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Design And Implementaion Of A Dual Tone Multi-Frequency (Dtmf) Based Gsm-Controlled Car Security

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Abstract: - This paper focused on developing an enhancement of the vehicle antitheft security systems via a Phone call. It is designed to improve vehicle security and accessibility since it can be used to monitor and control other devices in the vehicle. The system will manipulate a mobile phone to send commands in form of DTMF signals to the vehicle. It utilizes an embedded system design with Dual Tone Multi Frequency (DTMF) and a GSM to monitor and safeguard a car. Upon activation, it automatically demobilizes the car by disconnecting the ignition key supply from the car battery. This makes it impossible for anybody to starts the car. The vehicle is controlled by a mobile phone that makes a call to the GSM mobile phone attached or incorporated into the vehicle. In the course of a call, if any button is pressed, a tone corresponding to the button pressed is heard at the other end of the call. This tone is called 'dual-tone multiple-frequency' (DTMF) tone. The vehicle perceives this DTMF tone with the help of the phone stacked into the vehicle. The received tone is processed by the microcontroller with the help of DTMF decoder. The decoder decodes the DTMF tone into its equivalent binary digit and this binary number is sent to the microcontroller. The microcontroller is programmed to take a decision for any given input and outputs. Upon receiving a code, the microcontroller will then carryout appropriate task based on the way it was programmed. The microcontroller is programmed to carry out the task of disconnecting the ignition or fuel system of the vehicle, or to control another device in the vehicle.

Keywords: *Dual Tone Multi Frequency, car security, GSM control system*

I. INTRODUCTION

There has been increased in the cases of car theft which necessitates the use of car security systems to deter car thefts. Several car security systems are reported in the literature .El-Medany et al (2010) describes a real time tracking system that provides accurate localizations of the tracked vehicle with low cost using GM862 cellular quad band module. Jiwa (2011) designed a mobile controlled car security system that is capable of providing an effective two-way communications between the alarm system and the car owner. This system is able to notify the car owner immediately when an intrusion is detected. Hu et al (2012) describes an automobile anti-theft system using GSM and GPS module. The system is developed using high speed mixed type single-chip C8051F120 and stolen automobile is detected by the use of vibration sensor. The system remains in contact with automobile owner through the GSM module, for the safety and reliability of automobile.

Fleischer et al (2012) describes development and deployment of GPS (Global Positioning System)/GSM (Global System for Mobile Communications) based Vehicle Tracking and Alert System. This system allows inter-city transport companies to track their vehicles in real-time and provides security from armed robbery and accident occurrences. Le-Tien et al (2010) describes a system based on the Global Positioning System (GPS) and Global System for Mobile Communication (GSM). It describes the practical model for routing and tracking with mobile vehicle in a large area outdoor environment .The system will acquire positions of the vehicle via GPS receiver and then sends the data to supervised center by the SMS (Short Message Services) or GPRS (General Package Radio Service) service.

Visa and Asogwa (2012) designed an antitheft security system which utilizes an embedded system designed with Dual Tone Multi Frequency (DTMF) and a GSM to monitor and safeguard a car. Upon activation, it automatically demobilizes the car by disconnecting the ignition key supply from the car battery. By dialing the phone number of the mobile phone attached to the circuit and sending a code after the phone has automatically been answered, puts the system to either "active or inactive" state, and on any attempt of theft the system sends a text message to the device owner, demobilizes the system (car) and then starts up an alarm. In this paper we presents DTMF based GSM controlled car security system that can be used as a remote control for controlling other devices in the vehicle or to switch the vehicle ON and OFF irrespective of the distance in addition to protecting the vehicle against theft.

II. METHODOLOGY

The overview of the whole security system is illustrated in the block diagram shown in figure 1.

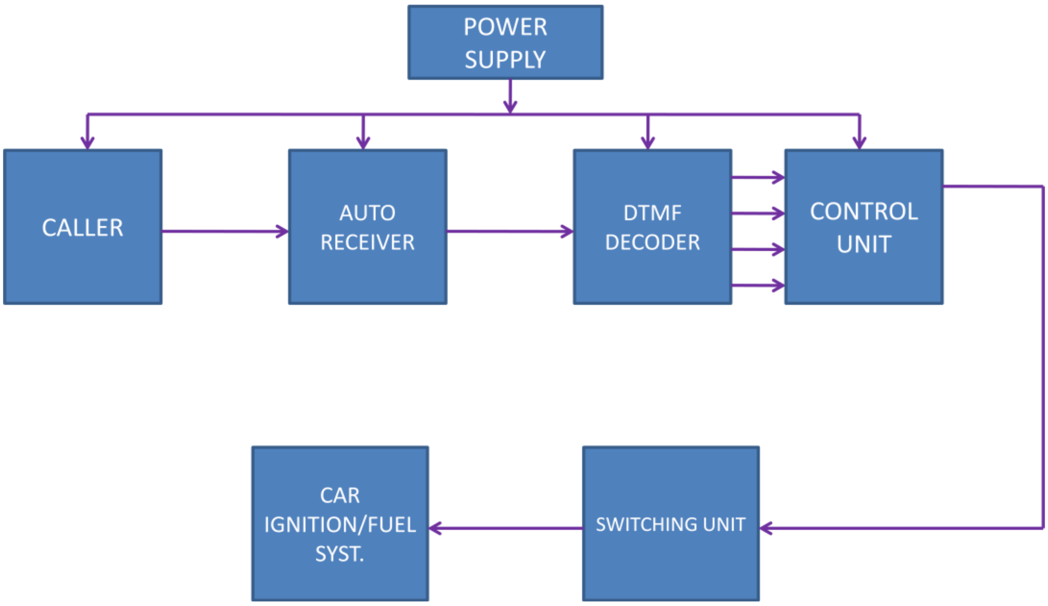

Figure. 1: Block Diagram of DTMF Based GSM Controlled car security system

A. POWER SUPPLY UNIT

The power supply unit consists of a 12V/500mA step down transformer, a bridge rectifier, 1000µF/35V capacitor, LM7805 and LM7812 voltage regulators, status indicator (LED); a 1K resistor which limits the voltage entering the LED. The 240V/50Hz input supply into the transformer passes through the rectifier which converts it to a D.C. voltage. The LM7805 and LM7812 regulate the voltage to give a voltage of 5V and 12V dc required as V_{CC}. These Voltages are then delivered to various loads based on their respective demands. D.C. voltage is isolated from the mains by the transformer. From the rating, it steps down 240v input to 12v before delivering to the output of the bridge rectifier. The rectifier circuit consists of four diodes configured into a full-wave bridge rectifier mode. The regulators used in this design provides regulated and stable D.C of 5Vand 12V respectively. The 5V D.C voltage drive all the chips used for this design and the 12V is used in the switching unit. The capacitor is designed to filter and remove surges that appear on either the input or output of the supply.

B. DECODER CIRCUIT

The decoder integrated circuit is shown in figure 2. This decodes DTMF signal that is transmitted through telephone line and gives 4 bit digital information. The DTMF keypad is laid out in a 4×4 matrix in which each row represents a *low* frequency and each column represents a *high* frequency. Pressing a single key sends a sinusoidal tone for each of the two frequencies. In DTMF there are 16 distinct tones. Each tone is the sum of two frequencies: one from a low and one from a high frequency group. There are four different frequencies in each group. Mobile phones only uses 12 of the possible 16 tones. In most conventional phones, there are only 4 rows (R1, R2, R3 and R4) and 3 columns (C1, C2 and C3). The rows and columns select frequencies from the low and high frequency groups respectively. Table 1 illustrate the DTMF keypad frequencies.

Table 1:DTMF KEYPAD FREQUENCIES

	1209 Hz	**1336 Hz**	**1477 Hz**	**1633 Hz**
697 Hz	**1**	**2**	**3**	**A**
770 Hz	**4**	**5**	**6**	**B**
852 Hz	**7**	**8**	**9**	**C**
941 Hz	*****	**0**	**#**	**D**

The outputs of the decoder integrated circuit are connected to the inputs of the micro controller. Hence the button pressed is determined by the program written and loaded on PIC16F876A micro controller.

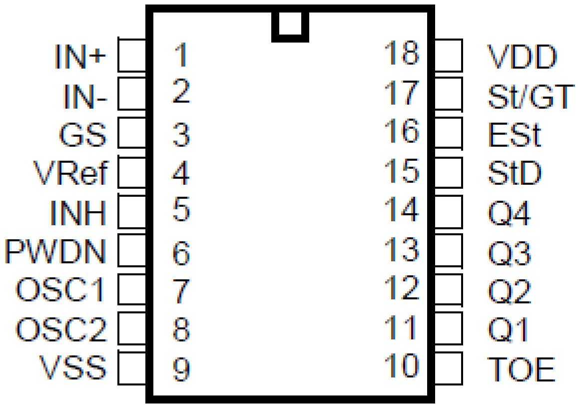

Figure 2: Pin Diagram of MT8870DE

The separation of low-group and high group tones is achieved by applying the DTMF signal to the inputs of two sixth-order switched capacitor band pass filters, the bandwidths of which correspond to the low and high group frequencies. Limiting is performed by high-gain comparators which are provided with the system. Following the filter section is a decoder employing digital counting techniques to determine the frequencies of the incoming tones and to verify that the corresponding signals are standard DTMF frequencies. A complex averaging algorithm protects against tone simulation by extraneous signals such as voice while providing tolerance to small frequency deviations and variations.

To ensure efficient filtering and decoding and hence better performance of the MT8870DE IC the following configuration were used according to the device datasheet. Steering and guard time circuit operation of the decoder, the target here is to have $t_{GTP} < t_{GTA}$.

$$t_{GTA} = guad\ time\ for\ tone\ absent$$

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$$t_{GTA} = R_p C \ log_e \left(\frac{V_{DD}}{V_{Tst}}\right) \quad ….(1)$$

$$t_{GTP} = R_1 C_1 log_e \left(\frac{V_{DD}}{V_{DD} - V_{Tst}}\right) \quad ….(2)$$

The steering arrangement adopted and hence the choice of guard time place more emphasis on the device (decoder) specification and the probable environment where the system could be applied. This help improve take off and noise immunity of the system.

Differential input gain (voltage gain)

$$A_r = \frac{R_5}{R_1} \quad ….(3)$$

Input impedance

$$Z_{in} = \sqrt{R_1^2 + \left(\frac{1}{wc}\right)^2} \quad ….(4)$$

The time constant of the device is obtained from the relation

$$\text{M (w) dB} = 20\text{log}\left(\frac{R_5}{R_1}\right) + 20log\frac{w\tau}{\sqrt{(w\tau)^2+1}} \quad ….(5)$$

The complete circuit diagram of the decoding unit is shown in figure 3.

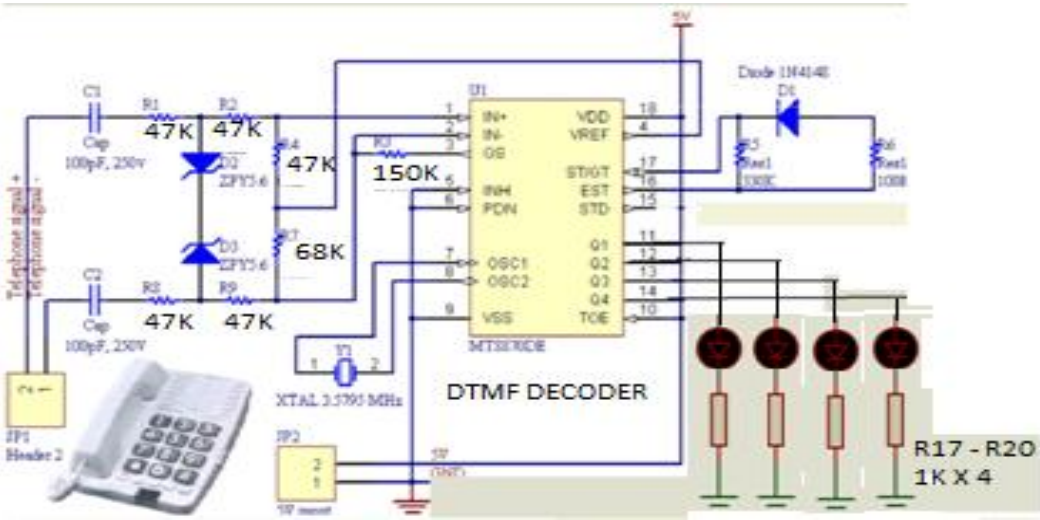


Figure 3: Decoding Unit

C. SWITCHING UNIT

This unit is made up of Relays. In this design, an NPN transistor (BC547) was used as a switch and current driver to the relay which control the output load. The transistor is used to establish the current necessary to energize the relay in the collector circuit. When a positive pulse is applied to the base, the transistor turns on, establishing sufficient current through the coil of the electromagnet to close the relay. Ideally, the current through the coil and transistor will quickly drop to zero, the arm of the relay will be released and the relay will simply remain dormant until the next on signal. To choose the transistor base resistance, the following relations were used.

$$V_{cc} = I_B R_B + V_{BE} \quad ....(6)$$

And

$$I_B = \frac{I_{c(sat)}}{\beta} \quad ....(7)$$

The complete circuit diagram of the switching unit is shown in figure 4.

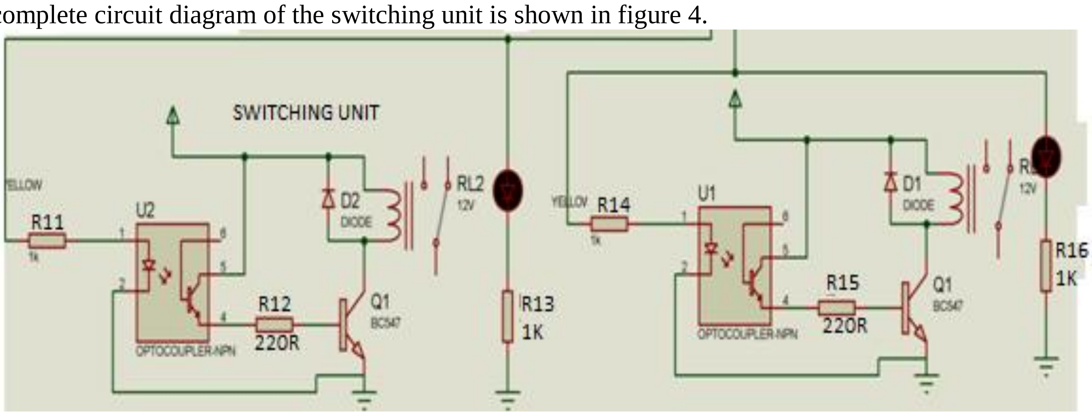


Figure 4: Switching Unit

D. CONTROL UNIT

This unit is basically a Microcontroller. The type of microcontroller used is PIC16F876A shown in Figure5 which has three input-output ports, namely; Port A, Port B and Port C.

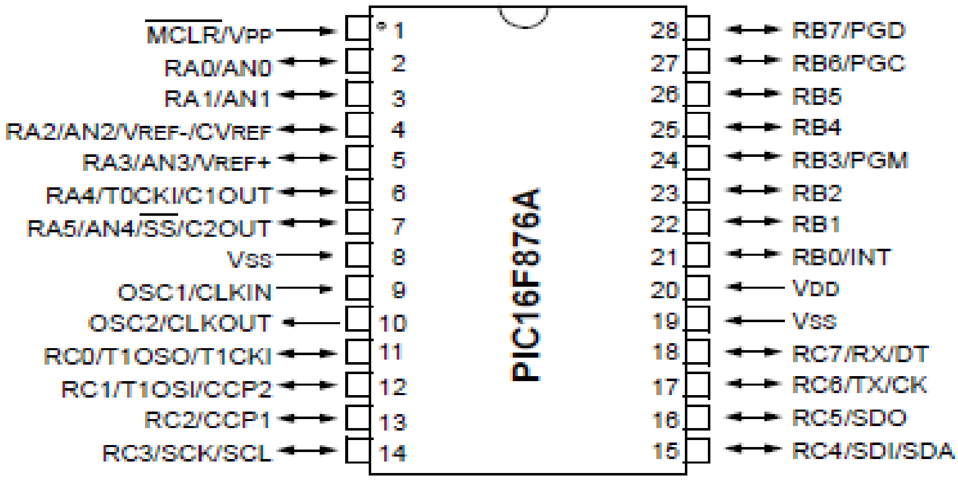


Figure 5: Pin Diagram of 16F876A

Because the microcontroller is high enable the MCLR pin is connected to V_{cc} via current limiting resistor.

$$R_{10} = {}^{5}/_{5 \times 10^{-3}}$$
$$= 1K$$

4MHz crystal oscillator was chosen to ensure precise timing and fast execution time.

$$T = \frac{1}{f} \qquad ….(8)$$

Capacitors were connected to the crystal oscillator to filter any noise component that can be generated in the system.

The codes chosen from the program loaded on PIC16F876A for controlling various devices are shown in table 2.The device can be the vehicle ignition system or anyother device in the vehicle. The complete circuit diagram of the control unit is shown in figure 6.

Table 2: CONTROL KEYS

DEVICE	ON	OFF
A	1 and 5	2 and 5
B	3 and 5	4 and 5
AB	6 and 5	8

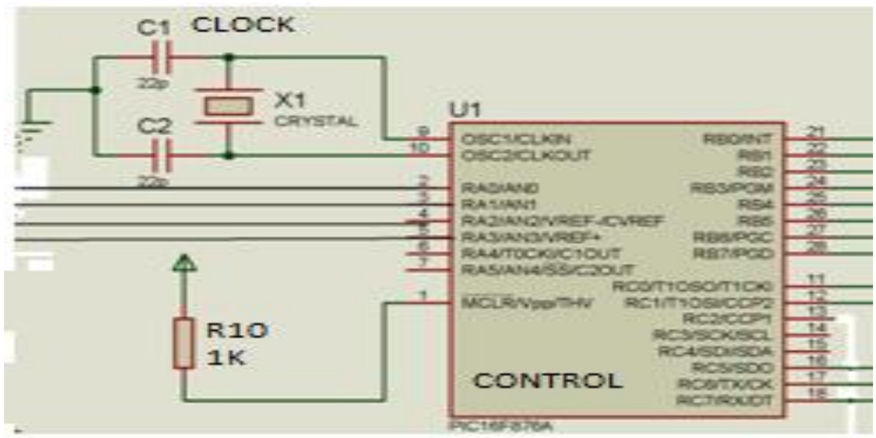
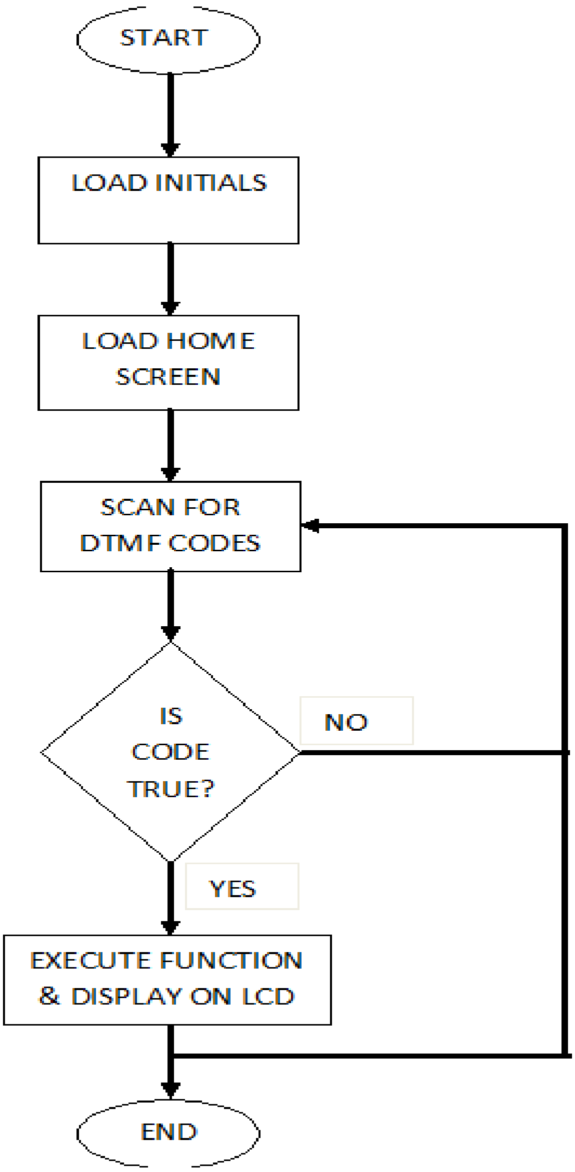


Figure 6.: Control Unit

E. Program

The system functions according to the program written and loaded on the PIC16F876A. The entire program is summarized in the flow chart shown in Figure 7.



Fiure 7: Program Flow Chart

III. COMPUTATION OF DESIGN PARAMETERS

To satisfy the steering and guard time circuit operation of the decoder i.e $t_{GTP} < t_{GTA}$, equations (1) and (2) were used. Thus we have

$$t_{GTA} = R_p C \, log_e \left(\frac{V_{DD}}{V_{Tst}}\right)$$

$$t_{GTA} = (976.74) \times (0.1\mu F) \times log_e \left(\frac{5}{2.5}\right)$$

$$t_{GTA} \cong 5.32ms$$

$$t_{GTP} = R_1 C_1 log_e \left(\frac{V_{DD}}{V_{DD} - V_{Tst}}\right)$$

$$t_{GTP} = (47 \times 10^3) \times (100 \times 10^{-12}) \times log_e \left(\frac{5}{2.5}\right)$$

$$t_{GTP} \cong 3\mu sec$$

The differential input gain and input impedance of the system (filter and decoder) are computed from equations (3) and (4) to be 3 and 2.3 MΩ respectively for R_s = 150 kΩ, R_1= 47 kΩ, C=100pF and f = 685 Hz. The time constant of the system was computed from equation (5) to be 0.6 ms by allowing the 0.1 dB of attenuation at 685 Hz.

An NPN transistor (BC547) was used as a switch. For this transistor
$I_{c(sat)} = 500mA \; and \; \beta = 200$
The base resistance was computed using equations (6) and (7) to be 4.52 kΩ with V_{CC}= 12 V

For the 4 MHz crystal oscillator in the control unit, the execution time was computed to be 0.25μs using equation (8).

IV. RESULTS AND DISCUSSION

The results obtained during the construction states after necessary troubleshooting were satisfactory. The system was able to respond to its operation when tested. The decoding of the tones sent by the mobile phone to the DTMF decoder and the sending of these tones to the microcontroller works effectively. Also, the microcontroller functions according to the program used for the software design implementation

V. CONCLUSION

This paper deals with the design and construction of a DTMF based GSM controlled car security which is meant to minimize the increasing rate of car theft. It is designed to improve vehicle security and accessibility since it can be used to monitor and control other devices in the vehicle. Using appropriate theories of electronics and Communication, the system was successfully designed, simulated on a computer software and tested. Having met all the design criteria, the system was finally constructed and was found to function satisfactorily.

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