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VEHICLE SECURITY SYSTEM WITH REMOTE-CONTROL VIA DTMF USING GSM

[1]Okuonghae T.E. and [2]Ojo K.O.

[1] Department of Physics, University of Benin, Benin City, Nigeria.
[2] Department of Science Laboratory Technology, University of Benin, Benin City, Nigeria.

Abstract

In a developing nation like Nigeria, vehicle theft and intrusion has been a perpetual problem and the inability to control vehicles remotely makes it more difficult to handle. The aim of this paper is to provide not only an enhanced security system which will prevent theft and intrusion but also remote - control features. These services would be real-time and unaffected by geographical distance or physical barriers. The implementation of this project comprises both hardware and software parts. The hardware components include a microcontroller (8051), dual tone multi-frequency decoder (MT8870), relays and GSM phone. The software part includes an Assembly Language program written to operate the microcontroller. In addition, proper hardware was designed to provide the necessary power and voltage levels to all the components. In the availability of high - quality global system for mobile communication (GSM) network, the device worked excellently well. The device was able to make calls when intrusion occurred and automatically terminated incoming calls as expected. Global system for mobile communication (GSM) phone key buttons was able to turn on or off ignition and manipulate any part of the vehicle that was connected to it.

Keywords**:** Global System for Mobile Communication (GSM), Microcontroller, Dual Tone Multi-Frequency (DTMF)

1. INTRODUCTION

Vehicle theft and snatching, is one of the biggest crimes which are hard to eliminate in developing country. Vehicle theft in Nigeria has taken many dimensions. One of which is to forcefully open the car, steal and drive away the car to an unknown location. Another way is to tow or push away the car; the latest trend of car theft involves the car being snatched away at gunpoint. There are many alternatives to prevent car theft, common car alarm system which nearly all recent cars have the system installed. Other alternatives include steering and gear locks, hidden kill switches which incapacitate fuel flow and many others. Car tracking service provided by some firms have also proved effective especially against car snatching, but the cost of providing the service is quite high and in most cases, people pay yearly renewal charges. There is need for a plug and play kind of device devoid of renewal charges or special service request/subscription from any firm. Moreover, it is a vehicle security device that offers excellent protection to one's vehicle [1]. An Anti-burglary vehicle security framework portrays a plan which permits access to the vehicle when the individual's finger impression matches with the framework as set in the vehicle [2]. The correlation will happen in MATLAB and result will be demonstrated on the LCD. On the chance that through illicit means the vehicle is accessed then vehicle fuel tank will be bolted through relay circuit so that at whatever point the tank gets unfilled, unapproved individual will never again have the capacity to refuel the tank. A burglary security framework uses an installed framework outline with Dual Tone Multi-Frequency (DTMF) and a Global system for mobile communication (GSM) to screen and shield an automobile and secures it against burglary [3]. Upon actuation, in an attempt of theft through the car doors or boot, the system sends text message to the car owner and at the same time starts up an alarm. A GPS based tracking system keeps track of the location of a vehicle and does alert the owner on mobile phone text message system which is able to provide real-time text alert for spend and location [4]. The present

Corresponding Author**:** Okuonghae T.E., Email: timothy.okuonghae@uniben.edu, Tel: +2348033188592

location can be locked, and the system will alert the owner if the vehicle is moved from its present locked location. On hourly bases the GSM modem or mobile will inform the owner by messaging its location in the form of latitude, longitude and speed information. The owner or user can control or stop the vehicle by simply sending the message stop to GSM modem or mobile connected to circuitry board. After receiving that message ignition system will turn off.

In this work, the technology of telecommunication, to be specific: voice call and DTMF is integrated or improved to present vehicle security system and remote - control feature. Instead of human to human telecommunication, this system creates new entity which is machine to human telecommunication. This system is an upgrading and improving vehicle security system by integrating voice call features to alert vehicle owners whenever intrusion occurs [5]. Further, it uses telecommunication dual tone multi-frequency DTMF to provide remote-control feature.

The work is conducted for additional features in the car alarm system. It can also serve as alternative to car tracking system. The device can be added to present car system without any major modification. Whenever the car alarm system is triggered, through forced entry or motion sensor detection, the security device which contains a GSM phone/module, will originate a call through the mobile phone to alert the owner on the status of the vehicle. Usually car owner's realizes that their vehicle has been stolen long after the incident, with the thief probably gotten away and disables all the security features in the car or cannibalizes the parts and expensive items. This happens when the owner is far away from the vehicle to hear the alarm. This device gives immediate alert to the car owner, even if the thief had gotten away with the car, so that the owner can immediately take instant actions to remotely switch off the vehicle and notify the local police department. It is designed to automatically terminate the call, then using phone keypads; one can remotely control and perform some function such as locking the car doors, winding the windows etc.

This research work shows a great improvement in the quest to reduce or stop car theft in our society. They centered on demobilizing the car and alerting the owner through SMS in case of any intrusion. Less work has been done on voice call, decoding DTMF and using these of fully remote-control the vehicle. Hence this research focuses on voice call and the use of key tones to control various parts of the vehicle.

2. MATERIALS AND METHODS

Remote-control system complete circuitry is been analyzed here with different modules in focus.

The transmitting and receiving unit:

In this case, we are making use of GSM phones. The use of GSM phone presents numerous advantages. Services such as real-time voice call and were used Dual Tone Multi-Frequency in this work.

DTMF decoder unit:

Table 1: *Keypad Dial Tone Frequency Table*

	1209 Hz	**1336 Hz**	**1477 Hz**	**1633 Hz**
697 Hz	1	2	4	A
770 Hz	4	5	6	B
852 Hz	7	8	9	C
941 Hz	*	0	#	D

DTMF is Short for ***Dual Tone Multi-frequency*** and the system used by touch-tone telephones. DTMF assigns a specific frequency (consisting of two separate tones) to each key so that it can easily be identified by a microprocessor. DTMF generation is a composite audio signal of two tones between the frequency of 697Hz and 1633Hz [3,4]. The DTMF keypad is arranged such that each row will have its own unique tone frequency and also each column will have its own unique tone. The table 1 is a representation of the typical DTMF keypad and the associated row/column frequencies. The tone frequencies were selected such that harmonics and inter modulation products will not cause an unwanted signal.

The DTMF decoder unit decodes key tones from GSM phone which are converted into bits and recognized by the microcontroller. This circuit detects the key/dial tone from a telephone line and decodes the keypad pressed on the GSM phone. This key/dial tone is called Dual Tone Multi-Frequency. In this project, the main component to decode the input key/dial tone to 5 digital outputs is the MT8870 decoder. The digital bits produced are interfaced to a microcontroller for further application.

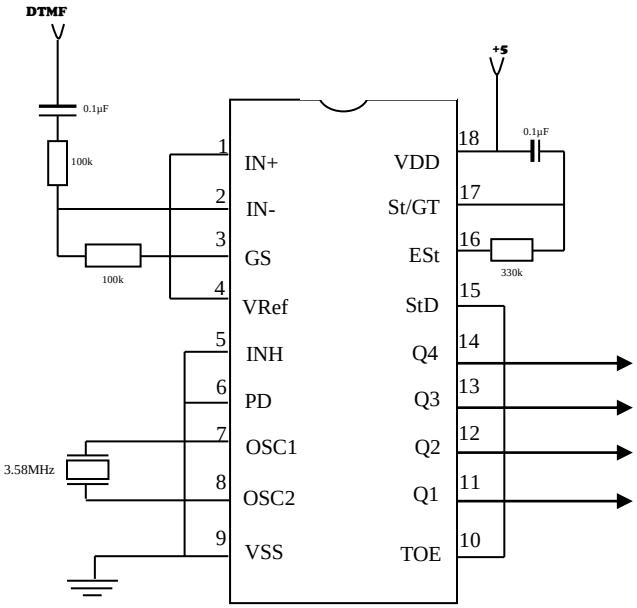


Fig 1: *M8870 DTMF decoder circuit*

The two resistors connected to pin2 and pin3 are chosen to setup a unity gain of the OP-AMP inbuilt in the integrated circuit while the capacitor is for filtering of noise. The input is connected at the inverting end of the OP-AMP (pin2) and the feedback resistor connected on pin3.

Voltage Gain Av = Vo /Vi = -Rf/R1..... (1)

Av =1, if Rf = R1, so Rf = R1 = 100K were selected.

The external circuit connected to pin 16, 17 and 18 is a steering circuit designed to check for valid signal duration. It is an external RC time constant driven by pin 16 (EST).

Components are chosen according to the formula:

tREC = tDP + tGTP ……(2)

Where:

tREC is the minimum DTMF signal duration required for valid recognition.

tDP is the time to detect the presence of valid DTMF

tGTP is the guard time

Sensing units: These are one of the inputs to the microcontroller. These include rider sensor, vibration sensor and battery removal sensor. But for this project, the inherent car sensor system was utilized.

The switching or triggering circuit: This is responsible for the appropriate powering of the different sections to carry out different actions like dial and answer call, on and off ignition, on and off the head lamp etc. It is called the switching unit because it interfaces the security system with the car. This unit switches on or off some devices in the car e.g. on and off ignition, close and open doors etc. It is made up of a relay to be driven by a transistor, MOSFET specifically. In other words, it allows a 12V from supply to pass through whenever there is trigger from microcontroller to the base of the transistor. The relay is used to ensure electrical isolation between the device and the vehicle systems.

Power circuit: This makes sure that proper voltage is supplied to the components. The +5 - volt power supply is based on the commercial 7805 voltage regulator IC. This IC contains all the circuitry needed to accept any input voltage from 8 to 18 volts and produce a steady +5 - volt output, accurate to within 5% (0.25 volt). It also contains current-limiting circuitry and thermal overload protection, so that the IC won't be damaged in case of excessive load current; it will reduce its output voltage instead. This unit is meant to have an input of 12volts and output of 5volts.

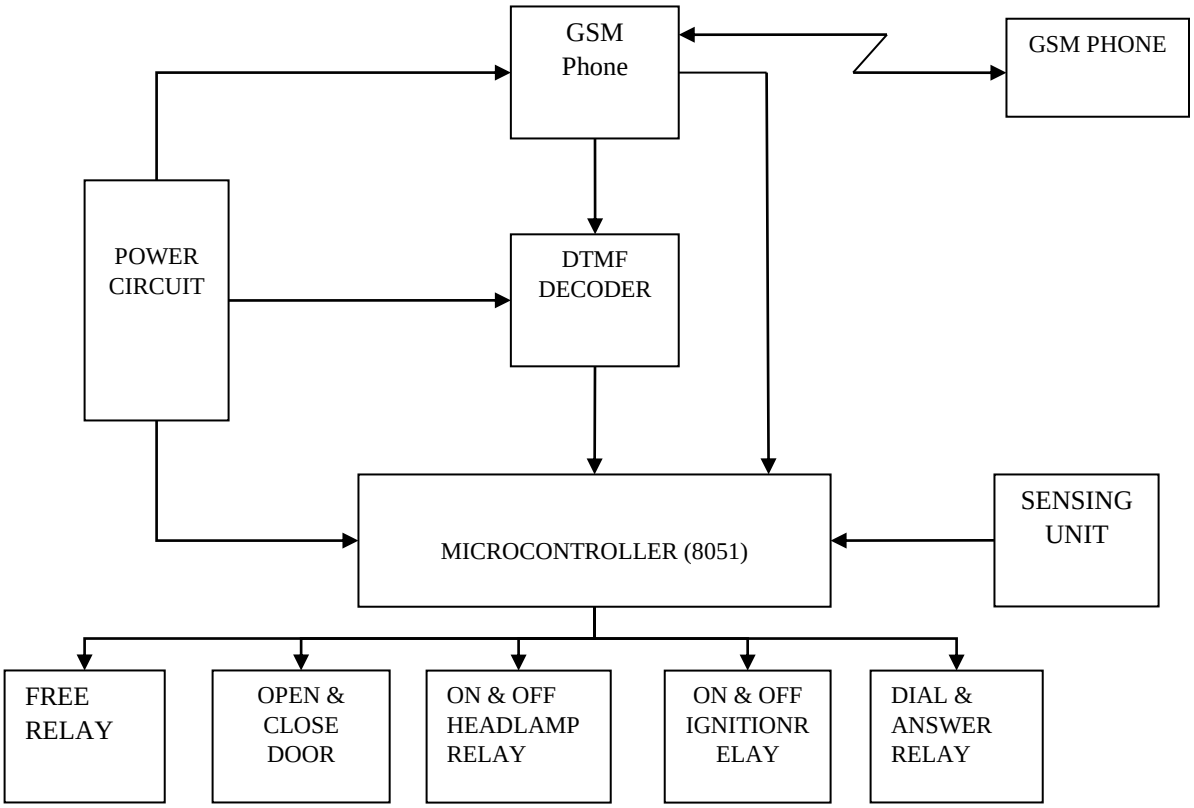


Fig 2: *A simplified block diagram of the complete circuit*

3. PROGRAMMING OF MICROCONTROLLER

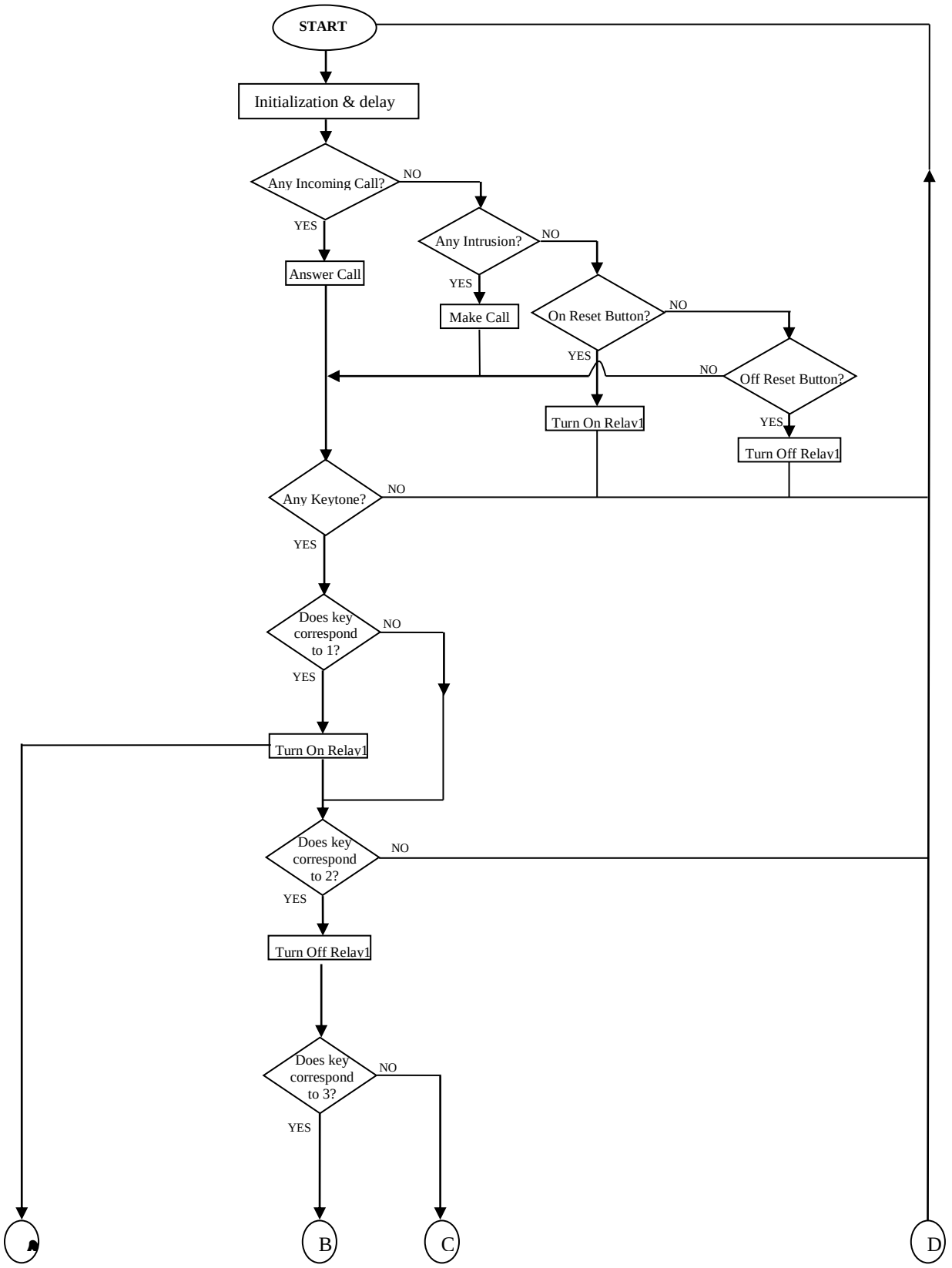
Microcontroller chip will be useless if no program is written on it. The microcontroller performs functions as specified in this program. The program in this project is written using Assembly Language. Assembly languages are low- level languages which are translated into machine code by an ASSEMBLER. Each assembly language instruction corresponds to one machine language instruction, but assembly language is more natural for the programmer to use than machine code.

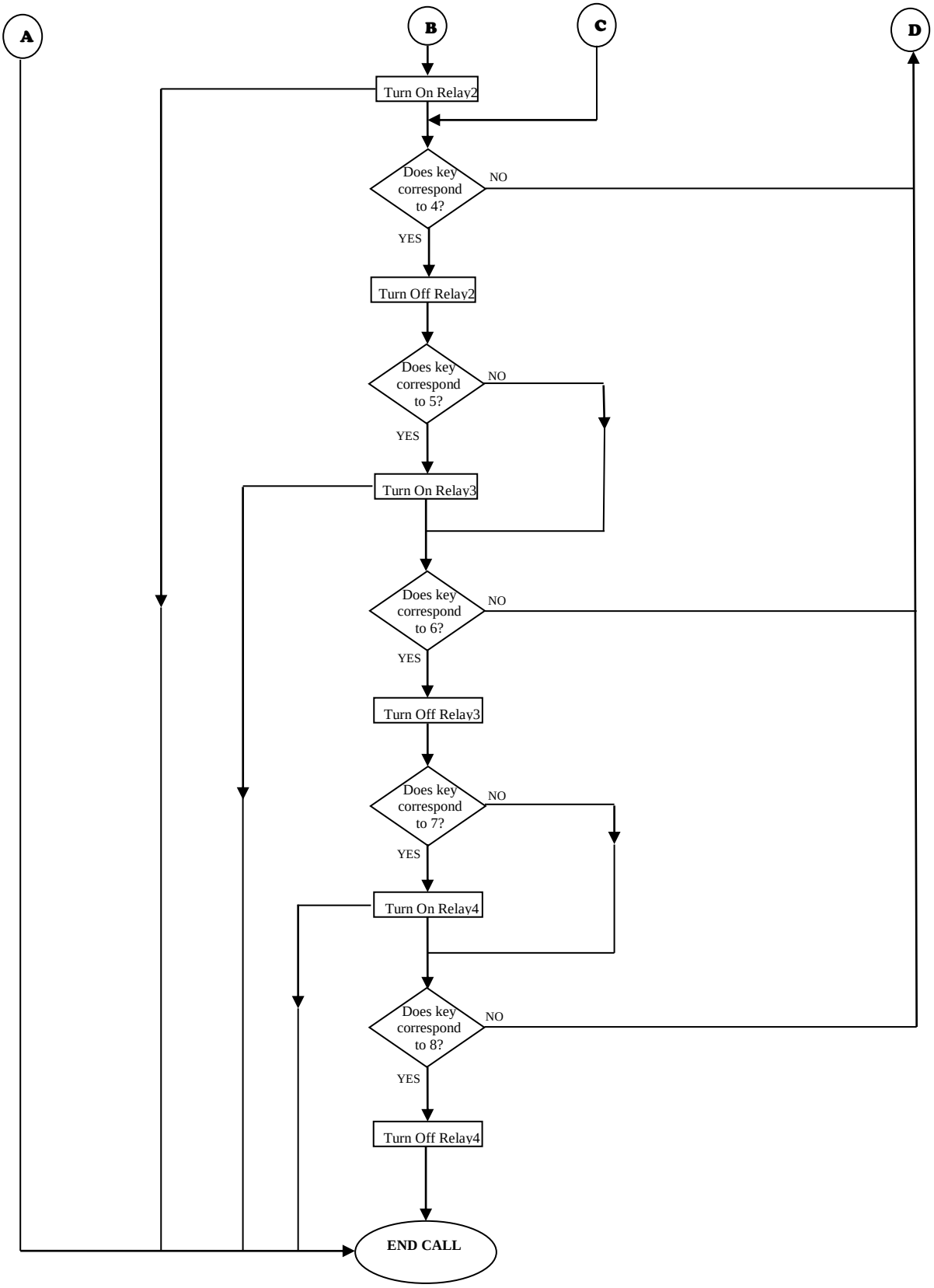
Procedures for writing a program

1. Write the program using the assembly language.
2. Run the program in an Assembler to check for error and generate the HEX file. Each time this is done, it will generate two files: error and HEX file. First the error file is checked for errors. If no error is found, then the HEX file will be burned into the microcontroller using special software called the flash programmer.
3. Connect the microcontroller to the computer through the burner device
4. Open the flash programmer software and perform the following functions:
   i. From the window, select the processor or microcontroller type.
   ii. Click on display buffer button to check if there is any already written program on it. If yes, click on clear buffer and ok to confirm the operation.
   iii. Then click on open file button to select the file to be written to the microcontroller. This should be the HEX file generated by the assembler.
   iv. Click on write to write the program unto the microcontroller. If this is successful, then a confirmation window will appear to confirm the operation.
   v. Verify by clicking on verify button.

It is good to note that other operations can be performed besides those above. These include reading an already written program in a microcontroller.

4. PROGRAM FLOW CHART




A
B
C
D
Turn On Relay2
Does key correspond to 4?
NO
YES
Turn Off Relay2
Does key correspond to 5?
NO
YES
Turn On Relay3
Does key correspond to 6?
NO
YES
Turn Off Relay3
Does key correspond to 7?
NO
YES
Turn On Relay4
Does key correspond to 8?
NO
YES
Turn Off Relay4
END CALL

5. COMPLETE CIRCUIT DIAGRAM

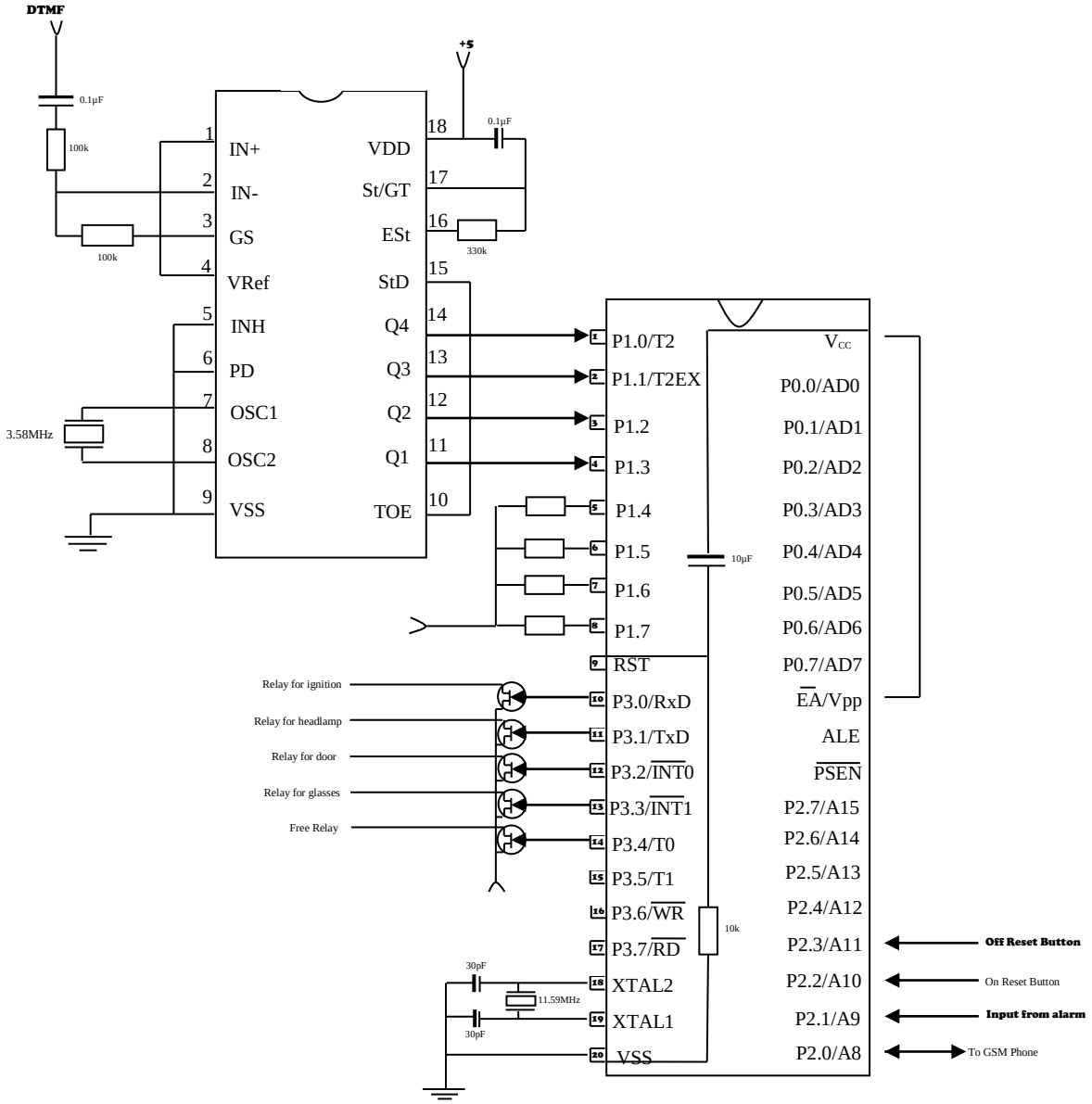


Fig 3: *Complete circuit diagram of the project*

Brief Description of the Circuit Diagram

In Pin 1, 2, 3 and 4 of the microcontroller are outputs from the DTMF decoder. Pull-up resistors are connected to pin 5, 6, 7 and 8. These set the pins to high to complete the 8-bit input entering the microcontroller. Pin 1 is the less significant bit (LSB) and pin 8 is most significant bit (MSB).

Pin 9 is the reset. This is achieved by holding the input high for a minimum of two machine cycles before returning it low for normal running. A resistor connects to pin (20 (Vss) allowing a power on reset using a capacitor to pin (40 (Vcc).

Pin 10, 11, 12, 13 and 14 are output used to drive a12V relay which control some operations in the vehicle. This signal is merely 5V, so a MOSFET transistor was used to amplify it.

Pin 18 (XTAL2) and 19 (XTAL1) contains an oscillator circuit of 11.59MHz. This circuit drives the internal clock generator. The clock generator in turn provides the internal clocking signal to the chip. The internal clocking signals are at half the oscillator frequency and define the internal phases, states and machine cycles.

Pin 20 (Vss) is the ground of the chip. Pin 21 (port2.0) is connected to the GSM phone call and answer button. This is used to make and answer calls.
Pin 22 (port2.1) is input from car alarm system. This is used to monitor intrusion. Pin 23 and 24 are for on and off reset buttons respectively.
Pin 31 is connected to pin 40 (Vcc). This makes pin31 to be continuously tied high and will execute programs from internal memory always.
The circuit using LM7805 ensures that stable 5V is provided for the circuit.

6. TESTING AND RESULTS

Specific results were obtained from the test carried out on the designed circuit. After constructing the tone decoder module, it was tested to ascertain the output bits. This is necessary in the programming because it has to be specified clearly, else the device will not work correctly. A multi meter was used to test the four ports Q1, Q2, Q3, Q4 (ports 11-14).
The following results were obtained:

Table 2: *DTMF decoder test results*

Phone Key	Q4 (port14)	Q3 (port13)	Q2 (port12)	Q1 (port11)	Functions
1	0	0	0	1	On ignition
2	0	0	1	0	Off ignition
3	0	0	1	1	On
4	0	1	0	0	Off
5	0	1	0	1	On
6	0	1	1	0	Off
7	0	1	1	1	On
8	1	0	0	0	Off

The voltage coming from the GSM phone dial/answer button was measured to be 3V. This is safe for the microcontroller.
The voltage at the output of MOSFET transistor and relay which perform different function in the car was confirmed to be 12V as expected.
To test the whole device, reset button was used to simulate for intrusion while 12V bulbs were used to represent various car parts controlled by the device. When called, the device automatically answered the call and identified the GSM phone key buttons. Key 1 and 2 were able to on and off relay1 respectively. Key 3 and 4 for controlling relay2, key 5 and 6 for controlling relay3 and key 7 and 8 for controlling relay4. These relays in turn drive some parts in the vehicle.

7. CONCLUSION

The system provided an effective two-way communication that gives higher level of security features compared to the conventional car alarm system. This device is capable of alerting its owner immediately intrusion is detected. Additionally, the car owner can remote control any security features and check its status at all times through a phone call. The system also has a potential to offer vehicle location detection capability based on GSM positioning concept. Currently, a mobile phone unit was used as a transceiver. To reduce production cost, a simpler transceiver which can access GSM network can be built as a substitute for the mobile phone. The sensing unit can be improved to have its own sensing device which is independent of the one in the vehicle. Lastly, by adding vehicle location information, this device could be the one that every car owner wishes for in securing their cars.

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