paul and Winfield, 2001). This section consists of four press switches \( S_1, S_2, S_3 \) and \( S_4 \). It is assumed that each switch is attached to a particular door.

![Sensor Section Diagram](image)

- \( S_1 \) connects RB3 (pin 9) to ground voltage when closed, thus activate the micro-controller (PIC 16F628).
- \( S_2 \) connects RB4 (pin 6) to ground voltage when closed, thus de-activate the micro-controller (PIC 16F628).
- \( S_3 \) connects RB4 (pin 10) to ground voltage when closed, indicating that door (A) has been opened.
- \( S_4 \) connects RB5 (pin 11) to ground voltage when closed, indicating that door (B) has been opened.
• S₅ connects RB₅ (pin 12) to ground voltage when closed, indicating that door (C) has been opened.

• S₆ connects RB₇ (pin 13) to ground voltage when closed, indicating that door (D) has been opened.

**Programmable Interface Controller Section:**
Programmable Interface Controller (PIC) is a microcontroller integrated circuit (IC). It is the heart of this work, a processing device that coordinates all the activities of all other components for proper functioning via the operating software programmed on it. Through software program, it monitors the voltage at the sensor and the control section via port B i.e. RB₀ (pin 6), RB₃ (pin 9), RB₄ (pin 10), RB₅ (pin 11), RB₆ (pin 12) and RB₇ (pin 13) and control all other output devices via port A i.e. RA₀ (pin 17), RA₁ (pin 18) and RA₂ (pin 1). Details are shown in figure 5.

![Fig. 5 Programmable Interface Controller section.](image)

- R₁ (1kΩ), R₂ (100Ω) and C₂ (47µF) reset the PIC 16F628 through the MCLR (pin 4) input. Thus making the PIC to start running it program from the beginning when main power is been applied, i.e. S₇ is closed.

- X₁ (16MHz), C₃ (27pF) and C₄ (27pF) formed the external oscillator generating 16MHz frequency for the PIC to run it program. X₁ (16MHz) is a crystal oscillator used to generate 16MHz frequency while the ceramic capacitors C₃ (27pF) and C₄ (27pF) stabilized the generated frequency.

- C₁ (470µF) is a smoothing capacitor used to smoothing the +5V at the V_DD (pin 14) of the PIC.

- R₄ (100Ω) is a current limiting resistor reducing the current entering the mobile phone receive data terminal (RX).
• R5 (1kΩ) is a pull-up resistor keeping the voltage at the RX (pin 7) and the output of the Op-amp at +5V.

• IC1 (LM 393) is an operational amplifier used to amplify the Transmitted signals from the mobile phone through its inverting input terminal (pin 2). It gives its output through pin 1 while pin 5 and 4 are positive and ground respectively (LM 393 data sheet).

• R6 (4k3Ω) and R8 (4k3Ω) form a voltage divider generating 2.5V for the non-inverting terminal (pin 3) of the operational amplifier, also determines the gain of the operational amplifier.

• Z1 (3V Zener diode), R7 (12kΩ) and D7 (1N4007) are used to charge the mobile phone battery with +3V since the handset battery voltage is 3V.

The PIC performs the enumerated tasks through the following:

• Through TX (pin 8) it transmits data serially to the mobile phone.

• Through RX (pin 7) it receives data from the mobile phone. Both Transmit and Receive data line form the communication channel through which information is been exchange between the Programmable Interface Controller and the mobile phone.

• Through RA0 (pin 17) it controls the ignition relay section.

• Through RA1 (pin 18) it controls the trafficator section.

• Through RA2 (pin 1) it controls the alarm section.

• Through RB0 (pin 6) it monitors the voltage at the de-activation button.

• Through RB1 (pin 9) it monitors the voltage at the activation button.

• Through RB4 (pin 10), RB5 (pin 11), RB6 (pin 12) and RB7 (pin 13), it monitors the voltage at sensors 1, 2, 3 and 4 respectively.

Alarm Section: This section is responsible for converting electrical pulses into audible sounds. The major component in this section is the buzzer as shown in the diagram below.

![Alarm section diagram](image)

Fig. 6 Alarm section.

Ignition Relay Section: This section is responsible for the mechanical switching ON or OFF of the engine’s ignition connection. It does so by making and breaking of the relay contact thereby opening or closing the circuit. This is accomplished via the instructions received from the PIC.
Fig. 7 Ignition relay section.

- R₀ (1kΩ) is a biasing resistor used to bias the base terminal of the TR₂ (BC 548).
- D₁ (1N4148) is a diode connected in forward biased mode to the supply voltage (+5V) and C₅ (4.7µF) are used in preventing the back emf or voltage spike produced from the relay coil as a result of switching ON or OFF of the coil.
- TR₂ (BC 548) is an NPN transistor connected in common emitter mode of operation (BC 548 data sheet). It is used as a driver transistor for the RLY₁ (5V relay).
- RLY₁ (5V relay) is an electro-mechanical device used to perform mechanical switching of the ignition-engine connection. It has 5 terminals: 2 coil terminals, 1 Normally Opened terminal (NO), 1 Normally Closed terminal (NC) and 1 Common terminal (C). The normally closed terminal is connected to the wire carrying current to the engine block from the ignition coil while the common terminal is connected to the wire carrying current away from the ignition coil.

Trafficator Section: This section is responsible for creating visual alert. It does that by blinking the set of four LEDs (Light Emitting Diodes) representing the four trafficator lights (Pointers).

Fig. 8 Trafficator section.

- R₃ (1kΩ) is a biasing resistor used to bias the base terminal of TR₃ (BC 548).
- TR₃ (BC 548) is an NPN transistor connected in common emitter mode of operation (BC 548 data sheet). It is used as a driver transistor for the four LEDs (LED₁, LED₂, LED₃ and LED₄).
- R₁₁ (1kΩ) is a current limiting resistor used to reduce the current entering the four LEDs.

Mobile Phone Section: The only device in this section is a mobile phone. It acts as the intermediary between the programmable Interface Controller and
the owner’s handset. It established a full duplex (to and fro) communication channel between these two devices. For the purpose of this work Siemens C45 mobile phone was used for its simplicity and low cost. Siemens C45 mobile phone has twelve pins, but only pin 1, 3, 4 and 5 are relevant to this work.

- Through pin 1, it shares a common ground with the entire circuit.
- Through pin 3, it gets its positive (+3V) charging voltage.
- Through pin 4, it sends out data to the RX of the PIC.
- Through pin 5, it receives data from the TX of the PIC.

Both pin 4 and 5 of mobile phone established a full duplex communication channel with the PIC.

The over all circuit diagram of the device is shown below.

Fig. 9 over all circuit diagram of the device
**Mode of Operation:** As shown in figure 9. Connect the battery clips across the battery terminals and switch ON the power switch $S_7$. Activation and deactivation can be achieved in any of the following ways:

1. By sending activation code *ON* to the mobile phone number inside the panel. Part of the software program the PIC carries is that it enables it to monitor any text message entering the mobile phone inbox. It responds to any inbox message stored in **memory slot 1** of the SIM card. It can only detect code *ON* or *OFF* and disregard any other text different from this. *ON* and *OFF* mean to activate and de-activate the security system respectively. This code can be sent from any mobile phone, after reading the text message it deletes the message immediately to allow other message to be stored in that same memory slot.

2. By pressing the activation button $S_1$ to activate the security system and pressing the de-activation button $S_2$ to de-activate the security system of the PIC.

When any of the door is opened, that is any of the switches in the sensor section is pressed, the PIC instructs the mobile phone to send the text message stored on the memory slot 2 of the SIM card which is at the outbox to the owner’s number. For this work, “Unauthorized operation in your car” was used. During intrusion it sounds the hooter (buzzer) as well as blinks the trafficator light to alert immediate neighbours. The owner on receiving this alert, sends the activation code “ON” back to the system. The code is received via the mobile phone, the PIC disconnects the car ignition via the relay’s (RLY.) The car ignition remains off until the de-activation code “OFF” is sent, otherwise it remains cut off no matter what effort the intruder makes to get the car running.

**Construction technique**

The implementation of the above circuit design was first based on the knowledge and theory behind the components, then again in accordance with schematic diagram. This electronic assembly was implemented principally on a veroboard because of the specific way its copper tract are usually laid and for its convenience over others. Building the circuit on veroboard was started by soldering the components on the copper tract one after the other in line with circuit schematics. Connecting and jumping wires were used to link components and lines accordingly.

**Testing /result**

The device was tested for efficiency by incorporating it into a mock vehicle. The ignition relay terminal was connected to the vehicle ignition, the four sensor press switches were connected to each door, the trafficator terminal was also connected to the vehicle trafficking system and the control section of the device was switched on. Test one: One of the doors was opened. The result was a loud sound from the buzzer, blinking of vehicle trafficators and SMS sent to each of the three owners mobile phones alerting the user. Test two: The car ignition was switched on, an SMS alert was immediately sent to configured mobile phones belonging to the vehicle owner intimating the owner of the intrusion, sounding of buzzer and blinking of vehicle trafficators. On sending “ON” to the devices mobile phone, the ignition was immediately switched off and remain off after several attempt at turning it on. But when the de-activation code “OFF” was sent from any phone in both cases, the ignition was turned on at the first attempt. These results indicate optimum performance in line with circuit design.

**Conclusion**

This security package is cheap, reliable and portable. The circuit design is simple and the micro-controller used ensured proper communication link with the mobile phones. This design is almost maintenance free except for the occasional recharging of the SIM card with air time in order to keep the line active on the network. The idea of sending alert to more than one phone on different network makes up for cases of network failures and lack of coverages in certain areas especially at point of intrusion. Incorporating this device in vehicle will in no small measure improve its theft resistance.

**References**


